Fire On Board U.S. Small Passenger Vessel *Express Shuttle II* Pithlachascotee River Near Port Richey, Florida October 17, 2004

Marine Accident Report

NTSB/MAR-06/02

PB2006-916402
Notation 7770A

National Transportation Safety Board
Washington, D.C.

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Adopted April 4, 2006

National Transportation Safety Board
490 L'Enfant Plaza, S.W.
Washington, D.C. 20594

National Transportation Safety Board. 2006. *Fire On Board U.S. Small Passenger Vessel* Express Shuttle II, *Pithlachascotee River Near Port Richey, Florida, October 17, 2004.* Marine Accident Report NTSB/MAR-06/02. Washington, DC.

Abstract: This report discusses the fire that destroyed the small passenger vessel *Express Shuttle II* on October 17, 2004, at the mouth of the Pithlachascotee River near Port Richey, Florida. The vessel was returning from the Gulf of Mexico after shuttling 78 passengers to an offshore casino boat. Only the master and two deckhands were on board when the fire broke out. None of the crew was seriously injured, although one of the deckhands was treated for smoke inhalation. Firefighters from Port Richey and Pasco County fought the blaze. The vessel, valued at $800,000, was a total loss.

From its investigation of this accident, the National Transportation Safety Board identified safety issues in the following areas: preventive maintenance, crew response to fire emergency, and fire detection systems.

On the basis of its findings, the Safety Board made recommendations to the U.S. Coast Guard, Paradise of Port Richey, and Caterpillar, Inc.

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Acronyms and Abbreviations

CFR	*Code of Federal Regulations*
CO_2	carbon dioxide
COI	certificate of inspection
COTP	captain of the port
MSO	Marine Safety Office
NVIC	navigation and vessel inspection circular
OCMI	Officer-in-Charge, Marine Inspection
PRFD	Port Richey Fire Department
PVA	Passenger Vessel Association
SIP	Streamlined Inspection Program
UL	Underwriters Laboratory

Executive Summary

On the morning of October 17, 2004, a fire broke out in the engineroom of the U.S. small passenger vessel *Express Shuttle II* while it was entering the mouth of the Pithlachascotee River near Port Richey, Florida. The shuttle was returning from the Gulf of Mexico, where it had ferried 78 passengers to an offshore casino boat, and was on its way back to the marina operated by the vessel's owner, Paradise of Port Richey. Only the master and two deckhands were on board when the fire broke out.

None of the crewmembers activated the vessel's fixed carbon dioxide fire suppression system. The crew attempted to fight the fire with portable extinguishers, but when the fire burned out of control, they prepared to abandon ship. A passing recreational boat rescued all three crewmembers. The master and one of the deckhands transferred to another company boat that took them ashore. The recreational boat took the other deckhand to shore, and an ambulance transported him to a local hospital. The deckhand was treated for smoke inhalation, held overnight for observation, and then released. Firefighters from Port Richey and Pasco County fought the blaze, but the vessel, valued at $800,000, was a total constructive loss.

The National Transportation Safety Board determines that the probable cause of the fire on board the *Express Shuttle II* was a fractured, improperly installed fuel injection line on the inboard side of the starboard engine that allowed diesel fuel to spray onto the engine and ignite. Contributing to the cause of the fire was the failure of Paradise of Port Richey to have a preventive maintenance program, which could have identified the company's ongoing problem with the vessel's fuel lines before a failed line led to the fire. Contributing to the extent of the damage were the vessel's faulty fire detection system and the crew's failure to employ proper marine firefighting techniques.

On the basis of its investigation, the Safety Board identified the following safety issues:

- Preventive maintenance
- Crew response to fire emergency
- Fire detection systems

As a result of its investigation of the *Express Shuttle II* fire, the Safety Board makes recommendations to the U.S. Coast Guard, Paradise of Port Richey, and Caterpillar, Inc.

Factual Information

Background

The *Express Shuttle II* was a 65-foot, twin-propeller, double-deck U.S. small passenger vessel (figure 1) inspected by the U.S. Coast Guard and owned by Paradise of Port Richey, operator of the SunCruz Port Richey Casino off Florida's Gulf Coast. Port Richey is at the mouth of the Pithlachascotee River in Pasco County, Florida (figure 2). The casino is part of the Florida day-cruise, or casino cruise, gambling industry. Florida does not have legalized casino gambling. The gambling industry, however, operates casino boats offshore, in international waters outside Florida's jurisdiction.

