



## National Transportation Safety Board

Washington, D. C. 20594

### Safety Recommendation

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Date: June 26, 1992

In Reply Refer To: M-92-40 through -47

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

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About 2350 on August 15, 1990, the 843-foot Hong Kong-registered motor tank ship MANDAN experienced a steering malfunction. Shortly thereafter, it rammed a U.S. Army Corps of Engineers' barge flotilla positioned at mile 10.5 Above Head of Passes near Venice, Louisiana, on the right descending bank of the lower Mississippi River. All personnel aboard the 13 barges were successfully evacuated. Quarters barge 4302 then capsized and sank. Crewmembers on the barges sustained minor to moderate injuries; no fatalities occurred. The MANDAN had minor damage; its crewmembers were uninjured.<sup>1</sup>

At the time of the accident, both main steering gear pumps were operating on the MANDAN, but not in unison. The Safety Board concludes that one or more pieces of the fractured circ clip ears lodged between the main hydraulic valve spool and its housing, thereby seizing the valve spool in the starboard rudder order position. As long as the starboard main steering gear pump was operating with its main hydraulic valve seized, the steering gear pump continued to supply pressurized hydraulic fluid to the steering gear vane engine for starboard rudder movement only. When a port rudder command was transmitted from the helm steering stand, only the port steering gear pump responded. Only the port steering gear pump supplied pressurized hydraulic fluid for port rudder movement; however, the rudder continued to move to starboard. With the discharges of the port and the starboard pump opposing each other, the pumps would reach their maximum discharge pressures. Therefore, the Safety Board concludes that the discharge pressure differential between the port steering gear pump and the starboard steering gear pump allowed the starboard pump, with its discharge pressure significantly higher

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<sup>1</sup>For more detailed information, read Marine Accident Report--"Collision of the Hong Kong-Registered Motor Tank Ship MANDAN with the U.S. Army Corps of Engineers' Barge Flotilla at Mile 10.5 Above Head of Passes in the Lower Mississippi River near Venice, Louisiana, on August 15, 1990" (NTSB/MAR-92/04)

than the port pump and its main hydraulic valve seized in the starboard rudder order position, to overpower the port pump and force the rudder in the starboard direction. If each pump had been equipped with a valved pressure gauge, the crew could have periodically checked pump discharge pressures and would likely have been alerted to the improper performance of the port pump. The Safety Board believes that both U.S. and foreign flag vessels should be required to have pressure gauges to indicate the accurate operating pressure at the discharge of each steering gear pump.

If at the time of the accident the discharge pressure of the port steering gear pump had been equal to the discharge pressure of the starboard steering gear pump, the rudder would have been hydraulically held in place, as long as the operator applied a port rudder command at the helm steering stand. Any action to apply starboard rudder from the helm steering stand would have moved the rudder to starboard, with the combined discharge pressures of both pumps acting on the vane engine and the rudder.

Because no alarm that could detect the steering malfunction was required, the problem within the steering gear could not have been evident to the MANDAN crew unless the gear had been disassembled. The routine maintenance of the steering gear system did not, nor should it, require disassembly of the hydro-block and, thus, would not have disclosed the weakening of or break in a circ clip in the starboard pump, even if the circ clip had broken some time before it jammed the mechanism. Therefore, the Safety Board believes that foreign flag vessels, operating on U.S. waters and fitted with a steering gear where multiple power unit operation is needed to meet the 28 seconds rudder movement standard, should be fitted with sensors that activate audible and visual alarms in the wheelhouse, the engineroom, and the steering gear room, identifying any power unit that does not respond to a rudder command from the wheelhouse controls. However, if the U.S. requirement for simultaneous power unit operation is rescinded, this requirement need not apply to U.S. and foreign flag vessels, operating on U.S. waters and fitted with multiple independent steering gear power units each of which is capable of meeting the 28 seconds rudder movement standard.

