Allision of the Passenger Vessel *Seastreak Wall Street* with Pier 11, Lower Manhattan, New York, New York January 9, 2013

Marine Accident Report

NTSB/MAR-14/01
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National Transportation Safety Board

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National
Transportation
Safety Board

490 L'Enfant Plaza, SW
Washington, DC 20594

National Transportation Safety Board. 2014. Allision of the Passenger Vessel *Seastreak Wall Street* with Pier 11, Lower Manhattan, New York, New York, January 9, 2013. Marine Accident Report NTSB/MAR-14/01. Washington, DC.

Abstract: This report discusses the allision of the high-speed passenger ferry *Seastreak Wall Street* with Pier 11/Wall Street in lower Manhattan, New York City, on January 9, 2013. Four passengers were seriously injured, and 75 passengers and 1 deckhand sustained minor injuries. The estimated cost to repair the ferry was about $166,200. The total cost of repairs to the pier was $333,349.

Safety issues identified in this report include oversight of vessel operations, control panel design, management of passenger access to stairwells to mitigate possible injuries, the importance of marine safety management systems, and the need for information captured by voyage data recorders in investigating and analyzing accident causes and identifying remedial actions to help prevent their recurrence.

The National Transportation Safety Board (NTSB) issues new recommendations to the United States Coast Guard regarding human factors standards for critical vessel controls, the need for operator control of ferry passenger access to stairwells, and the carriage of marine voyage data recorders. The NTSB also recommends that the owner of the *Seastreak Wall Street* improve specific control system displays and alerts, complete development and implementation of a safety management system, and revise its vessel operations and training manuals. The NTSB asks the manufacturer of the vessel's propulsion control system to improve its design and alert its customers to the changes. The report also reclassifies previous recommendations to the Coast Guard regarding safety management systems and voyage data recorders.

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Contents

Figures

Acronyms and Abbreviations

AIS	automatic identification system
CCTV	closed-circuit television
CFR	*Code of Federal Regulations*
COI	certificate of inspection
CPP	controllable pitch propeller
ECS	electronic chart system
EMS	emergency medical services
FDNY	Fire Department of the City of New York
GMATS	Global Maritime and Transportation School
IMO	International Maritime Organization
ISM Code	International Safety Management Code
ITC	International Convention on Tonnage Measurement of Ships
kW	kilowatt
LED	light emitting diode
MSC	Marine Safety Center (Coast Guard)
NOAA	National Oceanic and Atmospheric Administration
NTSB	National Transportation Safety Board
NVIC	Navigation and Vessel Inspection Circular (US Coast Guard)
NWS	National Weather Service
NYC DOT	New York City Department of Transportation
OCMI	officer in charge, marine inspection
SMS	safety management system
SOLAS	International Convention for the Safety of Life at Sea
S-VDR	simplified voyage data recorder
U.S.C.	*United States Code*
VDR	voyage data recorder

Executive Summary

The *Seastreak Wall Street*, a high-speed passenger ferry serving commuters traveling between New Jersey and New York City, struck a Manhattan pier at about 12 knots on the morning of January 9, 2013. Of the 331 people on board, 79 passengers and 1 crewmember were injured, 4 of them seriously, in the third significant ferry accident to occur in the New York Harbor area in the last 10 years.

During the captain's approach for docking, he intended to reduce speed and transfer control from one bridge station to another less than a minute before reaching Pier 11/Wall Street on the East River. Seastreak captains routinely used this procedure and changed stations for better visibility. In this instance, however, the maneuver proved unsuccessful, and the captain was unable to remain in control of the ferry before impact.

National Transportation Safety Board (NTSB) investigators identified the following safety issues pertinent to this accident:

- The captain's control of the vessel as it approached the pier;
- Procedures, guidance, crew training, and managerial oversight provided by Seastreak LLC, the managing owner and operator of the *Seastreak Wall Street* and similar ferries;
- Control of passenger access to stairways;
- Control panel design;
- Development and implementation of an effective safety management system (SMS); and
- The value of information captured by a voyage data recorder (VDR) in accident investigation.

Captain's control of the vessel. The captain's landing approach involved slowing the *Seastreak Wall Street* and transferring propulsion control from the center bridge control station to the starboard station. However, the vessel did not respond as the captain expected, and he could not determine why he was unable to maintain vessel control in the seconds before the vessel struck the dock. The captain also did not allow enough time to react to the loss of vessel control while approaching the pier.

Company procedures and managerial oversight. The NTSB investigation found Seastreak's management and oversight of vessel operations could have lessened the likelihood of this accident. More effective company policies and procedures would have included documentation of the ferry's recently retrofitted propulsion system, broader crew training, and risk mitigation and safety enhancement practices.

When the accident occurred, the *Seastreak Wall Street* operations manual had not been updated since the ferry was converted in July 2012 from waterjet to controllable pitch propeller (CPP) propulsion. Further, the transfer of control from one bridge station to another was a critical point in the vessel's approach, but no formal company guidance was available for

executing this procedure. The captain also could have benefited from the mate's assistance, but company policies did not adequately define crewmember roles.

Additional areas of vessel management that were absent from the operations manual and company oversight were passenger control policies, formal training for crewmembers in vessel operations, vessel incident assessment, identification of possible risks and corrective action, and application of a safety management system (discussed below).

Severity of passenger injuries. NTSB examination of the evidence revealed that the passenger requiring the most extensive medical treatment had fallen down a stairwell, sustaining severe head injuries. Seastreak ferry crewmembers were not directed to control passenger access to stairwells, even when approaching a landing, nor were they required to make a passenger safety announcement upon arrival.

Control panel design and mode indication. Identical sets of control panel pushbuttons were located on either side of the order levers, one set of buttons for each propeller, port and starboard. A small red light in the upper left corner of each button would light when the button was active. In addition to using the order levers to change main propulsion engine rpm, the operator could use these pushbuttons to control vessel actions such as changing propeller pitch. When illuminated, lights on each button also identified, for instance, whether that control station was active and which operating mode was engaged. However, the available visual and audible cues to indicate mode and control transfer status were ambiguous.

Safety management systems. A US vessel in domestic service is not required to develop and implement an SMS, and the *Seastreak Wall Street* operated without the guidance of such a system. Operators can, however, voluntarily meet well-established international SMS standards that are required for many ships, including provisions for safe vessel operation, emergency procedures, and internal audits and management reviews.

Several NTSB marine accident investigations highlighted the need for specific safety-related vessel operational procedures. These included two previous accidents involving ferries operating in New York Harbor. The NTSB previously issued recommendations in support of safety management systems and remains committed to the establishment of SMS requirements.

Voyage data recorders. Had the *Seastreak Wall Street* been fitted with a VDR, several aspects of the NTSB investigation would have benefited from considerably more evidence. A broader range of data would have provided substantial insight into the operation of the *Seastreak Wall Street* and its performance as it approached the pier. A VDR could have captured the vessel's operating conditions; propulsion commands ordered and system responses; audio recording on the bridge, which could have clarified interactions between officers and any alerts that were activated; the status of the controllable pitch propulsion system; and a precise record of vessel movements, among other information.

The NTSB continues to promote requirements for VDRs to enhance the depth and quality of accident investigation, further the identification of marine safety risks, develop recommendations to address those risks, and enhance the safety of passengers on board ferries and other vessels. Moreover, many operators in other modes of transportation have voluntarily equipped their vehicles with data recorders, demonstrating that these devices can benefit operations.

1 Accident Overview

1.1 Voyage and Allision

The high-speed passenger ferry *Seastreak Wall Street* was under way on its second regular commuter trip of the morning when it struck a pier in lower Manhattan, New York City, on Wednesday, January 9, 2013.[1] Of the 326 passengers on board, 75 sustained minor injuries, and 4 were seriously injured. Among the 5 crewmembers, 1 deckhand reported a minor injury.

The ferry was northbound from Atlantic Highlands, New Jersey, and approaching Manhattan when it allided with Pier 11/Wall Street on the East River at 0841 eastern standard time.[2,3] The *Seastreak Wall Street* is shown in figure 1.

Figure 1. *Seastreak Wall Street*.

[1] According to 46 *United States Code* (USC) 2101, a ferry is a vessel used on a regular schedule to provide transportation only between places not more than 300 miles apart and to transport passengers or vehicles or railroad cars that are being used or have been used in transporting passengers or goods.

[2] The term *allision* refers to a vessel striking a fixed object; in a *collision*, one vessel strikes another.

[3] Unless otherwise noted, all times in this report are eastern standard time (coordinated universal time – 5 hours) and are based on the 24-hour clock.

The captain told investigators that, as the *Seastreak Wall Street* approached the pier, he gradually reduced the vessel's speed and began turning to port to dock at Slip B, starboard side to the pier. He said he discovered he was unable to further slow the vessel before the ferry reached the dock, and he did not have time to warn the passengers or sound the danger signal because the event took place so quickly. The *Seastreak Wall Street*'s speed was about 12 knots when it struck the pier.

After impact, both main propulsion engines continued running for about 68 seconds, consistent with the time the vessel ran aground in shallow water near the pier. The captain said he instructed a crewmember to restart both engines and then maneuvered the vessel to Slip B at Pier 11 about 7 minutes later. Figure 2 depicts the *Seastreak Wall Street*'s route from New Jersey to Manhattan. Figure 3 plots the last 7 minutes of the ferry's voyage.

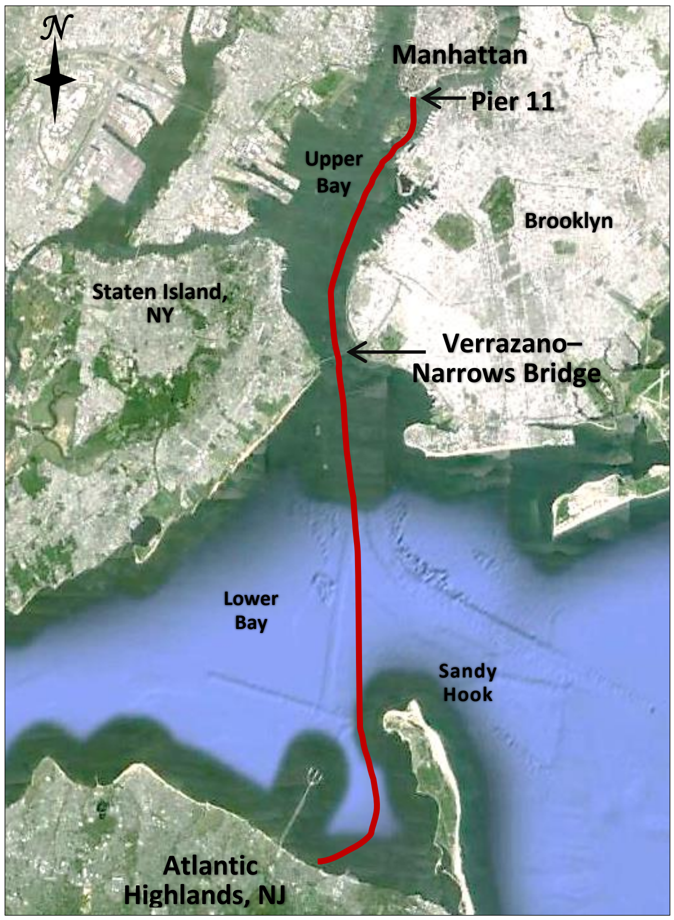

Figure 2. Approximate track of the *Seastreak Wall Street* from Atlantic Highlands to Manhattan is shown in red. (Background by Google Earth)

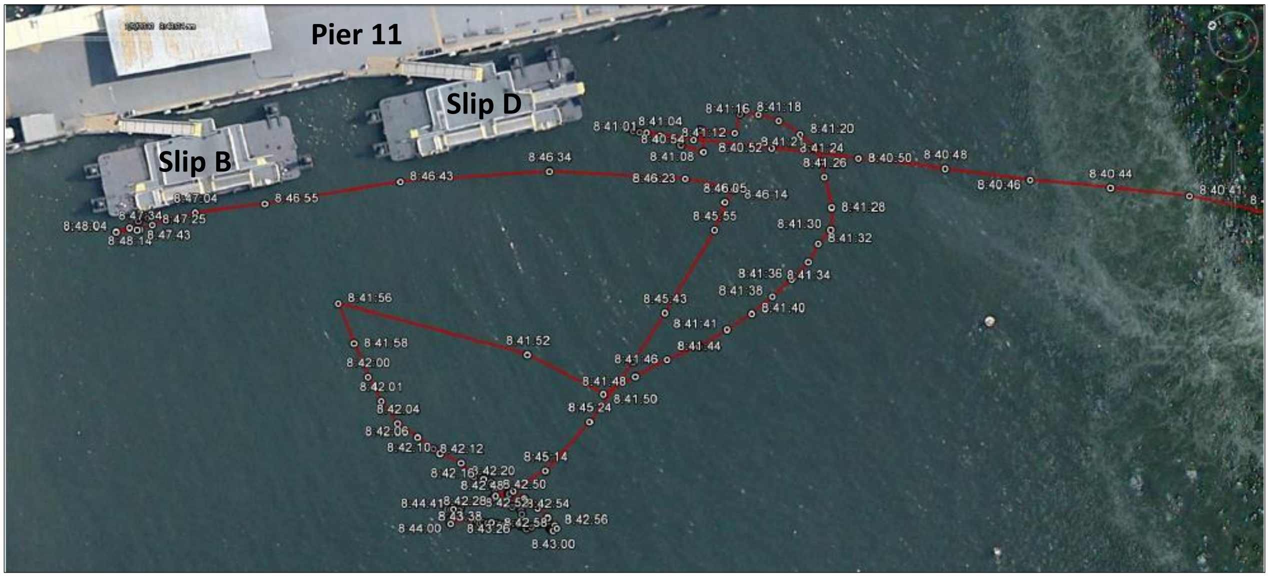

Figure 3. Automatic information system (AIS) data showing the ferry's trackline for the last 7 minutes of the accident voyage, including impact with the pier, grounding in shallow water nearby, and finally docking at another pier. Times are shown at locations where this information is available. (Background by Google Earth)

When the ferry was secured alongside Slip B, first responders already on scene boarded the vessel to assess injuries and begin transporting the injured to area hospitals. The first US Coast Guard unit arrived at the pier at 0930 to facilitate emergency response and begin its investigation.