Figure 1. *Express Shuttle II* en route near Port Richey, Florida.

Casino boats that operate off Florida's west coast "cruise" 9 nautical miles into the Gulf of Mexico, beyond the Florida state line,[1] where passengers can gamble. Small passenger vessels like the *Express Shuttle II* board patrons at onshore facilities and shuttle them to the casino boats. Throughout the day, the shuttle boats return to the casino boats

[1] In accordance with the Submerged Lands Act of 1953, the state waters of most coastal states extend 3 nautical miles from the coastline, as do those on Florida's east coast. For historical reasons, however, the state waters on Florida's west coast extend 3 leagues, approximately 9 nautical miles (10.376 statute miles), into the Gulf of Mexico.

and transport the patrons ashore. According to an online publication of the casino trade, in 2004, the Florida Day Cruise Association operated 17 casino boats in the state.[2] The same publication indicates that casino cruises also operate in Georgia, Massachusetts, South Carolina, and Texas.

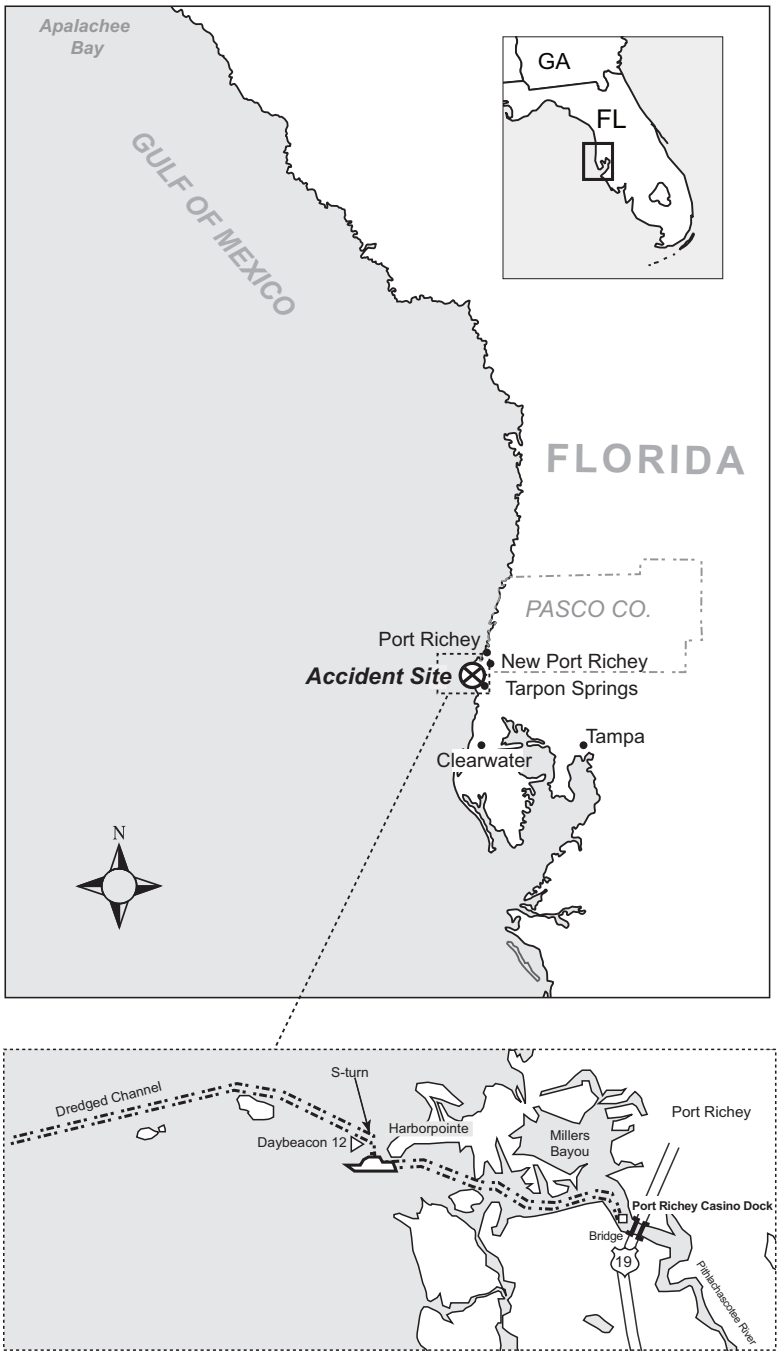

Figure 2. Accident site and other locations referenced in this report**.**

[2] As reported in Gamingfloor.com <www.gamingfloor.com/DayShips/html> (accessed August 31, 2005).

