National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: January 14, 1991

In reply to refer to: M-90-85 through -99

Admiral J. William Kime
Commandant
U.S. Coast Guard
Washington, D.C. 20593-0001

On June 29, 1989, the U.S. self-elevating uninspected liftboat M/V TITAN finished its work at Corpus Christi Oil and Gas Block 427 where it had been elevated in about 95 feet of water. The TITAN had a crew of four, plus five Laredo Construction, Inc., employees aboard. About 1330 the master lowered the liftboat and headed it toward Freeport, Texas. While the 160-foot legs were being raised, the TITAN began listing to starboard. The master believed the list was caused by mud on the starboard leg pad. However, the master found on inspection that the starboard leg was flooded and gushing water on deck through a fracture or fractures in the leg. The master directed the legs to be lowered to improve the stability of the vessel. While the legs were being lowered the TITAN capsized about 1345.[1]

Six survivors on the TITAN were rescued by the U.S. Coast Guard. Divers who searched the flooded vessel recovered one body from the galley, but two Laredo employees remain missing. The TITAN was valued at $2,200,000. The TITAN was salvaged and delivered to Freeport, Texas, on September 5, 1989.

The Coast Guard report, "Development of Standards for Liftboats,"[2] states:

> A recent survey of casualty figures . . . indicated that for a 3-year period, 5.6 percent of the liftboat fleet of approximately 250 vessels was involved in sinking or capsizing casualties. Major causes of these casualties were found to be operator error, inadequate stability, or leg failure. This survey indicated that the casualty rate for liftboats is eleven times greater than the casualty rate for the traditional offshore supply vessels.

---

[1] For more detailed information, read Marine Accident Report--Capsizing and Sinking of the Self-elevating Liftboat M/V TITAN, Gulf of Mexico, June 29, 1989" (NTSB/MAR-90/07).

[2] Interim Report for Select Project 9644, Development Standards for Liftboats, [by S.J. Allen and R.D. Sedat] (Groton, Connecticut: U.S. Coast Guard Research and Development Center, February 1989).

5175A

The master realized that the starboard leg was flooded only after the leg had been almost fully raised and water began gushing on deck from the leg crack located at the top of the jacking tower. The TITAN had a history of leg cracks that caused leg flooding, and leg repairs had been made at least twice before this accident.

Action could be taken by a liftboat master to locate the entrance of water and possibly affect repairs. Offshore workers employed aboard liftboats usually include workers capable of making underwater repairs; if not, workers capable of this might be transported to the vessel while it is positioned offshore. If effective repairs could not be made while on station, a master may be able to raise the legs more slowly or in steps so the water could be gradually drained while the legs are being raised. Although this procedure may be time consuming, the instability caused by the water in the flooded leg could be eliminated or minimized. Also, the master could have holes cut in the legs so the water could be drained from them before they are fully raised. The Safety Board recognizes the difficulty presented in eliminating the water from a flooded leg and believes that attention needs to be given to a practical solution for removing the water from liftboat legs that are designed to be watertight.

The TITAN operating manual contained considerable information about vessel stability and operations. However, it did not address actions that could be taken to maintain stability if legs flooded nor the effects that sea water on deck and wave-induced motions would have on stability. Had the TITAN operating manual contained a precaution to inspect for leg flooding and instructions for corrective action to be taken by the master, he may have been able to prevent the capsizing.

Moreover, a liftboat operating manual should include clear and concise instructions for masters about loading and stability, as well as general vessel operation. However, it can benefit only if written in clear, concise language and if the reader has the necessary training to properly apply the information presented. Had the TITAN master received formal training on liftboat stability, he may have been more inclined to use the load condition summary sheet forms, contained in the operating manual, for calculating stability. The Safety Board believes that liftboat owners should be required to provide their masters with operating manuals that include instructions in clear, concise language that is understandable to liftboat masters. The Safety Board further believes that the Coast Guard should develop an outline of the contents to be included in the operating manual that will be a guide for liftboat owners to ensure that their manual adequately covers safe liftboat operations.