1.2 Injuries

Injuries sustained in the *Seastreak Wall Street* accident are summarized in figure 4.

Type of Injury[4]	Crew	Passengers	Other	Total
Fatal	0	0	0	0
Serious	0	4	0	4
Minor	1	75	0	76
None	4	247	0	251

Figure 4. Injuries sustained in the *Seastreak Wall Street* allision.

[4] Title 49 *Code of Federal Regulations* (CFR) 830.2 defines a fatal injury as any injury that results in death within 30 days of an accident. It defines serious injury as that which requires hospitalization for more than 48 hours, commencing within 7 days from the date the injury was received; results in a fracture of any bone (except simple fractures of fingers, toes, or nose); causes severe hemorrhages, nerve, muscle, or tendon damage; involves any internal organ; or involves second- or third-degree burns or any burn affecting more than 5 percent of the body surface. The NTSB considers any injury that is not fatal or serious to be minor.

Of the four seriously injured passengers, one required surgery as well as ongoing treatment and rehabilitation following release from the hospital. The other three were treated and released.

One seriously injured passenger fell down a staircase and hit the overhead section of the stairwell structure. His injuries included a broken neck, brain hemorrhage and contusions, lung collapse, facial fractures, lacerations, nerve injuries, and scalp lacerations. The passenger required surgery as well as ongoing treatment and rehabilitation after he was discharge from the hospital more than 5 weeks after the accident.

The other three seriously injured passengers included one who was standing halfway down the starboard outboard stairs and sustained three broken ribs, face laceration, and a knee contusion. Another passenger fell down 10 steps and suffered a head laceration, minor concussion, and neck pain and required shoulder joint cartilage surgery. The third was thrown off balance and fractured a shoulder blade. These three passengers were treated and released from the hospital.

1.3 Damage to Vessel and Pier

1.3.1 *Seastreak Wall Street*

The *Seastreak Wall Street* sustained damage to the bow of its starboard hull and minor damage to the passenger cabin, and its port propeller was fouled with debris. The total estimated cost of repairs was about $166,200.

One interior window at the bottom of a stairwell was broken, broken glass was found in the main deck forward stairwell and at the second deck starboard aft door, and a passenger seat back rest on the main deck was broken. Damage to the vessel hull was principally to the starboard bow and to the cross-member connecting the two hulls. Impact to the starboard hull at the point where it struck the pier resulted in a 30-inch opening beginning about 30 inches above the waterline and extending 45 inches at the lower side and 76 inches at the upper side. In this area, the side shell was crushed and peeled away from the hull, and internal frames were displaced (see figure 5).

Figure 5. Damage to the *Seastreak Wall Street* starboard bow.

After the accident, a diver found the port propeller was fouled with a 4-foot steel bar and a 3-foot length of stranded wire cable of unknown origin (see figure 6). When the vessel was hauled out of the water for hull repairs, both the port and starboard propellers were found to be damaged, and the port propeller cone was missing (see figure 10 in section 1.6.2) for an illustration of a propeller and cone). Damage to the port propeller consisted of gouges and dents at blade tips, with significant deep scratches on the faces of the blades near their leading edges. The starboard propeller was similarly bent and gouged at the tips of all four blades.

Figure 6. Debris found in ferry propeller, a 3-foot length of wire cable and 4-foot steel bar, both about half an inch in diameter.

1.3.2 Pier 11, Slip D2—Dock Barge *Desiree M*

The dock barge *Desiree M* served as Slip D2 of Pier 11. The barge, 108.5 feet long and 35 feet wide, sustained an 8-inch-wide puncture of its hull and deck distortion in the area of the point of impact as well as damage to the fender, sideloader screw jack, platform, and gangway from the barge to the pier. A portion of the damage is shown in figure 7. The total cost of repairs was $333,349.

Figure 7. Damage to the Slip D2 dock barge, gangway, and upright supports.

1.4 Waterway

The New York–New Jersey port district includes 650 miles of navigable waterways along New York City and northeastern New Jersey, encompassing about 240 miles of shipping channels, anchorages, and port facilities. Several public and private commuter ferry operations serve the area.

The East River, where the accident occurred, is a 14-mile-long tidal strait that connects Long Island Sound with New York's Upper Bay and runs between the western end of Long Island and the eastern side of lower Manhattan. The southern end of Manhattan is noted for its strong tidal currents. According to the National Oceanic and Atmospheric Administration (NOAA) predicted tidal currents for the Brooklyn Bridge, which is about 0.3 miles from Pier 11, slack water on the day of the accident was at 0712, and a maximum ebb current at 1007 was 222 degrees true at 4 knots.[5] Water temperature was 43°F. At 0841 at Pier 11, the *Seastreak Wall Street* would have experienced an ebbing current of about 2 knots, which was confirmed by the ferry's captain.

1.5 Weather Conditions

Official meteorological observations closest to the accident location were recorded by automated stations at LaGuardia Airport, about 8.5 miles northeast of the accident site, and Newark Liberty International Airport, about 8 miles west of the accident location.[6] At the time of the allision, the wind was reported calm, and visibility was unrestricted up to 6 miles.

The Coast Guard Sector New York Command Center/Vessel Traffic Service reported clear weather, good visibility at 10 miles or more, northwest winds at 4 knots, and air temperature of 42°F.

1.6 Vessel Information: *Seastreak Wall Street*

1.6.1 Vessel Structure and Design

The *Seastreak Wall Street* was a twin-hulled catamaran classified by the Coast Guard as a domestic high-speed vessel and certificated as a small passenger vessel. Originally constructed with waterjet propulsion, the vessel underwent major refitting from February through July 2012. The four main engines were replaced with two diesel engines, the waterjets were replaced with controllable pitch propellers, and new propulsion and steering control systems and rudders were installed.

[5] Slack water occurs when no current is present. Data on tidal currents are from NOAA (see References).

[6] The National Weather Service (NWS) and Federal Aviation Administration designate official weather reporting stations. The LaGuardia and Newark airport stations are part of the NWS Automated Surface Observing System, one of the primary weather data collection and measurement networks in the United States.

The Coast Guard deemed the work a major conversion under 46 *United States Code* (U.S.C.) 2101(14a), inspected the refitted vessel during this overhaul, and issued a certificate of inspection on July 24, 2012.

The vessel's particulars are detailed in figure 8.

Vessel name	***Seastreak Wall Street***
Vessel type	Small passenger vessel (ferry), inspected
Flag	United States
Managing owner/operator	Seastreak LLC
Port of registry	Atlantic Highlands, NJ
Official number (US)	1145690
International Maritime Organization (IMO) number	8982010
Builder, date	Gladding-Hearn Shipbuilding, Somerset, MA Delivered September 30, 2003
Classification society	n/a[a]
Construction	Welded marine-grade aluminum, twin hull
Length	130.6 ft (39.8 m)
Breadth	34.2 ft (10.4 m)
Draft	6.6 ft (2.0 m)
Gross registered tons	98 (417 ITC[b])
Engine type, power	Two 2,467-hp (1,840 kW) MTU Friedrichshafen diesel engines, geared drive, twin controllable pitch propellers, twin rudders
Persons on board	326 passengers 5 crewmembers

[a] According to section 1.1 of the original version of the *Seastreak Wall Street* Vessel Operating Manual, the ferry was built to (but not classed to) Det Norske Veritas (DNV) High Speed Vessel Rules. See the docket for this accident investigation (DCA13MM005) at http://www.ntsb.gov.

[b] Measured according to the IMO International Convention on Tonnage Measurement of Ships (ITC), in force 1982.

Figure 8. Vessel particulars for *Seastreak Wall Street*.

The ferry provided passenger seating on three decks. The first and second deck seating areas were fully enclosed and air conditioned, while the third deck was open and uncovered for seasonal passenger seating. At the time of the allision, the third deck was closed to passengers. The navigation bridge was at the forward end of the second deck. Figure 9 depicts the layout of the *Seastreak Wall Street*.

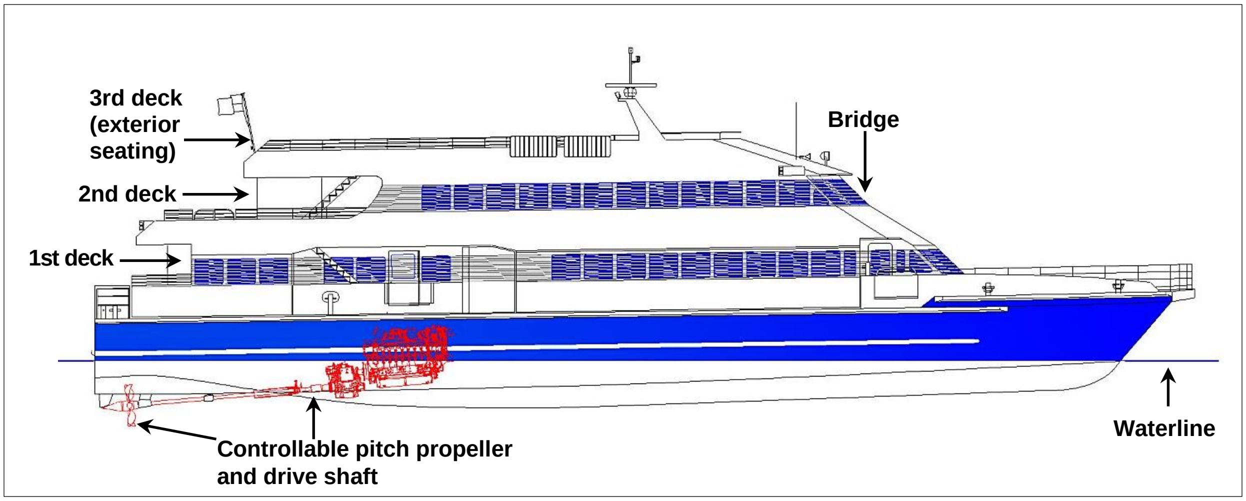

Figure 9. Profile view of the *Seastreak Wall Street* indicating deck levels and location of the bridge. The vessel's controllable pitch propulsion system is highlighted in red from the engine to the propeller. (Vessel drawing provided by Seastreak)

Passenger access between the three deck levels was by use of inclined ladders, or stairs. Three stairwells were fitted between the first and second deck passenger compartments: a double-width stairwell was at the forward section of the deckhouse, and just aft of midships was a single-width stairwell at each side of the passenger cabin. Fitted between the second deck (aft of the deckhouse) and open third deck was a double-width stairwell. These four stairwells were aligned longitudinally along the vessel. A fifth single-width stairwell was fitted aft of the deckhouse and aligned transversely to the vessel.

The two 9-foot-wide catamaran hulls were connected by a bridging structure on which the deckhouse was mounted. Each catamaran hull had five watertight compartments with spaces for fuel, water, and sewage holding tanks as well as compartments for machinery and steering gear. Contained at the aft end of each hull was a machinery space and lazarette. Within the machinery space were a main propulsion engine, propulsion system electronic controls, main reduction gear (gearset), 110 kW diesel-electric generator, and associated auxiliary equipment. An independent steering gear system was fitted in a lazarette.

1.6.2 Engines and Propulsion System

An independent diesel propulsion system, manufactured by Servogear AS of Norway, was fitted in the aft section of each of the two hulls, port and starboard, and each diesel engine drove a controllable pitch propeller (CPP). Except for the main engines, Servogear designed, built, and supplied the propulsion system as the Servogear Ecoflow Propulsor™ package, promoted as providing higher efficiency, lower fuel consumption, more economical operation, and less pollution. Figure 10 depicts the components of the Ecoflow Propulsor. Control systems for the vessel's propulsion and steering were manufactured by Scana Mar-El AS, a subcontractor to Servogear.

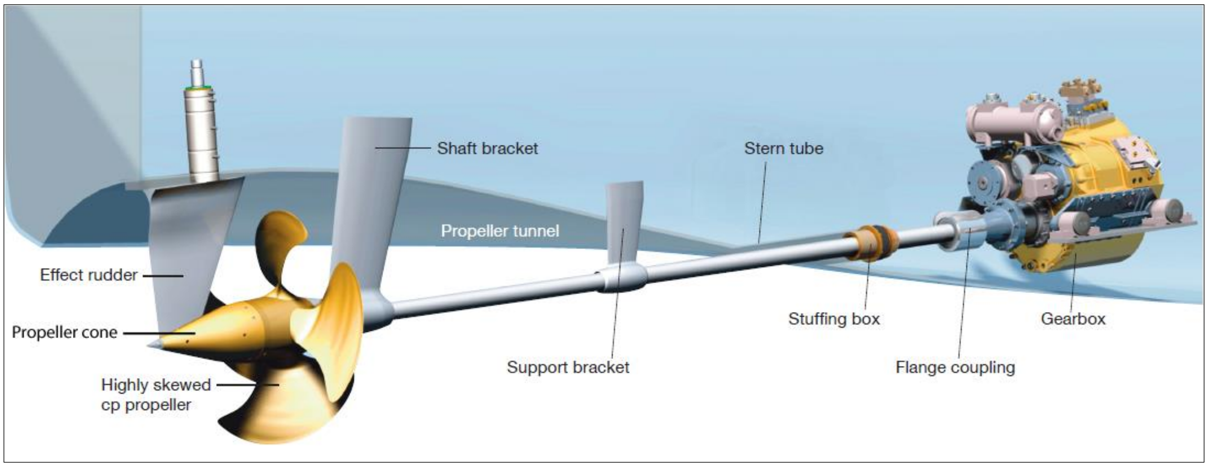

Figure 10. Servogear Ecoflow Propulsor system components. (Schematic drawing by Servogear)

1.6.3 Bridge Controls

The *Seastreak Wall Street* could be controlled from any of three stations on the bridge, located center, port, and starboard. The layout of the bridge and the control stations is shown in figure 11.