Events Preceding Fire

On October 12, 2004 (5 days before the fire), while transporting passengers from Port Richey to the casino boat *Royal Casino I*, one of the Paradise of Port Richey masters[3] reported to the company's port captain that "grayish" smoke was coming out the *Express Shuttle II*'s starboard engine exhaust port. After the *Express Shuttle II* docked in Port Richey, the port captain took the vessel out of service and contacted Ring Power Corporation (authorized local representative of Caterpillar, Inc., manufacturer of the *Express Shuttle II*'s engines).

On October 13, Ring Power Corporation sent two service technicians to investigate the *Express Shuttle II*'s starboard engine. When interviewed postaccident by Safety Board investigators, one of the technicians said that after the port captain ran the starboard engine for "a second or two," they discovered that the fuel delivery line to the engine's No. 6 cylinder was "broken" and leaking fuel oil. The technician said that no support clamps were installed on the broken fuel line.[4] In bold type at two places in the service manual for its high-performance marine engines provided by Caterpillar, Inc., is the following warning:

> Be sure the fuel injection line clamps are installed in the correct location. Incorrectly installed clamps may allow the fuel injection lines to vibrate and become damaged. The damaged lines may leak and cause a fire.

Caterpillar's service manual also contains several instances of the following warning:

> Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire.

The port captain retrieved a replacement fuel line from the *Express Shuttle II*'s onboard stock, and the field technicians installed it. When the starboard engine was started again, its No. 1 cylinder misfired. The technicians discovered carbon buildup in the engine's No. 1 cylinder and also a crack in the engine cylinder head between the valves on the No. 5 cylinder. The port captain brought a replacement cylinder head from the company's stock but it was inappropriately configured for the *Express Shuttle II* engine, so one of the technicians took the cylinder head to Ring Power Corporation's machine shop in Tampa to have it reworked.

Both technicians returned the next day (October 14) with the reworked cylinder head and reassembled the starboard engine. The technicians and the port captain, accompanied by another Paradise of Port Richey employee, took the *Express Shuttle II* into the Gulf of Mexico to test the engine. It did not perform satisfactorily, but after the technicians adjusted the valves back at the dock, a second trial was successful. One of the technicians told investigators that they did not install any clamps on the replaced fuel line before they left the scene.

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[3] At the time of the accident, Paradise of Port Richey employed two shuttle boat masters.

[4] The clamps, separate pieces of equipment that hold two lines together for mutual support, consist of two plates with grooves where the lines are inserted and a screw that can be tightened to hold the plates together.

On October 15, according to a Ring Power Corporation service report, the company was called again to reassess the *Express Shuttle II*'s starboard engine because it was running at less than full power. The Ring Power technician who made the service call told investigators that he noticed that some of the support clamps on the engine's fuel lines were not attached. He said that he informed a Paradise of Port Richey employee who was helping him about the clamps. The employee said that he "noticed that there was no fuel line clamps on the fuel lines . . . and went ahead and put the fuel line clamps on" while the Ring Power technician was present. The technician, however, said that when he left the vessel, he was not sure whether all the clamps were on.

On Saturday evening, October 16 (the night before the fire), while transporting passengers to the casino boat, the *Express Shuttle II* master who on October 12 had reported smoke coming from the starboard engine's exhaust noticed a "sudden loss of power" that he "determined . . . was probably a fuel line, with the experience of that boat, a fuel injector line." The master told investigators that after his passengers had disembarked onto the casino boat, he shut down the vessel's engines and replaced a leaking fuel line on the outboard side of the starboard engine. He said that he completed the repairs about 2000,[5] while the *Express Shuttle II* was alongside the casino boat.