During the Safety Board's investigative examination, investigators operationally tested the port steering gear pump and found the discharge pressure to be 529 psi, well below the design operational discharge pressure of 845 psi. After the removal of the port steering gear pump internals, the investigators found the heavily worn main bearing, which allowed the recirculation of hydraulic fluid from the discharge side back to the suction side of the port steering gear pump. Investigators could not determine how long the bearing had been worn and the discharge pressure had been reduced. The Safety Board concludes that the recirculation of the hydraulic fluid discharge resulted in the severely decreased discharge pressure from the port steering gear pump but did not cause the steering malfunction. However, it was the reason the combined units in operation did not comply with the time (performance) standard to move the rudder from 35 degrees on one side to 30 degrees on the other side. If the predeparture and prearrival steering tests had included measurements of the time to swing the rudder by each steering gear pump operating alone, the significantly longer time required by the port pump would have called attention to its malfunction. Therefore, the Safety Board believes that the predeparture steering gear tests should include the timing of the rudder movement from 35 degrees on one side to 30 degrees on the other, while operating each steering gear pump individually.

The MANDAN met the requirements of the Safety of Life At Sea (SOLAS) '74, as amended, steering gear regulations in Chapter II-1, Part C - Machinery Installations, Regulations 29 and 30 and in Chapter V, Safety of Navigation, Regulations 19-1 and -2. Nevertheless, a malfunction in the steering gear left the vessel without rudder control. The crew had no indication of the nature or location of the malfunction.

The MANDAN experienced the malfunction in a hydraulic power actuating system while operating both steering gear motor/pump sets (power units) simultaneously; this simultaneous operation is required by the U.S. and international steering gear operational standards. The MANDAN was fitted with a main steering gear that had two identical sets of power actuating systems. However, the failure in one power actuating system did render the other one ineffective, if not inoperative.

In SOLAS '74, as amended, Regulation 29, the passenger vessel steering gear performance standard requires the main steering gear to be capable of moving the rudder from 35 degrees on either side to 30 degrees on the other side in not more than 28 seconds, while operating with any one of the power units out of operation. On a passenger vessel with dual steering power units, this provides full redundancy, full rudder performance with either pump operating alone. Regulation 29 also permits that in a cargo ship, the main steering gear be capable of moving the rudder from 35 degrees on either side to 30 degrees on the other side in not more than 28 seconds, while operating with all power units. This regulation further stipulates that in every tank ship 10,000 gross tons and more, two or more identical power units be installed and all power units, acting simultaneously in normal operation, can be used to meet the rudder performance standard of 28 seconds. Thus, a passenger ship has greater reliability in the use of the steering machinery without degrading steering performance, and wear on the steering power units is reduced.

The SOLAS '74, as amended, regulation that permits tank ships and other cargo vessels to meet the steering gear performance standard by simultaneous operation of all installed pumps creates a hazardous operating condition. If one pump fails, the vessel loses its required maneuverability by not being able to meet the performance standard with the other pump(s) operating alone. The Safety Board believes that all ships should be provided with multiple power units each of which operating alone can meet the performance standard.

Title 33 Code of Federal Regulations (CFR) Subpart 164.11(t) - Navigation Underway - parallels SOLAS '74, as amended, Chapter V, Safety of Navigation, Regulation 19-1. Subpart 164.11(t) requires that the person in charge of each vessel (foreign or domestic) underway in the navigable waters of the United States ensure that at least two of the steering gear power units on the vessel are in operation when such units are capable of simultaneous operation; Regulation 19-1 requires that in areas (coastal waters, rivers, or harbors) where navigation demands special caution, ships have more than one steering gear power unit in operation when such units are capable of simultaneous operation.

From accident investigation data of this and other steering gear failures, the Safety Board has found that a failure in a power actuating system during the simultaneous operation of both main steering gear power units can nullify the safety benefits that component redundancy, such as duplicate power units, supposedly provides to a steering system. The Safety Board has determined that the nature of the steering malfunction that occurred in this and other accidents is common and not associated with a specific manufacturer or steering gear design. When a malfunction, such as a seized actuating valve, occurs during the

simultaneous operation of steering gear pumps, the effectiveness of both pumps is diminished or negated, and rudder control is lost. The navigation watch on the bridge is faced with a series of time-consuming, trial-and-error procedures, which require switching between duplicated control modes, control systems, and pumps, to bypass the malfunction once it is identified and regain rudder control. However, if the steering gear is operated with one pump running and the other pump on standby, then the occurrence of a steering gear malfunction only requires that the navigation watch switch to the standby pump to regain rudder control.