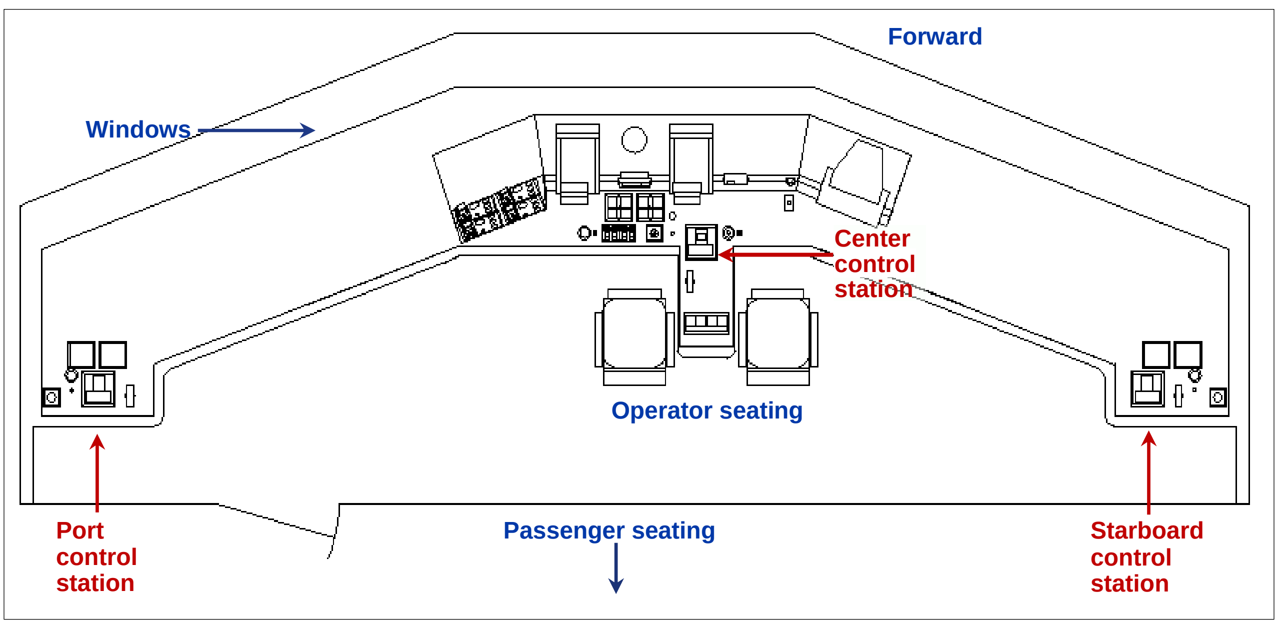

Figure 11. Simple schematic of *Seastreak Wall Street*'s bridge indicating center, port, and starboard control stations (details not identical to those of the ferry as constructed). The bridge is 34 feet wide. (Drawing excerpted from Seastreak vessel plan)

The three bridge control stations were the primary operator interfaces with the propulsion and steering control systems. They were identical in design and layout, and each had all the necessary components to monitor and control the engine rpm and propeller pitch for both starboard and port propulsion systems. Each station included controls for both propulsion systems, port and starboard: two order levers, two button and alarm indicator panels located on either side of the order levers, two analog rudder angle indicators, two digital propeller pitch indicators, and two main propulsion engine and propeller shaft rpm indicators (see figure 12).

An operator could quickly shut down the port or starboard main engine with an electronic emergency stop function. This could be ordered from the engine room or from the center bridge control station using two red pushbuttons, one for each engine.

Figure 12. Photo of bridge control panel showing order levers, pushbutton controls and alarm displays, and engine and propulsion controls and indicators.

Two operating modes and a Backup system were available to control the main engine rpm and propeller pitch when maneuvering the vessel:

- **Combinator mode.** This was the *Seastreak Wall Street*'s normal operating mode. The order lever simultaneously controlled both engine rpm and propeller pitch according to a fixed relationship, with a linear scale at the control station indicating the percentage of power ordered ahead or astern.
- **Constant rpm mode.** In this mode, the engine rpm was preset to a fixed value and did not vary as the propeller pitch changed. The order levers could control only pitch. This mode was not normally used on the ferry.

- **Backup system, or mode.**[7] If a control system failure occurred, the propulsion mechanism automatically switched to Backup mode, and a steady audible alarm sounded until reset by the operator. This system allowed the operator to control engine rpm and pitch functions separately, if necessary. The order levers controlled engine rpm, and pushbuttons controlled propeller pitch.

Only one of the three bridge propulsion control stations could be active at one time, indicated by illumination of a red light emitting diode (LED) in the In Command button at that control station.[8] To transfer control from one station to another, an operator performed two basic actions from the station where control was wanted:

1. Move order levers to the same position as order levers at the station currently in control and

2. Push the In Command button.

A successful control transfer resulted in a steady light in the In Command pushbutton. Once a command change request was initiated, if the position of the requesting control station's order levers were not matched within plus or minus 10 percent of the In Command station's order levers, an audible alert and a flashing LED lamp in the pushbutton indicated incomplete transfer of control. If the command transfer did not take place within about 15 seconds, the light would stop flashing and turn off. NTSB investigators demonstrated activation of the audible alert while testing the system on scene.[9]

Each control station was fitted with a monitoring system that would activate other visual and audible alarms to indicate, for instance, loss of control voltage or failure of the propulsion system. In the event of a system failure, the propulsion system would automatically shift to Backup mode for pitch control and sound a steady audible alarm to indicate Backup control was active until reset by the operator. Backup mode could also be manually selected by the operator. The control system was unable to save a history log of system faults, however, so no record of control system alarms occurring around the time of the accident was available for analysis by investigators.

1.7 Seastreak Ferry Operations

Seastreak LLC operated seven vessels, four of which were high-speed catamarans—the *Seastreak Wall Street* and three other ferries equipped with the original waterjet propulsion. The

[7] The Scana propulsion control system user manual also identified the Backup system as "individual mode." Also, The *Seastreak Wall Street* system was not fitted with a separate lever for pitch control as described in the user manual; pitch was controlled using pushbuttons. See "User manual: Neptune Compact CPP, Propulsion Control System," section 7.1.2, initially released by Scana in 2003 (also see References).

[8] These and other pushbuttons on the propulsion control panel were membrane switches rather than mechanical pushbutton switches. The membrane switches had integral red LED lamps to indicate system status.

[9] Investigators measured the duration of the alarm while testing the vessel's propulsion controls. This alert is not documented in the propulsion system operating manual.

vessels offered daily passenger ferry service between Manhattan and central New Jersey as well as seasonal ferry service between New Bedford, Massachusetts, and the ports of Oak Bluffs and Vineyard Haven in Martha's Vineyard, Massachusetts.

The owners of Seastreak LLC also owned and independently operated Moran Towing Co. and the Interlake Steamship Company. Together, the companies operated 9 Great Lakes freighters, 105 tugs, 25 barges, and 7 passenger ferries.

1.8 Regulatory Authority

The *Seastreak Wall Street* was a small passenger vessel, inspected and certificated by the Coast Guard under regulations at 46 CFR Parts 114–124 (Subchapter K). After the Coast Guard issued a 5-year certificate of inspection (COI), the vessel was subject to annual Coast Guard inspections of its machinery and safety equipment, the number of crewmembers, and their performance of emergency drills as required by these regulations. The vessel received an initial COI following construction in September 2003, and the COI was renewed in 2008 and on July 24, 2012. The Coast Guard conducted the required hull inspections at 2-year intervals.

Because Seastreak LLC wanted to operate its high-speed ferries at speeds of 30 knots or more, the vessels were also subject to Coast Guard Navigation and Vessel Inspection Circular (NVIC) 05-01, "Guidance for Enhancing the Operational Safety of Domestic High-Speed Vessels"[10] (Coast Guard 2001). The NVIC included a description of the regulatory authority each Coast Guard officer in charge, marine inspection (OCMI), might use to set additional operational parameters when a vessel operates at 30 knots or faster.[11]

Seastreak and the Coast Guard identified the particular hazards of operating at 30 knots or more and agreed upon measures to mitigate those hazards, as outlined in NVIC 05-01. Accordingly, the Coast Guard required that Seastreak create and comply with a training manual and an operations manual that addressed the identified risks posed by high-speed operations in that sector.[12] Following approval of the manuals, the Coast Guard endorsed the vessel's COI on November 8, 2010, for operations at 30 knots or more.

The Coast Guard inspector who was the primary author of the NVIC told investigators that the NVIC was intended to address issues that might develop when a vessel was actually operating at 30 knots or more. According to this inspector, when a vessel slowed down to less

[10] In NVIC 5-01, the Coast Guard defines a high-speed vessel as having a loaded service speed greater than 30 knots. (See References, United States Coast Guard, Navigation and Vessel Inspection Circular No. 5-01, "Guidance for Enhancing the Operational Safety of Domestic High-Speed Vessels.")

[11] The OCMI is the Coast Guard official responsible for the inspection of vessels in order to determine that they comply with applicable laws, rules, and regulations (33 CFR 1.01–20).

[12] NTSB investigators found that Seastreak's high-speed operations manual required by the COI, in addition to containing requirements for operating at 30 knots or more, included procedures for departure and arrival and information on best industry practices as identified by a joint Passenger Vessel Association/Coast Guard high-speed craft working group.

than 30 knots, the NVIC no longer applied, and the vessel operated as any other small passenger vessel in accordance with applicable regulations in Subchapters T or K of CFR Title 46.[13]

The Coast Guard's vessel inspection and review procedures and certification requirements are discussed in more detail in section 2.3, Seastreak Management Oversight.

1.9 Personnel Information

Captain. The captain of the *Seastreak Wall Street*, 36 years old at the time of the accident, started working as a deckhand on charter fishing boats at age 15. In 1996, he began working for a ferry company and then was hired by Seastreak's predecessor company in 1998, first as a deckhand and then as an engineer, from 1996 to 2000. In 2000, he obtained his 100 ton master's credential (near-coastal) and began working part-time as a captain, becoming a full-time captain in 2001. His credential carried no medical restrictions, and he was taking no medications.

Mate. The mate, age 31, began working part-time on weekends as a deckhand on charter fishing boats at age 15 and worked full-time on charter boats since he was 21. In 2010, he was credentialed as a 100 ton master (near coastal), and in April 2012, he came to work as a deckhand with Seastreak. He also completed training as a radar observer 2 months before the accident. The mate was the *Seastreak Wall Street*'s second in command. In addition, he reported the passenger ticket count and handled the ferry's lines when mooring. He was on the bridge at the time of the accident.

Deckhands. The vessel crew also included three deckhands whose positions on the ferry did not require merchant mariner credentials. One deckhand served in the US Navy and then worked as a civilian ordinary seaman and able seaman on a Military Sealift Command tanker. At the time of the accident, he had been working for Seastreak for 1.5 years and had served 1 year in the US Coast Guard Auxiliary.

The second deckhand previously worked on charter boats, held a New Jersey Boater's Safety Certificate for Recreational Craft, and was qualified as a New Jersey Fire Fighter I. He was serving as a volunteer fire fighter in his department's marine unit as well as working as a deckhand for Seastreak, where his duty under way was tending the bar.

The third deckhand had been working as an engineer for Seastreak for 3 months at the time of the allision. He previously served 8 years at sea in the Myanmar merchant marine. He was licensed in Myanmar as a chief engineer and held a bachelor's degree in mechanical engineering. He monitored maintenance of the main propulsion engines and generators, checked fluids, and recorded pressures and temperatures.

[13] Regulations, including equipment and operating requirements for small passenger vessels, are found in 46 CFR Subchapter K, Small Passenger Vessels Carrying More than 150 Passengers or with Overnight Accommodations for More than 49 Passengers (Parts 114–124), or Subchapter T, Small Passenger Vessels (Under 100 Gross Tons) (Parts 175–187).

1.10 Toxicological Testing

The *Seastreak Wall Street* crew submitted specimens within the required time frame for toxicological testing, 2 hours after the accident for alcohol and 32 hours for drugs.[14] All results were negative for alcohol and the five classes of illicit drugs for which the Coast Guard, in accordance with US Department of Transportation regulations, requires postaccident screening: marijuana, cocaine, opiates, amphetamines, and phencyclidine.

[14] Time frames for toxicological testing are specified in 46 CFR 4.06-3 and apply to time elapsed following a serious marine accident, unless precluded by safety concerns directly related to the accident.

2 Investigation and Analysis

In analyzing the circumstances of this accident, NTSB investigators collected and examined information and data from many sources, including:

- Interviews with *Seastreak Wall Street* crewmembers, Seastreak management personnel, representatives of the vessel's mechanical component manufacturers, Coast Guard personnel, passengers, and other witnesses;
- The vessel's AIS data provided by the Coast Guard;
- The engine monitoring system and closed-circuit television (CCTV) captured on board the vessel;
- Testing and examination of propulsion, steering, and control systems;
- Usage records obtained from cell phone service providers, medical records provided by local hospitals, and information from the FDNY regarding the first response efforts; and
- Documentation related to Seastreak company policies and governmental regulations, *Seastreak Wall Street* operating procedures, manufacturers' manuals for vessel maneuvering and control systems, Coast Guard inspections, an underwater survey of the accident area, among other documents and records.