The master said that this was the third time in 6 months that he had replaced a broken fuel line on the *Express Shuttle II*'s starboard engine, and that all three fuel lines had broken clean at their connection to either the engine or the fuel pump. He also told investigators that other company masters had had the same problem with the starboard engine. Invoices obtained from Ring Power Corporation indicate that Paradise of Port Richey had purchased 13 fuel lines between January 26 and October 13, 2004, on 11 different dates (table 1). The *Express Shuttle II* was the only one of Paradise of Port Richey's vessels equipped with Caterpillar engines, which had external fuel lines (eight on each engine).[6] According to company records, the *Express Shuttle II*'s port engine was rebuilt in February 2004. Company employees told investigators that they did not work on the port engine after it was rebuilt, so all 13 new fuel lines were intended for the *Express Shuttle II*'s starboard engine.

Ring Power Corporation technicians told investigators that ordinarily, the fuel lines were "very durable" and seldom failed. One of the technicians said that it had been "5 or 6 years" since he had seen a broken fuel line, and that the line had failed because of a loose clamp.

[5] All times are eastern standard time, based on a 24-hour clock.

[6] For further information about the vessel's propulsion system, including an engine schematic, see "Vessel Information" section.

Table 1. Fuel lines purchased by Paradise of Port Richey during 2004 for *Express Shuttle II*'s starboard engine.

Invoice Date	Number of Lines	Part Number	Cylinder
January 26, 2004	1	4P-7678	8
February 3, 2004	1	4P-7678	8
February 10, 2004	1	4P-7678	8
March 26, 2004	1	4P-7675	5
April 1, 2004	1	4P-7671	1
May 17, 2004	1	4P-7678	8
July 23, 2004	1	4P-7671	1
	1	4P-7676	6
September 14, 2004	1	4P-7676	6
	1	4P-7677	7
September 21, 2004	1	4P-7671	1
September 23, 2004	1	4P-7677	7
October 13, 2004	1	4P-7676	6
Total	13	--	--

Accident Narrative

At 0930 the morning of October 17, 2004, the *Express Shuttle II* departed the Paradise of Port Richey marina carrying 78 passengers into the Gulf of Mexico, where the *Royal Casino I* was waiting (2 hours earlier, the shuttle had transported the *Royal Casino I*'s crew and employees to the casino boat). The shuttle boat took about 30 minutes to reach the casino boat. After the passengers disembarked, the *Express Shuttle II* began the return trip to the marina. According to the master, the *Express Shuttle II*'s engines ran without difficulty until the vessel reached an area in the dredged channel known as the S-turn (figure 2).

As the vessel neared daybeacon 12, where a posted no-wake zone began, the master said he reduced both engines to idle (about 5 knots). Moments later, the vessel's starboard engine surged to full throttle, then returned to idle. Seconds later, the starboard engine surged again, then shut down, causing a loss of power to the starboard propeller shaft. The master said that when the engine surged, he noticed that the low-voltage annunciator on the instrument panel was blinking.

Powered only by the port engine, the master then began the turn at daybeacon 12. Moments later, he lost power to the port engine. The vessel was about 100 yards from shore. The master said that he continued to turn the vessel, intending to beach it on a sandbar outside the channel. At that point, he said, both deckhands came to the pilothouse and told him that smoke was coming from the engineroom.

Investigators received a slightly different account of events from the deckhands. They said that they were completing their assigned cleanup tasks when they smelled smoke. Deckhand No. 1 said he heard a noise "like something dropped, or . . . grinded," and both

deckhands looked aft and saw white smoke coming from the small hatch astern of the starboard engine (see "Vessel Information" section for construction details). They lifted up the hatch and smoke poured out. Although one deckhand said they closed the hatch, the other said he could not remember whether they had closed it. Deckhand No. 1 said that he then ran to the pilothouse and told the master there was smoke in the engineroom.

Deckhand No. 1 told investigators that when he came back to the main deck, he and the other deckhand moved the tables and chairs out of the way of the larger hatches over the engineroom (the tables and chairs were not fastened to the deck). The deckhands went to the hatch over the starboard engine and when they lifted it, "fire shot out." Deckhand No. 2 ran back to tell the master they had "a bigger situation than we thought," while deckhand No. 1 retrieved a portable fire extinguisher. Neither the deckhands nor the master recalled hearing an alarm go off in the pilothouse or anywhere else on the vessel before or during the fire, and none of them attempted to activate the *Express Shuttle II*'s manually operated carbon dioxide (CO_2) fire suppression system, located in the fuel compartment, forward of the engine compartment (see "Vessel Information" section for details about the fire detection and fire suppression systems). According to investigators' interviews with the crewmembers, the master was aware of the CO_2 system but the deckhands were not.