Postaccident examination of the leg fractures by the Safety Board revealed that the starboard leg crack began at a weld repair in the forward rack gear. The development of the leg crack at the forward rack gear was most likely caused by leg overstress forces from the rolling and pitching of the liftboat with the leg fully raised. The direction of bending necessary to generate the crack indicated that the top of the leg had been bent aft and slightly inboard. Extensive corrosion of the fractured surfaces and the restrictions imposed on cutting and cleaning the leg precluded a thorough inspection of the rack gear and leg fractures to determine the initiating features of the fracture.

The failure of the leg at the Todd shipyard repair suggests that either the previous repairs did not correct the original problem or the repair introduced additional defects. The Safety Board concludes that the initial cracking and the recurring need for repairs indicates a deficiency in the design of the TITAN's legs. The Safety Board notes that about 30 percent of liftboat accidents are due to failure of legs or leg systems and urges the Coast Guard to issue final rules, as soon as possible, that include both inspection and structural standards.

TITAN had a maximum deck cargo capacity of 150 short tons (1 short ton = 2,000 pounds), but it was carrying only about 20 short tons of construction equipment, evenly distributed and secured in position on the main deck, when the vessel departed the offshore platform. According to the relief master, the two crane booms had been lowered and their ends seated in their cradles, and other deck gear had been secured before the vessel was lowered into the water. No evidence emerged that deck gear or equipment on the main deck initially caused the instability of the TITAN. However, when these items became loose and shifted to the starboard side during the capsizing, their shifting accelerated the capsizing. The Safety Board concludes that no excessive or imbalanced cargo was on deck before the TITAN capsized; nevertheless, if the equipment on deck had been better secured, it may not have broken loose and shifted when the vessel's list increased to starboard.

The practice of securing equipment on deck by tackwelding can create undesirable stresses and possible fracturing of deck plating, as well as fire and explosion hazards because flammable liquids may be stored in tanks below deck. Furthermore, this practice is unsuitable when the possible need to rapidly redistribute deck loads because of accidental tank flooding or some other casualty occurs. Therefore, the Safety Board believes that liftboats should have sufficient securing devices installed about the main deck making tackwelding to secure equipment unnecessary.

The Safety Board notes that Navigation and Vessel Inspection Circular (NVIC) No. 5-86 recommends that "exposure suits should be stored in a very accessible, dry place, such as the wheel house." However, NVIC No. 5-86 does not make recommendations about the stowage of life preservers except that they be "readily accessible." The TITAN capsized in 30 to 35 seconds. The survivors' inability to get life preservers during this accident again illustrates the hazards of stowing these in sleeping accommodations and crew quarters. The Safety Board believes that simply stating that life preservers should be "readily accessible" is too vague to provide adequate guidance for their proper stowage for use in emergencies on various types of vessels. The Safety Board recognizes a preference by mariners to have their own life preservers at bunks or in lockers; however, the Safety Board continues to favor the stowage of additional life preservers outside of passenger and crew berthing rooms and closer to emergency stations.

The capsizing of the TITAN was so rapid that a radio distress message could not be sent. Since the TITAN was outside the safety fairways used by large transiting vessels, it appears unlikely that any of these vessels would have detected the accident. Therefore, it was fortuitous that the passing fishing vessels CAPTAIN GABRIEL and the ALYSIA RENEE sighted the capsized liftboat about 1930. Shortly thereafter, the CAPTAIN GABRIEL master notified the Coast Guard of the capsizing over radiotelephone channel 16. The Coast Guard then diverted a Coast Guard boat in the area and dispatched a helicopter to render assistance. The action taken by the Coast Guard in performing its search and rescue mission was timely after the distress notification was received from the fishing vessels. The Safety Board concludes that the delay in the rescue after the capsizing is attributable to the survivors' lack of means to signal their distress.