Examination of the evidence indicated several conditions were not factors in the accident.

Mechanical operation. The captain said he was unable to control the ferry's propulsion system at the starboard control station as the ferry approached Pier 11. To determine whether a failure of the propulsion system caused or contributed to the accident, both the port and starboard propulsion systems were extensively examined and tested.

Over several days following the accident, investigators functionally tested the port and starboard propulsion control systems in a variety of configurations and modes, including with and without the main propulsion engines operating, both pierside and under way. Both port and starboard system responses to control inputs were satisfactory, and system operation indicated no anomalies in the tests performed. All propulsion and steering system components were found to be fully operational. Investigators tested transfer of control between the three propulsion control stations on the bridge, also without operational anomalies.

In addition to functional testing of the propulsion control system, investigators thoroughly examined the system's hardware—its electrical and mechanical components—for indications of damaged components or loose electrical connections. No abnormal conditions were found with any of these systems' components.

The port and starboard propulsion control systems were fully independent and redundant, with battery-backup supplies to power propeller pitch control in the event of main power loss. The propulsion control system was designed to be failsafe, as required by Coast Guard regulations at 46 CFR 62.30-1, and Coast Guard Marine Safety Center personnel verified that design.[15] Local Coast Guard marine inspectors checked that the system installation complied with these regulations before the vessel was certified to carry passengers.[16]

NTSB investigators found no operational anomalies in the propulsion system during postaccident examination and testing, and the system had a history of reliable operation.

Cell phone use. Records were retrieved from cellular service providers in response to NTSB subpoenas for cell phones carried by the captain and the mate on the bridge at the time of the accident as well as the company phone kept on the bridge. Review of the timing of incoming and outgoing calls revealed no evidence that the captain or the mate had been using cell phones at the time of the accident.

Fatigue and medical factors. NTSB investigators examined the sleep schedule of the captain, the sole operator of the ferry, to determine whether fatigue played a role in the accident. The captain was not diagnosed with a sleep disorder and was not taking prescribed or over-the-counter medications in the days leading up to the accident. His schedule preceding the accident was consistent; he slept about 7 hours a night, sleeping and arising about the same time each day. The accident occurred in the morning, after he had operated one round-trip from New Jersey to New York City, at a time when he ordinarily was awake.

The day before the accident, the captain napped for more than 2 hours between his morning and afternoon shifts, and that night he slept just over 7 hours, for a total of more than 9 hours in the preceding 24 hours. This amount of sleep was sufficient to preclude an acute sleep loss at the time of the accident. He suffered neither a chronic nor an acute sleep deprivation and sustained no disruption to his circadian sleep cycles before the accident. In addition, no evidence indicated that the captain had a sleep-inhibiting medical disorder or used sleep-impairing medication. Therefore, investigators believe the captain had sufficient rest at the time of the accident to avoid being fatigued.

Based on toxicological analysis, Coast Guard records, and the captain's statements, he was not subject to any impairing medical condition, was not taking prescribed or illicit medications that could have adversely affected his performance, and maintained a regular sleep schedule in the days preceding the accident.

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[15] The Coast Guard Marine Safety Center (MSC) is responsible for "verification of compliance with technical standards for the design, construction, alteration, and repair of commercial vessels" through examination of plans for conformance with US laws and regulations as well as international standards. For further information, see http://www.uscg.mil/hq/msc.

[16] According to Coast Guard regulations at 46 CFR 62.35-5(e)(3), remote propulsion control systems "must be failsafe by maintaining the preset (as is) speed and direction of thrust until local manual or alternate manual control is in operation, or the manual safety trip control operates. Failure must activate alarms on the navigating bridge and in the machinery spaces." The failsafe state is defined in 46 CFR 62.10-1(a) as "a pre-determined design state of least critical consequence."

Weather. Meteorological surface and visibility conditions did not affect the operator's ability to maneuver the vessel.

The NTSB therefore concludes that mechanical failure, distraction due to cell phone use, fatigue, use of alcohol or illicit drugs, the captain's health, and weather were not factors in this accident.

Emergency response. FDNY began dispatching units, including FDNY emergency medical services (EMS) responders, at 0843—about 2 minutes after the vessel allided with the pier. The first units arrived on scene at 0847, and personnel located injured passengers and crew and provided first aid. Other FDNY units also offered first aid, checked on the injured, and searched for anyone possibly in the river. Responders verified the vessel was secure to the dock and not taking on water and set up a casualty treatment site on the pier adjacent to the vessel. Fifty-three FDNY units were dispatched to the scene, including fire trucks, EMS units, a marine unit, a rescue unit, and hazardous materials and tactical support.

The Seastreak vice president for operations said he received a call about 0845 from the mate on board the *Seastreak Wall Street* reporting the allision. The captain then took the phone, said the vessel had hit the pier and injured passengers needed ambulances, and asked him to call 911 for assistance. From Seastreak headquarters in New Jersey, however, the vice president was unable to reach New York emergency services, so he called the Coast Guard Vessel Traffic Service.

The most seriously injured passenger was transferred to New York–Presbyterian Hospital. The ambulance left Pier 11 at 0940 and arrived at the hospital at 0947. Ambulances transported others needing additional treatment to several area hospitals.

Given the quick response of emergency services and the rapid attendance to injured passengers, corroborated by witness accounts, the NTSB concludes that the emergency response by the Fire Department of the City of New York was timely and appropriate.

2.1 Accident Events and Captain's Actions

2.1.1 Approach to Pier and Allision

Following installation of the vessel's new propulsion system in July 2012, personnel from the manufacturer of the new controls trained the captain in operating the system. The captain then delivered the vessel from the shipyard in Louisiana, where the vessel had been refitted, back to its home port in New Jersey. The captain instructed other Seastreak captains in the new propulsion system and controls and was the primary operator of the ferry for more than 6 months. Therefore, investigators considered the captain to be trained and knowledgeable about the new system and its use in controlling the vessel.

On the accident voyage, the captain followed the usual course through Sandy Hook Bay and Chapel Hill Channel in the Lower Bay, beneath the Verrazano–Narrows Bridge, and north along Anchorage Channel in the Upper Bay and Buttermilk Channel between Governors Island and Brooklyn to the East River. The 20-mile trip usually took 40–45 minutes.

The first round-trip that day was uneventful, with all systems performing normally. On the second trip, the vessel's AIS showed the speed of the vessel was 30.0 to 32.1 knots for most of the transit. When approaching the Verrazano–Narrows Bridge in the vicinity of Swinburne Island, the captain reduced speed to below 30 knots. During the captain's second interview,[17] he told investigators that just north of the bridge he felt a slight vibration. Suspecting that a propeller might be fouled, he switched from Combinator mode to Backup mode on both port and starboard systems and adjusted the starboard propeller pitch, but the vibration did not change. He stated he then changed the pitch slightly on the port propeller, and the vibration increased, which indicated to him the port propeller may have been fouled. He told investigators he did not believe the vibration would adversely affect the vessel so he returned the propulsion control to Combinator mode. AIS data show the vessel returned to a speed above 30 knots about 1.5 miles north of the bridge.

Figure 13 depicts controls and indicators at a *Seastreak Wall Street* bridge control station panel.

Figure 13. Closeup of bridge control panel order levers and command buttons.

In the captain's statements to investigators, he recounted his approach to Pier 11 as follows: When the vessel was about 500 yards from the dock, he began the ferry's approach by gradually moving the order levers from 100 percent to 0 to slow the vessel. He moved to the

[17] During the captain's first interview with investigators, he did not mention changing to Backup mode during the voyage but did describe Backup mode and its purpose and function.

starboard control station and began turning the vessel toward Slip B at Pier 11. He pressed the In Command button to transfer propulsion control from the center control station to the starboard station. When he moved the port order lever at the starboard station in the reverse direction to further slow the vessel, he realized the propulsion system was not responding. He pressed the In Command button a second time but found the system still did not respond as he expected. The captain said he then applied full astern on both port and starboard order levers. He said he recalled hearing an alert but could not identify the time it sounded or its source.

The mate said he was about to leave the bridge at this time for his mooring station when he heard the captain say he "had a problem," so the mate stayed on the bridge. The captain told investigators he believed control must have remained at the center station, so he returned to that station and put both order levers in reverse, but the vessel still did not respond as he expected. He then returned to the starboard station to try the controls there, but the ferry struck the pier before he was able to regain control.

As recorded by AIS, the *Seastreak Wall Street* was traveling about 12 knots when it allided with the corner of Slip D2 of Pier 11 about 0841. The captain did not broadcast a warning to passengers and crew or activate the emergency alarm before impact, nor did he direct the mate on the bridge to do so before impact.

2.1.2 Examination of Electronic Accident Data

NTSB investigators recovered four sets of electronic data to be correlated during the analysis of this allision:

- AIS data, including chronologically time-stamped information related to the vessel's position, course, and speed;
- Two independent sets of main propulsion engine data from the monitoring systems, with data items identified by operating time for each engine; and
- Video from six CCTV channels—four views of the engine spaces, one view astern, and a view of the second passenger deck. The videos were time-related by an independent recorder clock.

Based on AIS data, the time of allision was established as 0840:58. AIS information also indicated that speed decreased suddenly, in about 2 seconds, from nearly 12 knots to less than 1 knot, and this was used as a reference point to help time-synchronize the other data sets.

The engine space video showed the effects of rapid deceleration, with unsecured objects moving suddenly. Video from the passenger deck showed passengers thrown forward at the same time. The engine space video also revealed camera vibration consistent with the engines still running for about 1 minute after the allision. The AIS and video footage helped investigators determine the time reference to analyze the engine data sets, which suggested that the engines continued to operate for about 68 seconds after the vessel struck the pier.

Correlation of the four sets of recorded data indicated to investigators that the captain began to reduce engine power and slow the vessel about 700 yards from Pier 11 approximately 90 seconds before the allision. Vessel speed fell to 9 knots at 0840:10 before increasing to about

14 knots at 0840:18. One limitation of the available data was the frequency at which information was recorded. The engine monitoring systems sampled data once per minute during normal operation. Each engine's control unit also included a "crash recorder," which activated after an engine shutdown. An engine shutdown resulted in data capture at three concurrent sampling rates:

Time before engine shutdown	Recording frequency
20 seconds	10 times per second
60 seconds	Once per second
60 minutes	Once per minute

As engine monitoring data were recorded only once per minute during most of the voyage, the engine rpm is unknown during the 1-minute intervals between data points. After the ferry allided with the pier, AIS data show the vessel moved away from the pier and then moved south and west. Higher-frequency engine rpm data available for this period—up to 60 seconds after the allision—showed changes in rpm order and actual rpm. The vessel moved into a charted shallow area and likely struck submerged obstructions, damaging both propellers and causing both main propulsion engines to shut down. A crewmember was able to restart both engines, and the captain maneuvered the vessel to Slip B at 0848:30.

With no indication of mechanical failure before the accident, the investigation focused on the captain's operation of the vessel. Based on the vessel's speed as it approached Manhattan, its propulsion system performance, and the captain's and mate's statements, the captain did not maintain propulsion control as the vessel approached the docks, and because he did not understand why this happened, he was unable take appropriate action to avert the allision.

Investigators considered the possibility that the captain did not return propulsion control from Backup to Combinator mode after passing under the Verrazano–Narrows Bridge. Propulsion controls functioned differently depending on the system's active operating mode. Figure 14 compares the significant difference between the ferry's response to order lever movement when in Combinator mode and in Backup mode.

Order lever movement	Combinator mode	Backup mode
Forward		
Engine rpm:	——— Increases ———	
Propeller pitch:	Automatically changes pitch ahead	Unchanged from current position (adjusted manually using pushbuttons)
Set to 0		
Engine rpm	——— Idle speed ———	
Propeller pitch:	Moves to 0	Unchanged from current position (adjusted manually using pushbuttons)
Astern		
Engine rpm:	**——— Increases ———**	
Propeller pitch:	**Changes pitch to astern**	**Unchanged from current position (adjusted manually using pushbuttons)**

Figure 14. Comparison of vessel response when operator adjusts order levers in Combinator and Backup modes. The dark shaded area describes the vessel's differing responses to setting order levers astern in Backup mode and Combinator mode.

In Backup mode, order levers controlled only engine rpm at the station in command, and ahead and astern pitch were controlled by pushbuttons at any control station. If the propulsion system were in Backup mode, rather than Combinator mode, while approaching the pier and the captain moved the order levers astern, the propellers would still be in the forward pitch position. Thus, any increase in rpm—even if commanded by moving order levers astern—would cause the vessel to increase forward speed rather than slow down. This scenario is consistent with AIS speed data, which showed an increase of nearly 2 knots in the seconds prior to the allision.

Because the vessel lacked a VDR, sounds from the bridge, such as a propulsion system alarm, were not recorded. Therefore, investigators could not verify whether the alarm sounded and, if so, why it activated, at what point in the voyage, and what caused it to stop, among other alarm characteristics.

To transfer propulsion control to another control station, the order lever settings must be matched within plus or minus 10 percent. Otherwise, an audible alert and flashing light would activate to indicate the mismatch. The alert would continue until control transfer was completed or until the 15-second period allowed for transfer ended with transfer incomplete. While the captain stated he heard an alert that could have indicated an order lever mismatch, he could not identify the time or source of the alarm, so investigators were unable to determine how the alarm related to his operation of the vessel's propulsion system.

According to his statement, the captain's practice when approaching Pier 11 was to transfer steering and propulsion control from the center to the starboard control station and then use CPP reverse thrust to smoothly reduce speed sufficiently to dock the vessel. Normally, Seastreak vessels were on a busy schedule, necessitating swift arrivals and departures. The

Seastreak Wall Street captain was accustomed to these approaches and told investigators that he had no previous problems operating or transferring propulsion control.