The master said that he came down to the cabin and so much smoke was coming out of the small engineroom hatch that he "couldn't go down there." He and deckhand No. 2 then tried to lift the larger hatch over the starboard engine so deckhand No. 1 could direct the portable extinguisher at the fire, but flames and black smoke poured out. The master said they lifted the hatch 1 1/2 to 2 inches and that the flames were "like a blowtorch." They dropped the hatch back over the opening. The master said the cabin was so full of smoke "you couldn't hardly breathe."

The master then went forward to retrieve the fire hose from its rack and directed deckhand No. 1 to turn on the fire pump switch, located at the rear of the cabin. The master then realized that without the engine running, the fire pump would not operate (the pump was driven by one of the engines[7]). Deckhand No. 1 reported feeling dizzy, and all three crewmembers left the cabin and went to the vessel's bow. By that time, they said, flames were climbing up the starboard cabin bulkhead and into the pilothouse.

At this point, the operator of a passing recreational boat, who happened to be an off-duty Coast Guard rescue swimmer, came alongside the *Express Shuttle II* and offered assistance. The master and deckhands abandoned the *Express Shuttle II* and boarded the recreational boat. (Crewmembers estimated that this was about 20 minutes after they first noticed the fire.) Shortly thereafter, a smaller Paradise of Port Richey boat arrived and the master and deckhand No. 2 climbed on board. The recreational boat took deckhand No. 1 to a dock at a commercial establishment, from where he was transported by ambulance to a local hospital.

Fire and rescue units from Port Richey and Pasco County responded to the fire, as detailed in the "Survival Factors" section of this report. Firefighters extinguished the fire by about 1530 that afternoon.

[7] Federal regulations for vessel fire-protection equipment at Title 46 *Code of Federal Regulations* (CFR) part 181.300(d) state: "A fire pump may be driven by a propulsion engine."

Injuries

Safety Board reports of marine accidents classify injuries according to the criteria of 49 CFR 830.2. None of the three crewmembers on board the *Express Shuttle II* sustained an injury meeting the criteria for fatal or serious injuries. Deckhand No. 1 was taken to Morton Plant North Bay Hospital in New Port Richey, 2 miles from Port Richey, where he was treated for smoke inhalation and held overnight for observation. The master and the other deckhand did not seek medical attention. No firefighter injuries were reported.

Damages

As a result of the fire damage, the owner's insurance underwriter declared the *Express Shuttle II* a total constructive loss. The vessel's declared value was $800,000.

Personnel Information

Small passenger vessels carrying more than six passengers for hire[8] may not operate without a valid Coast Guard certificate of inspection (COI), which is issued by the Coast Guard Officer-in-Charge, Marine Inspection (OCMI), for a given marine inspection zone—in this case, Tampa, Florida. The COI stipulates a number of operating requirements, including minimum crew size and qualifications.

When determining the number and competencies of crewmembers, the OCMI considers, among other things, the size of the vessel, its route, the type and horsepower of the vessel's propulsion machinery, the number of passengers the vessel will carry, the type and location of lifesaving equipment installed on the vessel, and the hazards associated with the route and service. According to its COI, the *Express Shuttle II* was required to carry a crew consisting of one master and two deckhands.

Master

The master on the day of the fire,[9] age 64, had 30 years' experience on shrimp boats and tugboats. He told investigators that he had been employed by Paradise of Port Richey for almost 2 years. He held a current Coast Guard license as "master of steam or motor vessels of not more than 100 gross registered tons (domestic tonnage) upon near coastal waters." The master's license was issued on April 17, 2002, and was due to expire on April 17, 2007.

[8] Small passenger vessels are defined by Title 46, *United States Code*, section 2101, as vessels of less than 100 gross tons that carry more than six passengers, including at least one passenger for hire. "Passenger for hire" is defined as "a passenger for whom consideration is contributed as a condition of carriage on the vessel, whether directly or indirectly flowing to the owner, charterer, operator, agent, or any other person having an interest in the vessel."