The Coast Guard regulations did not require that the TITAN be equipped with an Emergency Position Indicating Radio Beacon (EPIRB). The Coast Guard required only that at inspection the TITAN's owner show evidence of an attempt to obtain an EPIRB. However, the Notice of Proposed Rulemaking "Offshore Vessels Including Liftboats" (CGD 82-004 and CGD 86-074) specifies that when liftboats are inspected EPIRBs will be required. Had the TITAN been equipped with an EPIRB that activated after the vessel capsized, the search and rescue effort could have been initiated 5 to 6 hours earlier.

Three lifefloats were stowed flat on top of each other in a float-free rack on the starboard side of the third deck. However, the lifefloats failed to deploy during the capsizing. The vertical stanchions prevented the lifefloats from shifting horizontally and should have allowed them to float upward. But, since the lifefloats were stacked and stowed close to the pilothouse's exterior sidewall, they may have jammed against the stanchions and the sidewall when the rising sea water floated them as the TITAN capsized to starboard. Thus, the liftboat float-free stowage rack appears not to have functioned as expected because of its arrangement and location on the starboard side of the pilothouse. Had the TITAN not capsized so rapidly, the stacked lifefloats may have floated free. As the lifefloats did not float free, they were inaccessible to the survivors.

The Safety Board has expressed its opposition to the use of lifefloats as primary lifesaving devices and has recommended liferafts. Lifefloats do not provide out-of-the-water flotation to survivors. Lifeboats, liferafts, and inflatable buoyant apparatus provide more than just hypothermic protection to survivors. They also:

1. provide protection from marine predators;
2. provide support for unconscious or injured survivors;
3. do not require survivors to exert themselves to maintain themselves above the water;
4. provide better visibility for search and rescue;
5. provide a platform that permits the use of survival equipment, such as signaling and electronic homing devices; and
6. provide protection for the survivors from the inadvertent ingestion of sea water.

The Safety Board further believes that lifefloats should be phased out.

The TITAN did not have an adequate number of exit doors on the second deck level for rapid evacuation during the capsizing. Although an exit door was on the starboard side of the passageway to the accommodations on second deck level, none was on the port side. When the TITAN listed to starboard, the equipment on deck and the furniture and other items inside began to slide to starboard. The rigger-in-charge went from the TV room into the passageway and slid to the starboard door, but the sea water entering through this door prevented his exit. He was washed in waist deep water up the stairs to the main deck, entered the galley, and broke a window above the sink; however, he could not exit through that window because of the metal plate covering it outside, so he shouted for help. The master heard him, unbolted the metal cover, and helped him through the window. The window exits on the first deck level were intentionally covered by metal plates to prevent window breakage from waves when the vessel was lowered into the water. However, the metal plates that covered the windows could only be removed from the outside and created an obstruction in exiting the vessel. Had the master not been in a position to hear and rescue the rigger, the rigger probably would have remained trapped and become an additional casualty. The Safety Board is concerned that the windows on the main deck level had protective metal covers not removable from inside that obstructed exiting in an emergency. The Safety Board believes that a single starboard door was inadequate for rapid evacuation of persons from the second deck level. The Safety Board believes that had the TITAN been equipped with an additional door on the port side of the second deck level and windows designated for emergency exiting, it is possible that more persons on board may have survived.

The liftboat stability criteria as outlined in NVIC No. 8-81 change 1 are based on the concept that a vessel will probably capsize only when the wind overturning energy exceeds the vessel's righting energy. In addition, these criteria require that the vessel's righting energy exceed the wind overturning energy by at least 40 percent to account for wind gusts and waves. However, since these criteria are for intact conditions, they do not consider the effect of elevated and flooded legs, wave-induced motions, and sea water on deck.

The Safety Board calculations showed that the flooded starboard leg reduced the available righting energy by about 70 percent. Based on the preceding, the Safety Board concludes that the flooded starboard leg significantly reduced the stability of the TITAN. Therefore, the Safety Board believes that the Coast Guard liftboat stability criteria should specify minimum requirements for stability with flooded legs and take into consideration the adverse effect of wave-induced motions and sea water on deck.