The available electronic evidence did not include pitch and mode information and the engine data were recorded at a low sampling rate. To collect additional information for further analysis, investigators conducted sea trials with the *Seastreak Wall Street* after the accident in both Combinator and Backup modes. NTSB investigators compared the sea trial data with the accident data and calculated the necessary shaft horsepower at various engine rpm settings.

The vessel's torque and rpm after passing the Verrazano–Narrows Bridge did not follow a relationship (curve) consistent with operation in the Combinator mode. The increase in torque observed in the last pre-allision data point is consistent with the behavior expected of a fixed-pitch propeller at a slower vessel speed (Backup mode) and is inconsistent with the behavior expected in Combinator mode.

In Combinator mode, rpm and propeller pitch―and thus power―are a fixed function of command lever position. By about 0827, near the Verrazano–Narrows Bridge, this relationship changed: more torque was recorded for the same engine rpm. This correlation is consistent with propulsion behavior in Backup mode with the propellers at a less efficient pitch setting than would be provided while in Combinator mode. (See Appendix C for a more detailed explanation of these data relationships.)

The NTSB believes the captain did not change the system back to Combinator mode after the bridge. The NTSB further believes that, approaching the dock in Backup mode, the captain successfully transferred rpm control to the starboard station and then moved the order levers astern expecting the vessel to slow. Because the vessel was still in Backup mode—and the pitch was still in the forward position—the order levers increased the rpm, causing an unexpected acceleration ahead.

The NTSB concludes that the captain did not return the propulsion control system to Combinator mode after switching to Backup mode earlier in the voyage. The NTSB further concludes that the captain successfully transferred rpm control to the starboard station, and he attempted to slow the vessel by moving the order levers astern; however, this input resulted in forward acceleration because the system was in Backup mode.

Although the Seastreak captain was experienced in operating the ferry, some circumstances of the accident trip were unusual. He was aware of the vessel's slight vibration just after passing under the Verrazano–Narrows Bridge, in response to which he changed the propulsion mode from Combinator to Backup. He indicated in an interview that he had rarely used Backup mode with passengers on board. Operating in Backup mode presented a very different set of vessel responses to his commands. Given he was mistaken about which propulsion mode was active, he was unable to recover vessel control before impact. The captain's inability to recognize this error was likely the result of two factors:

- He was focused on attempting to avoid an accident when he returned to the center control station and the vessel was seconds from impact, and
- The stress of the impending allision limited his ability to understand why he was unable to regain propulsion control at either station.

The captain was required to attempt to avoid impact with the pier while diagnosing and addressing what was wrong. Despite his experience commanding the *Seastreak Wall Street* with the new propulsion system and instructing other crewmembers, the captain was not immune to making errors in controlling the system. If an operator made any errors at this point in the voyage that were not immediately identified and addressed, too little time and few options remained to resolve the situation. The NTSB therefore concludes that the point in the voyage at which the captain initiated transfer of the *Seastreak Wall Street*'s propulsion control did not allow sufficient time and distance to react to the loss of vessel control.

2.2 Control Panel Design and Mode Indication

The propulsion control system provided mirror-image displays for the port and starboard propulsion systems, as shown in figure 13 above. Each control station panel included two identical arrays, one for controlling each of the two propellers. On either side of the order levers were 15 pushbuttons, 11 of which were assigned functions. The pushbuttons were identical in shape, color, and lettering, and each included a red LED in the upper left corner that would illuminate according to its functional status.

In a stressful situation, looking at the control panel would require diverting attention from other critical tasks such as handling controls for an approach to the pier. Multiple LEDs would likely be illuminated. For example, in Combinator mode, the LEDs for 3 of the 11 pushbuttons would have been illuminated on each side. LEDs of identical color, luminosity, and size associated with identical buttons could confuse the operator. The design of these control panels could be improved to more readily display operating mode, applied pitch, and whether the control station was in command.

Audible alerts and alarms also could be improved. As currently designed, engaging Backup mode triggers a constant audible alert that could only be reset by the operator. After the reset silenced the alert, no further alarm would sound to remind the operator that Backup mode was still active. If the operator approached a dock without realizing the propulsion system was in Backup mode, the vessel would not respond as expected, thus posing a safety hazard.

A different, intermittent alarm would sound, regardless of propulsion mode, if an operator attempted to transfer propulsion control from one station to another without matching the control lever settings at both stations. This alert would terminate once the control lever settings matched or after about 15 seconds, regardless of whether the transfer had been completed. The system provided no indication of the reason for the alarm's activation or silencing, whether it was due to the control transfer, and if so, whether the alarm had timed out or if the transfer was complete. Given these shortcomings in the identification, clarity, and helpfulness of the control panel display—particularly in indicating operating mode and status of control transfer—the NTSB concludes that the propulsion control system on the *Seastreak Wall Street* used poorly designed visual and audible cues to communicate critical information about mode and control transfer status.

Such design shortcomings can lead to mistakes in operator performance, often referred to as "design-induced error." The circumstances of this accident point to the need for equipment providers to create systems that meet human factors and ergonomic standards. The NTSB addressed design-induced error in three previous marine accident investigations in which operators were unaware of the features of the components they used, the particular control they were about to engage, or the active operating mode of a critical system (NTSB 1997, 2008, 2010). The NTSB issued a safety recommendation to the Coast Guard to work with the IMO to encourage the incorporation of human factors principles in system design and manufacturing.[18]

In this accident, however, critical vessel components were subject to Coast Guard oversight, but the Coast Guard does not apply human factors standards to the domestic vessels it regulates. The operator's loss of vessel control highlighted by this investigation demonstrates the need for the Coast Guard to develop and implement design standards for domestically operated vessels that minimize the likelihood of design-induced error. Therefore, the NTSB recommends that the Coast Guard develop and implement human factors standards for the design of critical vessel controls for US-flag ships to include clearly identifiable and understandable audible alerts and displays indicating which mode is engaged.

In addition, the NTSB recommends that Scana Mar-El AS modify its design for new Neptune Compact propulsion control systems to include clearly identifiable audible alerts and easily visible and understandable displays that will remind the operator when Backup mode is engaged and revise its owner's manual accordingly. The NTSB also recommends that Scana Mar-El AS design a solution for existing Neptune Compact propulsion control systems to include clearly identifiable audible alerts and easily visible and understandable displays to indicate to operators when Backup mode is engaged, revise its owner's manual accordingly, and alert its customers to the circumstances of this accident and to the availability of the retrofit solution.

The NTSB further recommends that Seastreak LLC work with Scana Mar-El AS to implement a modification to the Neptune Compact propulsion control system that includes clearly identifiable audible alerts and easily visible and understandable displays to remind the operator when Backup mode is engaged.

2.3 Seastreak Managerial Oversight

While shipowners are responsible for the safe management and operation of their vessels, Coast Guard inspection includes a review of vessel documentation, including training and operations manuals, if the vessel is required to provide them. Accordingly, the NTSB investigation considered the Coast Guard's role in inspecting the *Seastreak Wall Street* and verifying that the vessel carried operations and training manuals required by NVIC 05/01. This guidance specified that the manuals outline certain instructions and procedures.

In 2010, the Coast Guard approved the manuals on board the *Seastreak Wall Street*. In 2012, Seastreak asked the Coast Guard to evaluate its plans to modify the vessel's propulsion system and submitted its failure modes and effects analysis (FMEA) for the Scana Mar-El control system. The Coast Guard issued a temporary COI to allow the *Seastreak Wall Street* to resume

[18] Safety Recommendation M-11-14, currently classified as "Open—Acceptable Response."

service in July 2012 after the shipyard modifications. Despite the major conversion, Seastreak had not revised its training and operations manuals to address operation of the new propulsion control system. After the accident and subsequent repairs, the Coast Guard reinspected the vessel, and Seastreak submitted new manuals for review before the permanent COI was issued in 2013.

Vessel owners and operators are responsible for updating these documents to reflect such changes to equipment. If Seastreak had had in place proper managerial oversight, document control, and auditing functions at that time, these measures would have identified and corrected any erroneous reference to the old propulsion system.

2.3.1 Company Procedures at the Time of the Allision

The *Seastreak Wall Street* operations manual addressed such aspects of vessel operations as functional procedures, company and regulatory expectations, and minimum requirements for the safe operation of Seastreak's four twin-hull craft (Seastreak LLC 2003). At the time of the accident, the vessel arrival procedures had not been updated since its modification to the new propulsion control system. The operating manual also did not require an arrival announcement to warn passengers to remain seated and stay away from stairwells while docking and undocking.

According to the captain, he began his approach within 500 yards of Pier 11. He slowed the vessel down from about 30 knots, turned toward the pier, and attempted to transfer propulsion control. Company procedures did not require the captain to confirm the transfer of control with the mate, nor did they define a geographic range where this transfer should be completed prior to docking. Transferring steering and propulsion control from the center to the starboard control station upon approach improved the captain's visibility when landing the vessel starboard side to the pier and was a normal, prudent operation which the captain had performed for several months.

Company procedures also did not encourage use of the mate in the routine transfer of navigational control. The captain's attempt to regain control without the mate's assistance indicated that such assistance was not routine. To ease the workload the captain encountered as he approached the dock without propulsion control, he could have asked the mate to move to the center control station. From that position, the mate could have told the captain the order lever setting at the center control station, applied astern propulsion, or depressed the engines' emergency stop buttons. The NTSB therefore concludes that Seastreak LLC bridge control transfer procedures at the time of the accident were inadequate as they did not reflect the new propulsion system nor did they define crewmember roles, which contributed to the loss of vessel control.

Seastreak had no crowd control policy regarding passenger access to stairwells while docking and undocking. A Seastreak company official said, "Passengers are free to move about the vessel. . . . On a calm day, they are free to roam." However, the number and severity of passenger injuries indicates a need for improved passenger protection measures. Medical records and passenger interviews indicate three passengers who sustained serious injuries were standing in stairwells during the docking attempt. The most seriously injured passenger, who had been standing in the starboard aft stairwell, suffered severe injuries when his head struck the stairwell overhead.

Seastreak procedures could have outlined circumstances in which the captain or mate should sound audible emergency signals, make an announcement alerting the passengers and crew to impending danger, or both. The NTSB concludes that the number and severity of injuries resulting from this accident could have been mitigated by alerting passengers and controlling their access to stairwells during docking and undocking.

After the accident, Seastreak amended procedures for all four of its high-speed ferries to include an arrival safety announcement directing passengers to remain clear of stairwells and crew to move to disembarkation stations. The revised arrival procedure also required a second qualified person on the bridge whenever paying passengers were on board except in three cases:

- in an emergency,
- when the vessel was at displacement speed (8–12 knots) with no other hazards present, or
- when the vessel was within 200 yards of the dock and the captain had already confirmed the ship's propulsion control had been successfully transferred.

Due to the serious injuries to people who were in and near stairwells the NTSB issued a safety alert stressing the need for more awareness among ferry operators and passengers of this risk of injury.[19] As safety alerts raise awareness about such important safety issues throughout the maritime community, the NTSB recommends that the Coast Guard distribute the National Transportation Safety Board safety alert outlining the circumstances of this accident to warn passenger vessel operators of the need to control passenger access to stairwells while performing maneuvers such as docking and undocking.

As mentioned above, after the ferry was substantially modified in 2012, the vessel operating manual was not updated to reflect the new steering and propulsion equipment. An outdated manual reflects upon document relevance and management oversight at Seastreak LLC. In addition, neither management nor crewmembers noticed the specified procedures were incorrect.

Seastreak also did not institute a formal training program for the vessel's newly installed propulsion control system. The captain, who was informally trained by the manufacturer after the refitting, trained other captains on the system. Using this approach, the captain could have inadvertently passed along to those operators erroneous information regarding propulsion control. Training curricula on critical equipment should be established, tracked, and continually reassessed by company officials to ensure safe, optimal operation.

The captain told investigators that he had learned of another captain who experienced difficulty transferring propulsion control to another station with the new equipment on the *Seastreak Wall Street* about 1 month after the modifications. The other captain had unsuccessfully

[19] Safety Alert SA-034, titled "Passenger Vessels: Stairway Hazards during Docking and Undocking," is provided in Appendix B and is also available at http://www.ntsb.gov/safety/safety_alerts.html.

attempted to transfer control at 40 percent and had to discontinue a docking maneuver. Seastreak management's assessment of the incident concluded that the transfer of control was rushed.

This earlier incident was not well documented by the management team, which missed the opportunity to reduce the risk of a recurrence. This suggests a process is needed to capture critical incidents or occurrences and address risks with identified corrective actions. In addition, Seastreak management did not have a formal audit program in place to ensure its procedures were implemented, updated, and followed correctly.

Due to inadequacies in its operational procedures and training, its failure to communicate circumstances regarding the earlier control transfer failure or take measures to prevent a recurrence, and the absence of a formal audit process, the NTSB concludes that Seastreak LLC provided ineffective oversight of the operation of the *Seastreak Wall Street*, including maintaining procedures that did not apply to the new propulsion configuration, providing inadequate crew training, and poorly identifying and mitigating risks.

2.3.2 Safety Management Systems

One method for improving operational oversight is the implementation of a safety management system. An SMS provides a company with methods for identifying and mitigating risks to operational safety. The IMO developed international safety management standards in the 1980s following serious marine casualties caused by human error or management failure. This led to the development of the International Safety Management (ISM) Code, the purpose of which is "to provide an international standard for the safe management and operation of ships and for pollution prevention" (IMO 2010). The IMO adopted the ISM Code in 1993. In 1994, IMO members, including the United States, adopted the ISM Code as Chapter IX of the International Convention for the Safety of Life at Sea (SOLAS). In 1998, the ISM Code was made mandatory for vessels on international voyages, such as passenger ships, high-speed craft, tankers, and cargo carrier ships. For other cargo ships on international voyage, the ISM Code took effect in July 2002. Vessels in US domestic service, however, are not required to have safety management systems.