[9] A different master from the one who experienced problems with the *Express Shuttle II* in the days before the fire.

The master stated that he had rested well in the 72 hours before the accident. He told investigators that he was a "borderline diabetic" and took glucose every morning to control the disease. He also said that he took medication for his prostate and an antibiotic for rosacea. He told investigators that he knew of no side effects of those medications that would affect his ability to operate the vessel.

Deckhand No. 1

Deckhand No. 1, age 19, had worked for Paradise of Port Richey for 2 months at the time of the accident. He told investigators, "I've been on boats my entire life." He did not hold and was not required by Federal regulations to hold any Coast Guard documents (see discussion of regulatory requirements under "Training," below). He stated that he had received no formal maritime training before joining the company and that he trained as a deckhand on the job. He told investigators that he had been present when the other master changed the fuel line on the *Express Shuttle II* the night before the fire.

Deckhand No. 2

Deckhand No. 2, age 32, had worked for Paradise of Port Richey for less than 1 month. He did not hold and was not required by Federal regulations to hold any Coast Guard documents. He had no formal maritime training; his most recent job was in retail sales. He told investigators that he was present when the Ring Power Corporation technicians worked on the *Express Shuttle II*'s starboard engine 4 days before the fire.

Training

Regulatory Requirements. To be certified as the master of a small passenger vessel, an individual must serve for at least 1 year on the type of vessel for which he or she is seeking licensure and must pass a license examination. To pass a licensing test, an individual must demonstrate that he or she is conversant in a number of subjects, including, but not limited to, piloting, shiphandling, watchkeeping, first aid, fire prevention and firefighting appliances, and emergency procedures. After passing the test, a master is not required to undergo periodic training or to be tested on subject-matter knowledge, except as a participant in drills conducted by the Coast Guard as part of its annual inspections (see "Vessel Certification and Inspection" for more information).

The CFR does not require deckhands on small passenger vessels to hold Coast Guard licenses or documents or to possess formal qualifications for their positions. Regarding emergency duties such as firefighting, abandoning ship, and rescuing people in the water, 46 CFR 185.420 stipulates the following, in part:

> The owner, charterer, master or managing operator shall instruct each crewmember, upon first being employed and prior to getting underway for the first time on a particular vessel and at least once every three months, as to the duties the crew member is expected to perform in an emergency including, but not limited to, the emergency instructions listed on the emergency instruction placard required by 185.510 of this part. . . .

In addition, the master of the vessel is required to conduct emergency drills, as stipulated by 46 CFR 185.520:

> The master shall conduct sufficient drills and give sufficient instructions to make sure that all crewmembers are familiar with their duties during emergencies that necessitate abandoning ship or the recovery of persons who have fallen overboard.

The master is also required by 46 CFR 185.524 to

> conduct sufficient fire drills to make sure that each crew member is familiar with his or her duties in case of a fire.

Title 46 CFR 185.520(f) and 46 CFR 185.524(d) require that abandon ship/man-overboard drills and fire drills be logged or otherwise documented for review by the Coast Guard on request. The records must include the date of the drill and a general description of the drill scenario and the training topics discussed.

Navigation and Vessel Inspection Circular 1-91. In February 1991, the Coast Guard issued a navigation and vessel inspection circular (NVIC) recommending qualifications and training for deckhands on small passenger vessels. The NVIC (No. 1-91) states, in part,

> The Coast Guard and the industry recognize that a Small Passenger Vessel's licensed officer(s) would be unable to navigate the vessel and effectively respond to emergencies such as fire, engineering casualties, collision, flooding, medical emergencies, man overboard, etc., without the assistance of trained and qualified deckhands.

The NVIC further states, "The employment and training of qualified deckhands is the responsibility of the marine employer (46 CFR 15.103)" and "the Coast Guard is responsible for determining that Small Passenger Vessels are manned with competent crews."

The stated intention of the NVIC was to provide guidance for marine employers and masters of small passenger vessels to use when structuring training programs for deckhands. The circular was further intended as guidance for Coast Guard OCMIs during inspections for certification and reinspections, when evaluating training programs, and during drills conducted to ensure crew competency.