The American Bureau of Shipping has published standards that detail the procedures, qualifications, and requirements to be followed during welding of steel vessels. These standards are very similar to those of the "Structural Welding Code - Steel," ANSI/AWS D1.1. of the American Welding Society (AWS). The welding code commentary in Chapter 7, "Strengthening and Repairing of Existing Structures," states:

> 7.2 Materials
>
> The first essential requirement in strengthening and repairing existing structures is the identification of the material.

> Obviously, with welding anticipated for either operation [strengthening or repairing], weldability of the existing steel is of primary importance. Together with the mechanical properties of the material, it will provide information essential for establishment of safe and sound welding procedures.

The AWS code qualifies procedures for the shielded metal arc welding of the rack gear material, ASTM A-514[3] grade 100, and specifies AWS E10018 filler rod with 100,000 psi as-welded yield strength should be used to achieve acceptable weld strength. Testimony revealed that E8018 filler rod having 80,000 psi typical as-welded yield strength was used during the Todd shipyard repairs.

The work order documentation supplied by McDermott included a Welding Procedure and the Procedure Qualification Record for flux core arc welding of AWS Group III[4] materials. Although the TITAN leg material (API 5L-X67) was not specifically listed, it had the characteristics of Group III material. However, the documentation does not establish whether the TITAN repairs done by McDermott in June 1988 were performed to these specifications. The documented procedures would meet the requirements of the AWS Structural Welding Code for weld repairs on the leg wall if the leg material were Group III.

The documented procedures, however, would not be suitable for welding the rack gear that was of different material. Welding of hardened steels, such as the rack material (ASTM A514), requires careful control of all steps of the welding process including joint design, preheat, postheat, interpass temperature, and selection of the proper filler metal (welding rod). In general, the choice of welding rod is determined by the yield strength of the material being welded. Higher yield strength materials, such as A514, require welding rods of equal or greater as-welded yield strength, such as E10018. Comparatively lower strength material, such as API 5L-X67, require lower strength welding rods, such as E8018. Welding without close control of these welding variables can result in brittleness, rehardened zones, softness, low-strength areas, and other detrimental effects.

In October 1988 Todd Shipyard made additional weld repairs to the starboard leg. These repairs appear to be those found at the forward rack. The repairs were specifically made to existing cracks in both the rack and the leg wall. This involved cutting an access window in the lower leg portion, gouging the fractures from inside and outside, applying an internal doubler plate, and filling the fracture with weld (E8018). The repair welds were then ultrasonically inspected for defects. However, the job order did not state any specific requirements or standards for quality, welding

---

[3]American Society for Testing and Materials standard specification for high-yield strength, quenched, and tempered hardenable alloy steel suitable for welding.

[4]AWS Group III are generally higher strength steels that require care during welding to prevent weld related deficiencies.

procedures, or workmanship, only that the work be done to the owner's satisfaction.

The Laredo employees on board were, according to the Coastal Marine Lift Barges, Inc., owner, to receive a safety briefing before leaving port for an offshore assignment; however, the Laredo survivors stated that they received no briefing before departure or while on board. The Laredo president stated that company policy was for employees to wear lifevests and stand on the pilothouse deck level when the liftboat raised or lowered. However, this procedure was not followed when the TITAN was lowered into the water for the trip to Freeport. It is critical that when offshore workers first board they receive a briefing about the vessel's safety features, including actions that should be taken in an emergency. The Safety Board believes that before departing on assignment liftboat masters should be required to give briefings to all on-board persons about the vessel's safety features and appropriate actions to be taken in an emergency, that emergency drills should be held regularly and recorded in the logbook, and that liftboat owners should monitor regularly the safety procedures conducted aboard their vessels.