The Coast Guard publishes US maritime rules for safe ship operation at 33 CFR Part 96, which also addresses safety management system certification of compliance with SOLAS Chapter IX. According to 33 CFR 96.230, a safety management system should meet several objectives:

- Provide for safe practices in vessel operation and a safe working environment on board the type of vessel for which the system is developed;
- Establish and implement safeguards against identified risks;
- Establish and implement actions to continuously improve safety management skills of personnel ashore and aboard vessels, including preparation for emergencies related to both safety and environmental protection; and
- Ensure compliance with rules and regulations.

The CFR also provides several functional requirements that companies should incorporate in effective safety management systems:

- Instructions and procedures to ensure safe operations of ships and protection of the environment, in compliance with relevant international and flag state legislation,
- Defined levels of authority and lines of communication between and among shore and shipboard personnel,
- Procedures for reporting accidents and nonconformities within the provisions of the ISM Code,
- Procedures to prepare for and respond to emergency situations, and
- Procedures for internal audits and management reviews.

This accident identified several issues which would be resolved by a properly implemented SMS incorporating the objectives and functional requirements listed above. For instance, the outdated manuals described earlier demonstrated the need for document control procedures. An SMS requires a company to maintain documentation, define the lines of authority, and conduct periodic management reviews. On the *Seastreak Wall Street*, the mate's role was not well defined, which left the captain unassisted as he tried to regain vessel control.

An SMS also would require the company to maintain emergency procedures and define the mate's and captain's responsibilities during various situations. Further, the company had no auditing functions in place to verify the crew's adherence to procedures. After a previous incident involving the *Seastreak Wall Street*'s new propulsion control system, no formal procedures were in place to identify corrective action. Finally, once an SMS is in place, management must provide employee training to integrate safe practices into routine vessel operations and prepare for emergencies.

After the accident, Seastreak management told NTSB investigators that the company would begin developing a formal safety management system, even though an SMS is not required for domestic passenger ferry vessels. In its own assessment of the accident, Seastreak stated that an SMS will help to address risks such as those demonstrated by this allision. The process can be lengthy, however, to complete the review of documentation and other requirements to qualify for SMS certification.

In February 2014, Seastreak reported substantial progress in updating and enhancing its safety program, including revising manuals, expanding passenger safety information, broadening crew training and performance requirements, and installing new equipment, among other improvements. Comprehensive SMS implementation can continue for years depending on the complexity of the company's operations. Seastreak reported the company is working with a third-party contractor to include software for a preventive maintenance and deficiency tracking system. The company expects to complete its SMS documentation by mid-spring 2014 and to qualify for interim certification later this year (Bevins 2014).

The NTSB continues to highlight the need for unambiguous, detailed operating procedures and believes they are prerequisite to managing a safe transportation system. A formal SMS is considered essential to enhancing the safety of Seastreak operations, and the NTSB therefore believes the company's SMS should be implemented as quickly as possible with companywide support. The NTSB recommends that Seastreak LLC expedite the complete implementation of a safety management system for its fleet that is appropriate for the characteristics, methods of operation, and nature of service of its vessels and the size of its operations.

In the months following the accident, Seastreak informed the NTSB that it changed its operations to include additional crew training to improve arrival and disembarkation procedures and crowd control, contracted for development of a continuous onboard passenger safety video and audio broadcast, and took other measures to improve vessel management and passenger safety. The company's training of its crews can, if properly designed, help captains better utilize available bridge equipment and personnel. Given the shortcomings in Seastreak's operations and training at the time of the accident, and until a fully functional SMS has been implemented, the NTSB recommends that Seastreak revise its operations and training manuals to include better utilization of crew and procedures for standard bridge operations, vessel emergencies, and control of passenger access to stairwells during docking and undocking.

2.3.3 Previous NTSB Actions Regarding Safety Management Systems

The NTSB has investigated several accidents that highlighted the need for improved vessel procedures. The Staten Island ferry *Andrew J. Barberi*, operated by the New York City Department of Transportation (NYC DOT), allided with a maintenance pier on October 15, 2003. That vessel had very few instructions or operating procedures in place, as indicated in the NTSB accident report:

> Explicit procedures provide the guidance operators need to operate the systems as intended and ensure that regardless of the individual, the system will be controlled as appropriate for each phase of operation. In any ferry system, each crewmember should have duties delineated in the procedures for all operational phases, for both routine and emergency conditions. (NTSB 2005)

After the accident, NYC DOT commissioned the Global Maritime and Transportation School (GMATS) to audit the management of the ferry system, and the GMATS report recommended the NYC DOT implement an SMS. Ferry Division staff planned to complete the SMS by October 2005, and in Safety Recommendation M-05-2, the NTSB asked the NYC DOT to adhere to this target date. The resulting SMS included emergency procedures for collision and allision response, postaccident crowd control, and crisis management, with specific step-by-step procedures.

In the same accident report, the NTSB also issued Safety Recommendation M-05-6 to the Coast Guard:

> Seek legislative authority to require all US-flag ferry operators to implement safety management systems, and once obtained, require all US-flag ferry operators to do so. (NTSB 2005)

On July 2, 2008, a collision between the Coast Guard cutter *Morro Bay* and the passenger ferry *Block Island* again stressed the need for detailed procedures on board passenger ferries. In particular, passengers generally thought a collision warning should have been made. Investigators found the company's safety philosophy was informal, and evidence indicated management oversight had been insufficient. The NTSB report concluded that a safety management system at the company owning the *Block Island* ferry "could have contributed to more thorough operational procedures on the *Block Island* and greater oversight by management" (NTSB 2010).

In October 2010, Congress passed the Coast Guard Authorization Act of 2010 (Public Law 111–281). Section 610 of the statute required the Coast Guard, in mandating SMS for passenger vessels, to consider the characteristics, methods of operation, and nature of the service of these vessels and, for ferries, the size of the ferry systems within which the vessels operate."

After a May 8, 2010, hard landing again involving the *Andrew J. Barberi*, the NTSB noted that implementation of detailed procedures had improved vessel operations and the emergency response by both the shipboard and shoreside employees "improved operational safety, including implementing a safety management system" (NTSB 2012). The NTSB concluded that the Ferry Division's SMS provided more specific emergency procedures, which the crew and shoreside personnel performed in a timely and effective manner, thus increasing passenger safety. In that accident report, the NTSB closed Safety Recommendation M-05-6 and superseded it with Safety Recommendation M-12-3:

> Require all operators of US flag passenger vessels to implement safety management systems, taking into account the characteristics, methods of operation, and nature of service of these vessels, and, with respect to ferries, the sizes of the ferry systems within which the vessels operate. (NTSB 2012)

The 2012 allision of the cargo vessel *Delta Mariner* with Eggner's Ferry Bridge near Aurora, Kentucky, involved a vessel operated by Foss Maritime Company, which had a fully operational safety management system. In that accident, the NTSB found, "After years of safe operations without adverse regulatory or safety reports, company attention to operational safety can decrease" (NTSB 2013). Investigators identified missed opportunities to address shortcomings in vessel operations and thus enhance safety. Even with a safety management system, the NTSB concluded that Foss Maritime Company provided ineffective oversight of the safety of *Delta Mariner* operations. This case illustrated that SMS is a tool for promoting risk mitigation behaviors and safety-oriented attitudes, but an effective SMS, even when regularly audited and found compliant with the ISM Code, depends greatly upon the commitment and motivation of all involved with the system to maintain its viability and effectiveness.

The incorporation of an SMS into operations of the *Andrew J. Barberi*, particularly in emergency response and management, clearly demonstrates the benefits of these safety measures as well as a commitment to the intent of SMS principles. On May 23, 2013, the Coast Guard wrote to the NTSB, stating that it agreed with Safety Recommendation M-12-3 and was developing appropriate regulations for all US-flag passenger vessels. This response is a positive step. Nonetheless, more than 3 years have passed since Congress authorized the Coast Guard to mandate SMS, and nearly 1 year has passed since the Coast Guard indicated its intent to initiate rulemaking—without result. Until safety management systems are mandated for all US passenger vessels, an unacceptable variation in the standards of passenger and crew safety will persist between ferry operators. The NTSB is committed to the implementation of safety management systems on board all US-flag passenger vessels and therefore reclassifies Safety Recommendation M-12-3 "Open—Unacceptable Response."

2.4 Vessel Performance Data and Accident Prevention

2.4.1 Data Recording on the *Seastreak Wall Street*

The ferry was not fitted with a voyage data recorder, nor was such carriage required for domestically operated passenger ferries. A VDR is a fire- and crash-protected recorder that captures critical vessel information as well as audio from the bridge environment. This information can be accessed by investigators following accidents and reviewed by vessel operators as part of their SMS programs.

The NTSB previously recommended requiring VDR installation on newly built ferries and, for existing ferries, retrofitting a simplified VDR (S-VDR). An S-VDR, suitable for retrofitting on existing vessels, is required to record fewer parameters related to command and control of a vessel in addition to basic ship data, if the information was not available on the bridge in digital format.[20] As the Coast Guard deemed the *Seastreak Wall Street* repowering project a "major conversion," Seastreak likely would have been required to include a fully capable VDR in the refitting of the vessel had domestic passenger ferries been subject to VDR carriage requirements.[21] The history of NTSB recommendations regarding VDRs is discussed further in section 2.4.2.

Although some operating data were recorded by the engine monitoring units, VDR data would have provided more complete evidence regarding several significant aspects of the allision. For instance, a VDR could have recorded comprehensive engine, propeller, and steering orders and responses as well as audio recordings and main alarm activity. These data sets would have been central to determining the causes of the allision, and even an S-VDR on board the ferry, where data were available in digital form, would have captured this information.

System information. Because the propulsion control system did not record any system information, investigators could not independently determine which control station was active when transfer between stations was initiated, which engine and propeller pitch commands were received by the propulsion system, and whether the propulsion system responded correctly. A VDR would have recorded this information. In addition, standard data recordings would have identified the time and magnitude of steering commands and system responses, which, along with evidence from other sources, would have helped to establish a more precise record of the captain's actions as he approached the pier.

Audio recording. The captain stated he recalled hearing an alarm at the starboard station at some time during his attempt to transfer control. He said he did not know which alarm sounded

[20] IMO performance standards for S-VDRs (Resolution MSC.163(78)) require that any additional items not specified in the S-VDR standard but listed by IMO with the requirements set out in full VDR standard (Resolution A.861(20)) "should be recorded when the data is available in accordance with the international digital interface standards using approved sentence formatters (IEC 61162)."

[21] In most cases, Coast Guard laws and regulations treated a vessel that had undergone "major conversion" as a new vessel as defined in 46 U.S.C. 2101(14a). In such cases, the owner was required to bring the entire vessel into compliance with the latest safety standards when reasonable and practicable.

or at what point, and available data were insufficient to identify its cause or what it indicated. A VDR can record the time and identity of all major system alarms as well as a time-stamped audio record of all audible alerts that had activated.

In addition, an audio recording from the bridge would have captured any comments by the captain or mate during the minutes before the allision, such as the captain's observations regarding the difficulties he was experiencing and the nature of interactions between the two officers.

Propeller pitch. A VDR would have captured how much pitch was ordered and delivered on each shaft, in what direction, and at what point in the voyage as well as activation of any pitch failure alarms. These data would have enabled investigators to determine when operational mode changes occurred.

Commands and system responses during voyage. Data recorded by the engines' electronic monitoring units were useful in understanding engine speed orders received, actual engine speeds, and engine load (torque) conditions. However, these data provided a limited record of engine parameters because most were recorded less frequently than a VDR requires. VDRs currently record 12 hours of data at a consistent frequency of one sample every second; therefore, a more detailed and longer account of the captain's engine control inputs and engine responses would have been available for analysis.

Actual propulsion commands. According to statements made by the captain, he slowed the vessel from 30 knots (100 percent thrust) to 0 thrust before attempting to transfer propulsion control. AIS speed data indicate a somewhat different record of engine thrust, such as an increase in throttle position and a possible attempt to transfer control at an order lever position other than 0 percent. While some engine data were recorded, in this critical portion of the voyage, data were recorded only once per minute. Had a VDR been fitted to the *Seastreak Wall Street*, an unambiguous, higher resolution record of propulsion and steering control inputs and system responses would have been available for analysis, and the vessel control actions made by the captain would have been better understood by investigators.

Common time reference. All four electronic data sets recovered by investigators were recorded on an independent time reference. A VDR records data using a common time reference for all parameters. Had the ferry been fitted with a VDR, an unambiguous time reference for the data would have been available, which would have removed the uncertainty in correlating four sets of independently timed information.

The benefits of recording operational data have led operators in other transportation modes to voluntarily equip their vehicles with recording devices. For example, many railroads have outfitted their locomotives with forward-facing video cameras, and many helicopter models now come equipped with cockpit area video, voice, and data recorders. Many motorcoach operators have equipped their coaches with inward- and forward-facing video cameras as well as engine data monitors.

In addition to providing accident investigation benefits, VDRs can be valuable tools in a company's SMS. Operators can review crew and vessel performance through data obtained during actual operations. The data can be used to study incidents, analyze vessel performance, and train operators.

Although investigators gathered vital information from AIS reports, engine monitors, interviews, testing, documentation, and many other sources, the absence of a VDR on board the *Seastreak Wall Street* precluded access to additional critical data. Further, VDR records would have yielded information that could have enhanced the range and depth of evidence subject to analysis, closed gaps in information, and allowed resolution of conflicting information. The NTSB therefore concludes that information that could have been captured by a voyage data recorder would have enhanced the NTSB's analysis of the loss of vessel control that caused the allision.