Regarding firefighting, the NVIC recommends that every deckhand "should be familiar with" the following:

- Fire detection and alarm systems.
- Classes of fires and the appropriate firefighting technique.
- Location and operation of firefighting equipment.
- Location and operation of power, ventilation, and fuel shutoffs.

- Location and operation of watertight doors, hatches, fire-screen doors, and escapes.
- Procedures for mustering passengers.
- Station bill assignment and duties.

Company Training. The deckhands of the *Express Shuttle II* and their supervisors told investigators that all their maritime training had been obtained on the job, either at Paradise of Port Richey or with previous employers (see "Company Operations" for more information on the company's shoreside employees). The deckhands' duties involved cleaning the vessel, handling the lines during docking and undocking, pumping the bilges, and so forth. The deckhands' training consisted of an orientation meeting during which they were informed about their duties and responsibilities. The company also gave employees a five-page handbook entitled "Shuttle Procedures" that listed daily procedures for cleaning the vessel, for checking its lines, and for ensuring that the vessel was refueled every morning by leaving a "fuel note" at the end of each day. The handbook contained no emergency procedures.

The master and deckhands of the *Express Shuttle II* on the day of the fire were not required by the Coast Guard to complete formal firefighting training and according to interviews with Safety Board investigators, none had done so. The master said he had had a "little bit" of firefighting training before he obtained his mariner's license. He told investigators that he was familiar with the vessel's fixed firefighting system (described below) but said he thought there were two 100-pound "bottles."[10] Neither deckhand could tell investigators what kind of portable extinguisher he had used in fighting the fire on the *Express Shuttle II*, and neither knew about the vessel's fixed CO_2 extinguishing system.

Regarding the emergency drills required by 46 CFR 185.520, the master told investigators, "I do a fire drill and a man-overboard drill at least once a month, and when we get new deckhands, I do it more often." He said that he made sure the deckhands knew how to turn on the fire hose and where to direct passengers in case of fire (to the bow if the fire was in the stern and vice versa). He also said that he had never conducted a drill with either of the deckhands who were on the *Express Shuttle II* the day of the fire "because they were new." The master said the emergency drills were documented in a logbook that stayed with the vessel, and that the company did not keep a duplicate record in the office. The fire destroyed the logbook.

[10] Cylindrical pressure containers of compressed gas are commonly called bottles. Such containers, filled with compressed CO_2, are commonly used in fixed fire suppression systems. The *Express Shuttle II*'s fixed fire suppression system is discussed in detail in the next section.

Vessel Information

The *Express Shuttle II* was a double-deck, single-hull fiberglass vessel built in 1997 by Arro Yachts Beaver Shipworks, Inc., of Arundel, Maine.[11] The vessel was originally named the *Gosnold Spirit*. Vessel particulars are as follows:

Length:	65 feet
Beam:	22 feet
Depth:	4 1/2 feet
Gross tonnage:	43
Crew:	3 (1 master, 2 deckhands)
Passenger capacity:	149
Propulsion:	Twin 800-horsepower Caterpillar model 3408 turbocharged diesel engines, two propellers, two rudders

Construction and Equipment

According to the vessel's as-planned drawings and a marine survey conducted in 2000 by Marine Surveys, Inc., of Holiday, Florida, the hull of the *Express Shuttle II* was molded fiberglass with fiberglass-covered stringers,[12] 3-inch-thick floor timbers, and fiberglass-covered plywood bulkheads. Both decks were made of fiberglass-covered plywood, supported by 4-by-4-inch fiberglass-covered spruce stringers.

The enclosed pilothouse was on the forward section of the vessel's upper deck (figure 3). Behind the pilothouse was an open deck with seating for passengers. The lower, or main, deck contained the foredeck, enclosed cabin space for passengers, toilets, and aft deck. Sliding doors on both sides provided egress from the passenger cabin. Exits on the port side of the main deck led to the stern and bow. Inside stairways led to the upper deck from the starboard bow and stern.[13]

The belowdecks area was subdivided by watertight bulkheads into six compartments that contained the fuel tanks, engines, generators, water and waste tanks, fire suppression apparatus, and other equipment (figure 4). The engineroom had a small access hatch in the main deck between the generators and a larger access hatch over each engine. Each of the other compartments also had an access hatch. The vessel had a fire pump driven by a pulley connected to the forward end of the port engine. The vessel had

[11] The company is no longer in business.