Additionally, the Safety Board believes that a need exists for all masters to understand stability and be able to make stability calculations with an adequate comprehension of the data that is derived. Both the master and the relief master on the TITAN had attended a marine training school for their license preparation. However, the master stated that he had learned little about stability during the preparation for his 500-ton license. The license preparation courses completed by the relief master did not include vessel stability. The Safety Board believes that Coast Guard license examinations given to liftboat masters should include questions that address the effects of flooded legs on vessel stability and the precautions to be taken before jacking (raising or lowering) operations begin.

Therefore, the National Transportation Safety Board recommends that the U.S. Coast Guard:

> In conjunction with operators of liftboats, conduct a study to explore means of monitoring watertight legs on liftboats to determine when and the extent to which flooding occurs, as well as the means of dewatering flooded legs and publish the results of the study to the operators of liftboats. (Class II, Priority Action) (M-90-85)
>
> Require that liftboat operating manuals contain instructions to liftboat masters to inspect watertight legs for flooding before jacking down, precautionary information about the detrimental effects on vessel stability because of flooded legs, and what to do if leg flooding is known or suspected to have occurred. (Class II, Priority Action) (M-90-86)
>
> Expedite the publication of final rules which include inspection and structural standards for new and existing liftboats. (Class II, Priority Action) (M-90-87)

Publish a standard outline of liftboat operating manual contents to provide guidance and to insure that critical information, as prepared by naval architects and liftboat owners, is adequately addressed in language readily understood by liftboat masters. (Class II, Priority Action) (M-90-88)

Require that liftboats be fitted with adequate cargo and equipment securing devices on the main deck so that tackwelding of equipment is not needed. (Class II, Priority Action) (M-90-89)

Require that an adequate number of life preservers on liftboats be stowed near exterior exits or the designated emergency muster station(s) for ready accessibility in an emergency by crewmembers and others on board, in addition to the life preservers stowed in the living quarters. (Class II, Priority Action) (M-90-90)

Require that all liftboats operating offshore be equipped with an approved float-free, automatic emergency position indicating radio beacon. (Class II, Priority Action) (M-90-91)

Require that liftboats be equipped with primary lifesaving equipment that protects persons from water immersion. (Class II, Priority Action) (M-90-92)

Require that an adequate number of exterior doors be installed on all accommodation deck levels of liftboats for the rapid exit of persons in an emergency. (Class II, Priority Action) (M-90-93)

Require that a sufficient number of windows on liftboats be designed, installed, and appropriately marked for use as exits in an emergency and that protective window covers be designed so that they do not prevent windows from being opened from inside the vessel. (Class II, Priority Action) (M-90-94)

Require that liftboat stability criteria allow for the adverse effects of raised flooded legs, wave-induced motions, and sea water on deck. (Class II, Priority Action) (M-90-95)

Specify standards for procedures and workmanship for weld and structural repairs on liftboat legs that conform to industry standards such as the American Welding Society "Structural Welding Code - Steel." (Class II, Priority Action) (M-90-96)

Require that before departing on assignment liftboat masters give briefings about the vessel's safety features and appropriate actions to be taken in an emergency to on-board persons and persons boarding later offshore be similarly briefed. Such briefings should be required to be logged by the master. (Class II, Priority Action) (M-90-97)

Require liftboat owners to monitor regularly the safety procedures conducted on board their vessels to ensure that on-board persons are briefed about the vessel's safety features, emergency drills are held regularly, and briefings and drills are logged by the master. (Class II, Priority Action) (M-90-98)

Include in Coast Guard license examinations given to liftboat masters questions that address the effects of flooded legs on vessel stability and the precautions that should be taken before jacking operations begin. (Class II, Priority Action) (M-90-99)

Also, the Safety Board issued Safety Recommendations M-90-100 through -103 to the Coastal Marine Lift Barges, Inc.; M-90-104 to the Laredo Construction Inc,; and M-90-105 through -109 to the Offshore Marine Services Association.

KOLSTAD, Chairman, COUGHLIN, Vice Chairman, and BURNETT, LAUBER, and HART, Members, concurred in these recommendations.

James L. Kolstad

By: James L. Kolstad
Chairman