2.4.2 Previous NTSB Action Regarding Voyage Data Recorders

Since 1976, the NTSB has consistently supported the fitting of recording devices such as VDRs in ferries and other vessels.[22] Initially, the Coast Guard rejected the recommendations, citing excessive equipment cost and suggesting that VDRs were of limited value to investigations. The Coast Guard later concurred with the intent of subsequent new recommendations but took little positive action for reasons including funding limitations for studying the VDR issue.

Since the development of international regulations for VDRs in 2000, the NTSB has investigated several other passenger vessel accidents in which the lack of information that would have been provided by a VDR created challenges for the investigation. For example, in its report on the 2008 collision of the US passenger ferry *Block Island* and Coast Guard cutter *Morro Bay*, the NTSB cited the reliance on limited information from crew and passenger interviews, electronic chart information, and security camera video (NTSB 2010). Data such as recorded conversations of crewmembers on the bridge, radar screen images, and vessel propulsion and steering control information were not available to investigators because neither vessel was fitted with a VDR. As a result of this investigation, the NTSB issued two recommendations to the Coast Guard:

> Require installation of voyage data recorders that meet the international performance standard on new ferry vessels. (M-10-5)
>
> Require installation of voyage data recorders on ferry vessels built before the enactment of voyage data recorder carriage requirements that will record, at a minimum, the same video, audio, and parametric data specified in the International Maritime Organization's performance standard for simplified voyage data recorders. (M-10-6)

The Coast Guard did not concur with the recommendations, citing findings from its own 2008 congressionally mandated study to support its position (USCG 2008). The Coast Guard

[22] The NTSB initially called for the fitting of "automatic recording devices," and later "voyage event recorders," before the development of international performance standards and the adoption of the term voyage data recorder.

study recommended against requiring VDRs or S-VDRs on ferries but acknowledged the value of recorded vessel information and recommended instead that ferries be required to capture the same type of information a VDR recorded. The study found that VDRs would have provided relevant information in a small percentage of a set of historical accidents, that VDRs were a costly means to gain meager benefits, and that electronic chart systems (for which carriage requirements currently are still pending) would have recording capabilities similar to those of a VDR.[23] As a result of the Coast Guard's position, the NTSB considered this response unacceptable.

The 2008 Coast Guard VDR study analyzed accident data for only the 75 largest US ferries, which was not a representative sample. In early 2014, 549 passenger ferries were operating in the United States. The Coast Guard conclusion regarding VDR benefits likely would have been different if the study had analyzed accident data for all ferries that would be subject to carriage requirements proposed by NTSB.

The NTSB disagrees with the Coast Guard's assessment because passenger safety is the most important aspect of vessel operations. The benefits to the traveling public warrant the installation of VDRs on passenger ferries, even if the costs of such installation are considered to be a burden. The NTSB has repeatedly found that when VDR data are available, investigations are more likely to result in well-developed findings and recommendations to enhance safety.

The NTSB's investigation of the 2010 allision of the passenger ferry *Andrew J. Barberi* also was hampered by a lack of VDR information. Although investigators obtained CCTV video recordings from the bridge, the system could not capture, record, and safeguard important detailed data from vessel navigation and control systems. As a result, investigators relied on witness statements, AIS data, and limited recorded engine data, and did not have the benefit of the rich data set that a VDR could have provided. The NTSB report of this accident reiterated VDR recommendations M-10-5 and M-10-6 from the *Block Island–Morro Bay* accident investigation.

The Coast Guard responded to the NTSB's reiteration of these recommendations by restating that it "feels that its original response remains appropriate" and the overall benefits of VDRs do not justify the cost. The NTSB strongly disagrees with this position. The cost of data recording devices has fallen dramatically in recent years. Although the NTSB realizes installation costs remain a barrier for older vessels, the S-VDR standard recognizes the challenges of interfacing with older vessels and makes allowances based on the equipment installed and the availability of the data in electronic format on the bridge. Installation of VDRs on new vessels during initial construction or vessels undergoing major refit, such as the *Seastreak Wall Street*'s 2011 modification, present a much lower cost hurdle.

The Coast Guard did not restate its previously expressed view that an electronic chart system (ECS) would have recording capabilities similar to those of a VDR, perhaps because the

[23] The US Marine Transportation and Security Act of 2004 mandated electronic navigation charts for all vessels required to be fitted with an AIS. According to a recent meeting summary report of the Coast Guard-sponsored National GMDSS Implementation Task Force, the Coast Guard work on this rulemaking is proceeding, and "the greatest challenges are determining its economic impact and which non-SOLAS vessels should be outfitted." (See References, USCG 2013, "Newsletter and Summary Record of 26 September 2013 Meeting.")

Coast Guard's rulemaking project for ECS carriage requirements has been pending for nearly 10 years with little indication of when it might be finalized. In addition, although the ferry was fitted with an ECS capable of recording navigation track history, it was not configured to do so.

Coast Guard regulations at 46 CFR categorized passenger vessels into three distinct classes. The largest passenger vessels were classified as Subchapter H and Subchapter K vessels, and the smallest passenger vessels were classified as Subchapter T vessels.[24] The NTSB believes that the greatest risk to passenger safety exists on vessels carrying the highest numbers of passengers, and therefore believes that these vessels should carry VDRs meeting the IMO performance standards. The IMO VDR standards were developed and revised over a number of years with input from accident investigators from many IMO member countries. These VDR performance standards represent the best thinking regarding which data are most important to accident investigation and how that data should be recorded in terms of security, integrity, format, and resolution. Equipment meeting IMO VDR performance standards has been successfully installed on thousands of vessels around the world, is competitively priced, and is available in the marketplace now.

This investigation again demonstrated the high value of VDR data to accident investigation, and the NTSB therefore recommends that the Coast Guard require installation of voyage data recorders that meet the International Maritime Organization's performance standard on new ferry vessels subject to 46 *Code of Federal Regulations* Subchapters H and K.

Further, recognizing the technical and financial challenges facing the installation of VDRs on existing (and usually older) vessels, the NTSB recommends that the Coast Guard require installation of voyage data recorders that meet the International Maritime Organization's performance standard for simplified voyage data recorders on existing ferry vessels subject to 46 *Code of Federal Regulations* Subchapters H and K. In light of these new recommendations, the NTSB reclassifies Safety Recommendations M-10-5 and M-10-6 "Closed—Unacceptable Action/Superseded."

Moreover, the NTSB recognizes that for many smaller ferries subject to Subchapter T regulations, installation of a VDR or S-VDR meeting international IMO performance standards is usually not technically or financially feasible, and a lower cost solution could be developed and applied to these vessels. The NTSB therefore recommends that the Coast Guard develop a US voyage data recorder standard for ferry vessels subject to 46 *Code of Federal Regulations* Subchapter T and require the installation of such equipment where technically feasible.

[24] Subchapter H applies to passenger vessels of greater than 100 gross tons. Subchapter K applies to vessels of less than 100 tons that carry more than 150 passengers or have overnight accommodations for more than 49 passengers. Subchapter T applies to vessels of less than 100 tons that carry 150 or fewer passengers or have overnight accommodations for 49 or fewer passengers.

3 Conclusions

3.1 Findings

1. Mechanical failure, distraction due to cell phone use, fatigue, use of alcohol or illicit drugs, the captain's health, and weather were not factors in this accident.

2. The emergency response by the Fire Department of the City of New York was timely and appropriate.

3. The captain did not return the propulsion control system to Combinator mode after switching to Backup mode earlier in the voyage.

4. The captain successfully transferred rpm control to the starboard station, and he attempted to slow the vessel by moving the order levers astern; however, this input resulted in forward acceleration because the system was in Backup mode.

5. The point in the voyage at which the captain initiated transfer of the *Seastreak Wall Street*'s propulsion control did not allow sufficient time and distance to react to the loss of vessel control.

6. The propulsion control system on the *Seastreak Wall Street* used poorly designed visual and audible cues to communicate critical information about mode and control transfer status.

7. Seastreak LLC bridge control transfer procedures at the time of the accident were inadequate as they did not reflect the new propulsion system nor did they define crewmember roles, which contributed to the loss of vessel control.

8. The number and severity of injuries resulting from this accident could have been mitigated by alerting passengers and controlling their access to stairwells during docking and undocking.

9. Seastreak LLC provided ineffective oversight of the operation of the *Seastreak Wall Street*, including maintaining procedures that did not apply to the new propulsion configuration, providing inadequate crew training, and poorly identifying and mitigating risks.

10. Information that could have been captured by a voyage data recorder would have enhanced the National Transportation Safety Board's analysis of the loss of vessel control that caused the allision.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of the *Seastreak Wall Street*'s allision with the pier was the captain's loss of vessel control because he was unaware the propulsion system was in Backup mode. In addition, his usual method of transferring control from one bridge station to another during the approach to the pier did not allow sufficient time and distance to react to the loss of vessel control. Contributing to the accident was Seastreak LLC's ineffective oversight of vessel operations. Contributing to the severity of injuries was Seastreak LLC's lack of procedures to limit passenger access to stairwells on the *Seastreak Wall Street* during potentially high-risk situations such as vessel docking and undocking.

4 Recommendations

4.1 New Recommendations

To the United States Coast Guard:

Develop and implement human factors standards for the design of critical vessel controls for US-flag ships to include clearly identifiable and understandable audible alerts and displays indicating which mode is engaged. (M-14-1)

Distribute the National Transportation Safety Board safety alert outlining the circumstances of this accident to warn passenger vessel operators of the need to control passenger access to stairwells while performing maneuvers such as docking and undocking. (M-14-2)

Require installation of voyage data recorders that meet the International Maritime Organization's performance standard for voyage data recorders on new ferry vessels subject to 46 *Code of Federal Regulations* Subchapters H and K. (M-14-3)

Require installation of voyage data recorders that meet the International Maritime Organization's performance standard for simplified voyage data recorders on existing ferry vessels subject to 46 *Code of Federal Regulations* Subchapters H and K. (M-14-4)

Develop a US voyage data recorder standard for ferry vessels subject to 46 *Code of Federal Regulations* Subchapter T and require the installation of such equipment where technically feasible. (M-14-5)

To Seastreak LLC:

Work with Scana Mar-El AS to implement a modification to the Neptune Compact propulsion control system that includes clearly identifiable audible alerts and easily visible and understandable displays to remind the operator when Backup mode is engaged. (M-14-6)

Expedite the complete implementation of a safety management system for your fleet that is appropriate for the characteristics, methods of operation, and nature of service of your vessels and the size of your operations. (M-14-7)

Revise your operations and training manuals to include better utilization of crew and procedures for standard bridge operations, vessel emergencies, and control of passenger access to stairwells during docking and undocking. (M-14-8)

To Scana Mar-El AS:

Modify your design for new Neptune Compact propulsion control systems to include clearly identifiable audible alerts and easily visible and understandable displays that will remind the operator when Backup mode is engaged and revise your owner's manual accordingly. (M-14-9)

Design a solution for existing Neptune Compact propulsion control systems to include clearly identifiable audible alerts and easily visible and understandable displays to indicate to operators when Backup mode is engaged, revise your owner's manual accordingly, and alert your customers to the circumstances of this accident and to the availability of the retrofit solution. (M-14-10)

4.2 Previous Recommendations Reclassified in This Report

Two previous recommendations to the United States Coast Guard are reclassified "Closed—Unacceptable Action/Superseded":

To the United States Coast Guard:

Require installation of voyage data recorders that meet the international performance standard on new ferry vessels. (M-10-5)

Require installation of voyage data recorders on all ferry vessels that will record, at a minimum, the video, audio, and parametric data specified in the International Maritime Organization's performance standard for simplified voyage data recorders. (M-10-6)

Safety Recommendations M-10-5 and M-10-6, previously classified "Open—Unacceptable Response," are superseded by Safety Recommendations M-14-3 through M-14-5 in section 2.4.2.

One previous recommendation to the United States Coast Guard is reclassified "Open—Unacceptable Response":

To the United States Coast Guard:

Require all operators of US flag passenger vessels to implement safety management systems, taking into account the characteristics, methods of operation, and nature of service of these vessels, and, with respect to ferries, the sizes of the ferry systems within which the vessels operate. (M-12-3)

This recommendation, previously classified "Open—Acceptable Response," is reclassified in section 2.3.3.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

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Member

CHRISTOPHER A. HART
Vice Chairman

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Member

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Member

Adopted: April 8, 2014

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Appendix A—NTSB Investigation Information

The National Transportation Safety Board launched a team of investigators and a Board Member to the accident scene the afternoon of January 9, 2013, the day of the allision. The Coast Guard classified the accident as a major marine casualty, and the NTSB was designated the lead federal investigative agency. The NTSB team collected initial information from the accident scene, conducted extensive propulsion testing on the *Seastreak Wall Street*, and later visited the vessel to perform a damage assessment, witness installation of a pitch deviation alarm, and review operation of the propulsion control system. NTSB investigators also visited the propulsion equipment manufacturers headquartered in Norway.

Parties to the NTSB investigation were the Coast Guard; Seastreak LLC; the New York City Department of Transportation, owner of the pier; Servogear AS, manufacturer of the controllable pitch propulsion system; and Tognum America, the engine manufacturer.

Appendix B—NTSB Safety Alert

NTSB
SAFETY ALERT
National Transportation Safety Board

Passenger Vessels: Stairway Hazards during Docking and Undocking

Falls in stairways caused serious injury in recent passenger vessel allision while docking

The problem

The NTSB recently investigated a vessel accident in which people were seriously injured when the vessel allided with the dock.