However, both U.S. and international steering operational standards require, in areas where navigation demands special caution, the simultaneous operation of steering gear pumps when such units are capable of simultaneous operation. These operational requirements are diametrically opposed to the findings of the April 1988 Coast Guard study that concluded "no apparent advantage is gained...by operating two pumps simultaneously." As illustrated above, the simultaneous operation of motor/pump sets and their power actuating systems creates a condition that reduces the reliability of the steering gear. For this reason, the Safety Board believes that vessels of all flags should be fitted with a steering gear where each motor/pump set operating alone meets the 28 second performance standard and that rudder control should be effected with one pump operating and the other pump(s) on standby.

Title 33 CFR Subpart 164.39(h)(2) - Steering Gear Tankers - states that the U.S. steering gear operational standard is 28 seconds maximum time allowance to move the rudder from 35 degrees on one side to 30 degrees on the other side, with either pump operating alone. This standard is the same for both U.S. passenger and cargo ships (including tankers).

On September 28, 1990, the Coast Guard published its Notice of Proposed Rulemaking (CGD 83-043) to amend 33 CFR Subpart 164.39(h)(2) to conform to SOLAS '74, as amended, Chapter II-1, Regulation 29, for rudder movement from 35 degrees on one side to 30 degrees on the other side, while operating all steering gear power units simultaneously. This amendment to change the U.S. requirement of two steering gear power units (each of which is required to meet the performance standard) to two or more steering gear power units (all of which, operating simultaneously, are permitted to meet the performance standard) would reduce the level of safety for U.S. vessels. The Safety Board believes that the Coast Guard effort to conform the U.S. steering gear performance standards requirements with the international requirements would in effect reduce the reliability of the steering gear systems and counteract the built-in safety level provided by equipment redundancy. Therefore, the Safety Board urges the Coast Guard not to amend the U.S. steering gear performance standard, but to request the International Maritime Organization to amend the SOLAS '74 steering performance standard to conform with the U.S. requirement.

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

Amend 33 Code of Federal Regulations, Subpart 164.11(t), Navigation Underway, by rescinding the requirement for U.S. flag vessels operating in U.S. waters to simultaneously operate their main steering gear power units. (Class II, Priority Action) (M-92-40)

Amend 33 Code of Federal Regulations Part 164.25 to require that predeparture and prearrival steering gear tests include the timing of the rudder movement from 35 degrees on one side to 30 degrees on the other, while operating each steering gear pump individually. (Class II, Priority Action) (M-92-41)

Require the installation of a valved pressure gauge to indicate the operating pressure at the discharge of each hydraulic steering gear pump on all U.S. self-propelled vessels of 1,600 gross tons and over. (Class II, Priority Action) (M-92-42)

Propose to the International Maritime Organization that it amend Safety Of Life At Sea '74 to require that cargo and tank ships meet the 28 second rudder performance steering standard by each steering power unit as required by Chapter II-1, Machinery Installations, Regulation 29/6.1.1. (Class II, Priority Action) (M-92-43)

Propose to the International Maritime Organization that it rescind, for those vessels having steering gear power units where each unit meets the 28 second rudder performance standard, Regulation 19-1, that requires the simultaneous operation of all main steering gear pumps where navigation demands special caution. (Class II, Priority Action) (M-92-44)

Propose to the International Maritime Organization that it amend Safety of Life At Sea '74, Chapter V, Regulation 19-2, to require that predeparture steering gear tests include the timing of the rudder movement from 35 degrees on one side to 30 degrees on the other, while operating each steering gear pump individually. (Class II, Priority Action) (M-92-45)

Propose to the International Maritime Organization that it require the installation of a valved pressure gauge to indicate the operating pressure at the hydraulic discharge of each steering gear pump on all self-propelled vessels of 10,000 gross tons and over. (Class II, Priority Action) (M-92-46)

Propose to the International Maritime Organization that it require the installation of a sensor that activates audible and visual alarms in the wheelhouse, the engineroom, and the steering gear room, identifying any power unit which does not respond to a rudder command from the wheelhouse controls, on all self-propelled vessels of 10,000 gross tons and over. (Class II, Priority Action) (M-92-47)

Also, the Safety Board issued Safety Recommendations M-92-38 and -39 to the International Association of Classification Societies and M-92-48 through -53 to the U.S. Army Corps of Engineers.

COUGHLIN, Acting Chairman, and LAUBER, KOLSTAD, HART, and HAMMERSCHMIDT, Members, concurred in these recommendations.

  
By: Susan M. Coughlin  
Acting Chairman