Five stairways provided passenger access between three deck levels. As the vessel approached the pier, some passengers stood in stairways as they anticipated arrival. When the vessel unexpectedly struck the dock, passengers lost their balance and fell, causing head injuries, fractured ribs, and cuts and bruises. The most severely injured passenger fell down a stairway and suffered a broken neck, brain hemorrhage, lung collapse, facial fractures and lacerations, and nerve injuries. He spent more than 5 weeks in a hospital.

The NTSB encourages vessel operators to control passenger access to stairways while docking and undocking.

What can be done?

- Vessel passengers: Even if you see unrestricted stairways on board your vessel, please avoid them during docking and undocking. A momentary loss of balance can cause you to fall and be seriously injured.

  Reduce the risk of injuries by remaining seated or holding on to a handrail or seat back during docking. Always be prepared for unexpected vessel movement.

- Vessel operators: To reduce the risk of serious injuries, develop procedures to control passenger access to stairways during docking and undocking.

For more information about this accident, see *Allision of Passenger Vessel* Seastreak Wall Street *with Pier 11, Lower Manhattan, New York, New York, January 9, 2013.* The report is available at www.ntsb.gov under report number NTSB/MAR-14/01.

Appendix C—NTSB Vessel Power Study

The following excerpts are from an NTSB *Seastreak Wall Street* power study analyzing data from AIS and the vessel's engine monitoring systems related to propeller pitch, engine rpm, and power.

This power study was conducted to determine if the accident data were consistent with operation in Combinator mode or Backup mode. The ferry's propulsion was normally controlled in Combinator mode, in which order lever position controlled propeller pitch and engine rpm, according to a predetermined schedule, as shown in figure C-1. In Backup mode, propeller pitch was controlled independently of the order lever, which controlled only the engine speed.

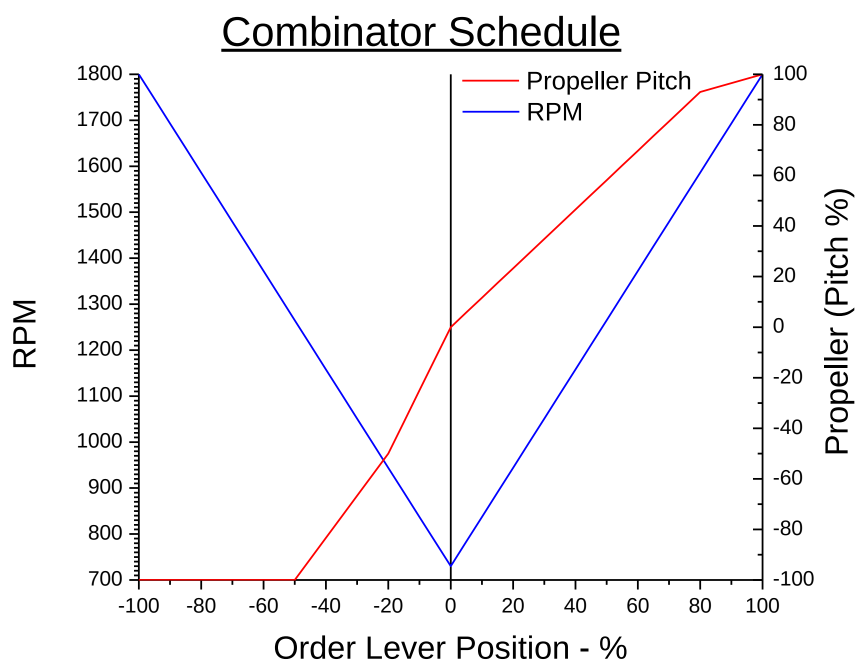

Figure C-1. Combinator mode schedule.

Figure C-2 shows torque as a function of shaft horsepower for two decelerations from 30 knots in Combinator mode.

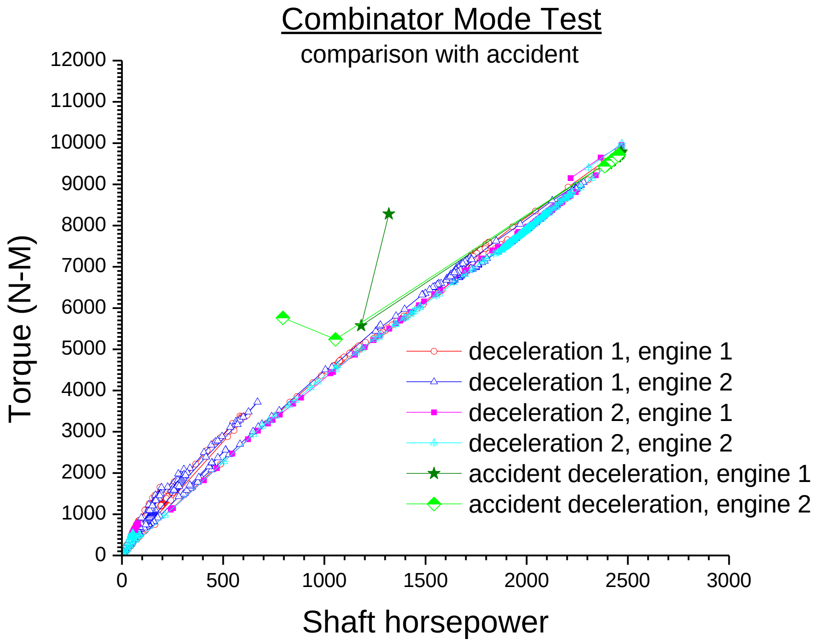

Figure C-2. Torque versus shaft horsepower in Combinator mode.

Engine data were recorded once per minute before the allision. Acceleration is plotted with shaft horsepower in figure C-3 to indicate the power change trends required for the recorded speed. The acceleration curve indicates that the power reduction occurred about 0839:30, approximately 40 seconds after the last recorded 2500-horsepower engine data point. The acceleration curve also shows that forward power was increased about a minute before the allision. This would require an increase in rpm and, thus, rpm control.

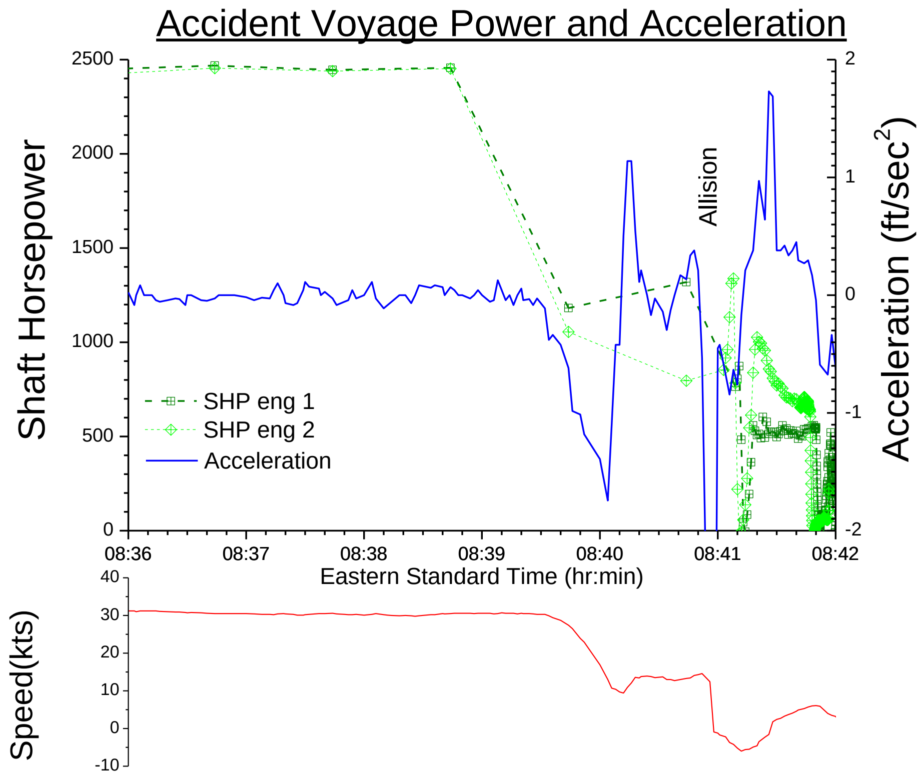

Figure C-3. Power, speed, and acceleration.

The data were also examined to check whether the power parameter relationships earlier in the voyage could provide insight into the propulsion control mode (Combinator or Backup). Calculated power, recorded rpm, torque, and speed are plotted in figure C-4 for the accident voyage. Note that AIS speed data were not available before about 0805. The engine traces indicate acceleration to cruise beginning about 2 minutes earlier and accompanied by a power spike to about 2335 shaft horsepower.

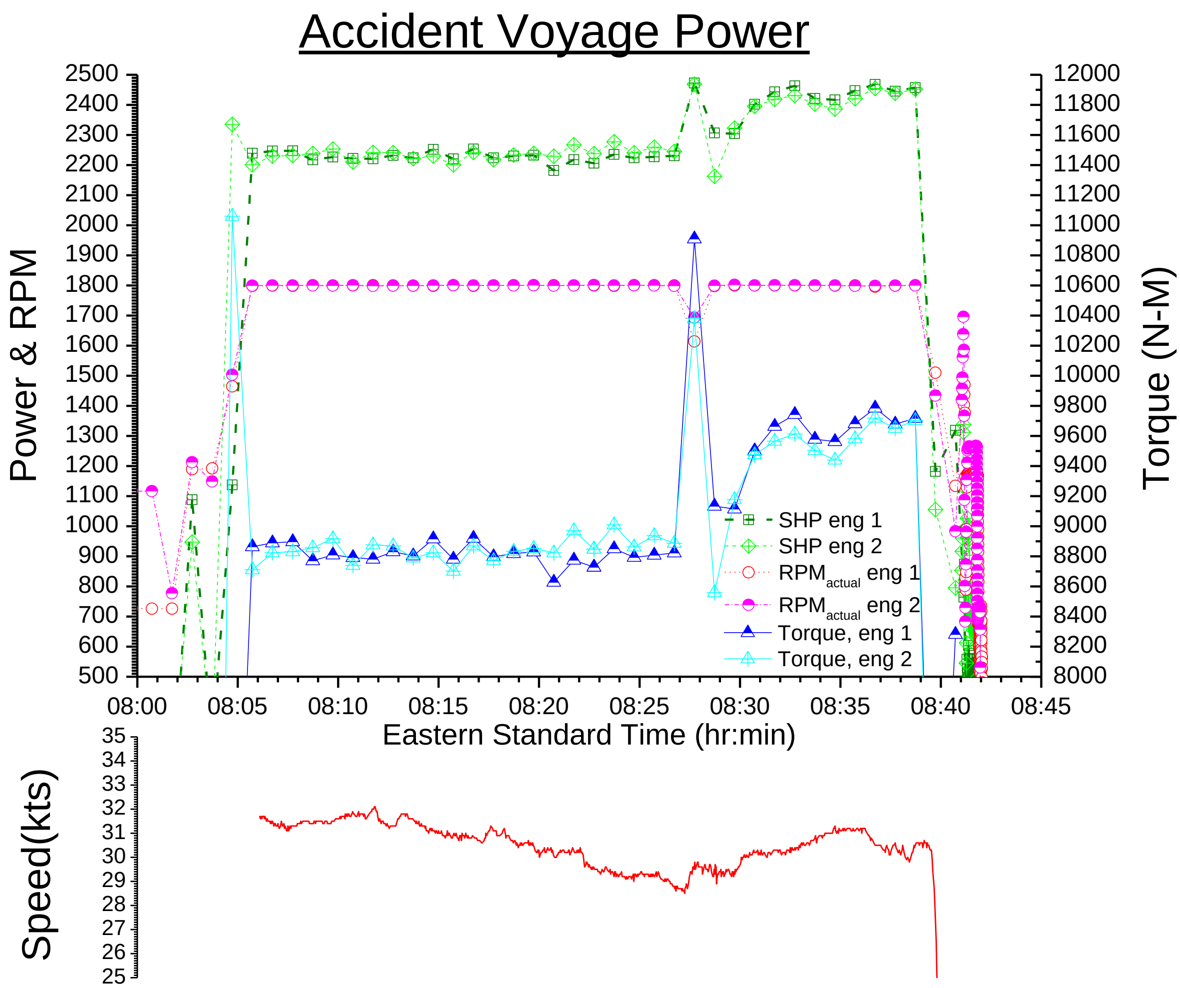

Figure C-4. Engine rpm, power, torque, and speed for the accident voyage.

In Combinator mode, the order levers controlled engine rpm and propeller pitch, and thus power. Until about 0820, a fixed relationship existed between the three parameters. About 0820, the port and starboard torque and power separated while engine rpm remained constant at 1800 rpm. The steady rpm indicates that the command lever position must have been constant through this period. At 0827, torque and power increased while rpm decreased. This was not possible in Combinator mode, indicating that the vessel was in Backup mode by this time. After 0827, the engines returned to 1800 rpm while torque decreased briefly below the earlier cruise value before increasing to a value significantly above the earlier cruise value at 0831. These torque changes were thus independent of the command lever and necessitated manual pitch changes continuing in Backup mode.

The higher torque and power after 0831 were consistent with lower propeller efficiency than would have occurred with the pitch optimized in Combinator mode. The higher power during this period equaled the power required for the rapid acceleration to cruise speed at the beginning of the voyage. Note this lasts until the deceleration for approaching the dock just before the allision, showing that the vessel was in Backup mode at least until this period.

Torque and rpm for the accident did not follow the relationship required for Combinator mode after 0827. The increase in torque seen in the last pre-allision engine data point is consistent with the behavior expected of a fixed-pitch propeller at a slower vessel speed but is inconsistent with the behavior expected in Combinator mode. The data show a change in power control during the deceleration about a minute before the allision.