[12] A stringer is a supporting brace that runs the length of the hull.

[13] According to 46 CFR 177.500(a), "each space accessible to passengers or used by the crew on a regular basis must have at least two means of escape, one of which must not be a watertight door." Only one means of escape is required in certain circumstances, such as from deck areas of less than 322 square feet (46 CFR 177.500[o]).

one bilge pump, driven by a pulley on the forward end of the starboard engine. The bilge pump could also operate as an emergency fire pump

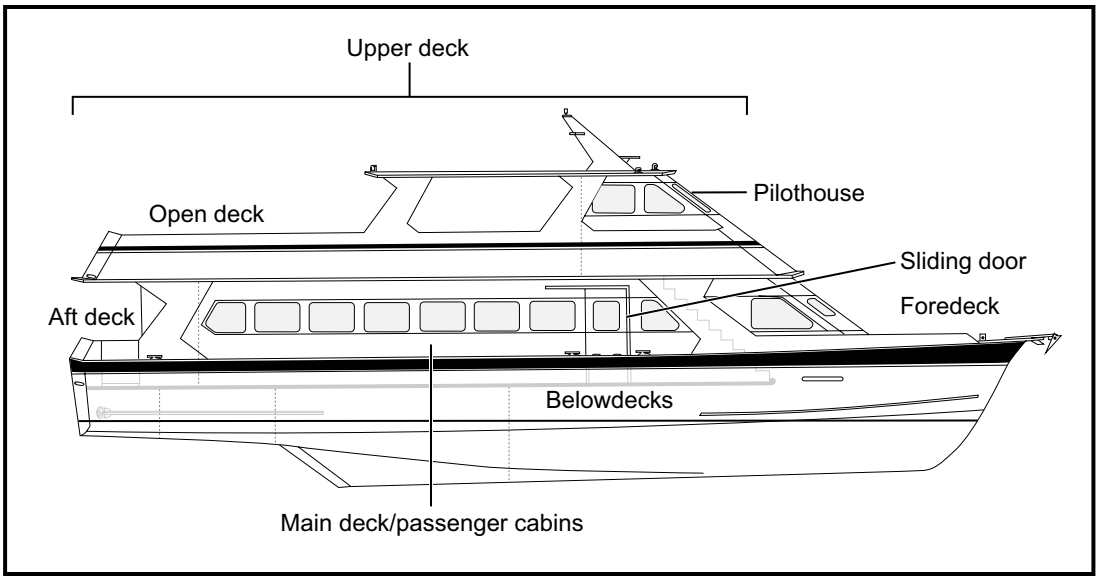

Figure 3. Profile view of *Express Shuttle II*. Passengers were carried in the enclosed cabin or on the open part of the upper deck. The maximum number of passengers allowed on the upper deck was 64.

According to the 2000 marine survey, the *Express Shuttle II*'s navigation equipment included an autopilot, a 24-mile radar, global positioning system instruments, depth-meter, fish-finder, and compass. The vessel was also equipped with two VHF radios and a Nextel cellular telephone.

Propulsion System

The *Express Shuttle II* was powered by two Caterpillar eight-cylinder, 800-horsepower model 3408 diesel engines. The *Express Shuttle II* was the only Paradise of Port Richey vessel with Caterpillar engines. Each engine had two turbochargers, inboard and outboard, and was equipped with aftercoolers.[14] Fuel was delivered from the fuel tanks to the engine cylinders through a series of fuel supply lines (figure 5 illustrates the layout of the *Express Shuttle II*'s engines, including the configuration of the fuel lines). Each engine was coupled to a shaft and a four-bladed propeller by means of an electrohydraulic transmission system. The master controlled forward and reverse engine speeds by moving levers on the pilothouse console.

[14] A turbocharger compresses the air that is forced into the cylinders. The denser air entering the cylinders increases the efficiency with which the engine burns fuel, resulting in increased power output. According to the Caterpillar service manual for the 3408 diesel engine, an aftercooler, essentially a radiator, is positioned between the turbocharger and the engine to cool the air. The air from the turbocharger compressor flows into the aftercoolers and passes through the core assembly, which contains coolant. The cooled air flows out of the aftercooler and into the air chamber, and from there through ports into the cylinder heads.

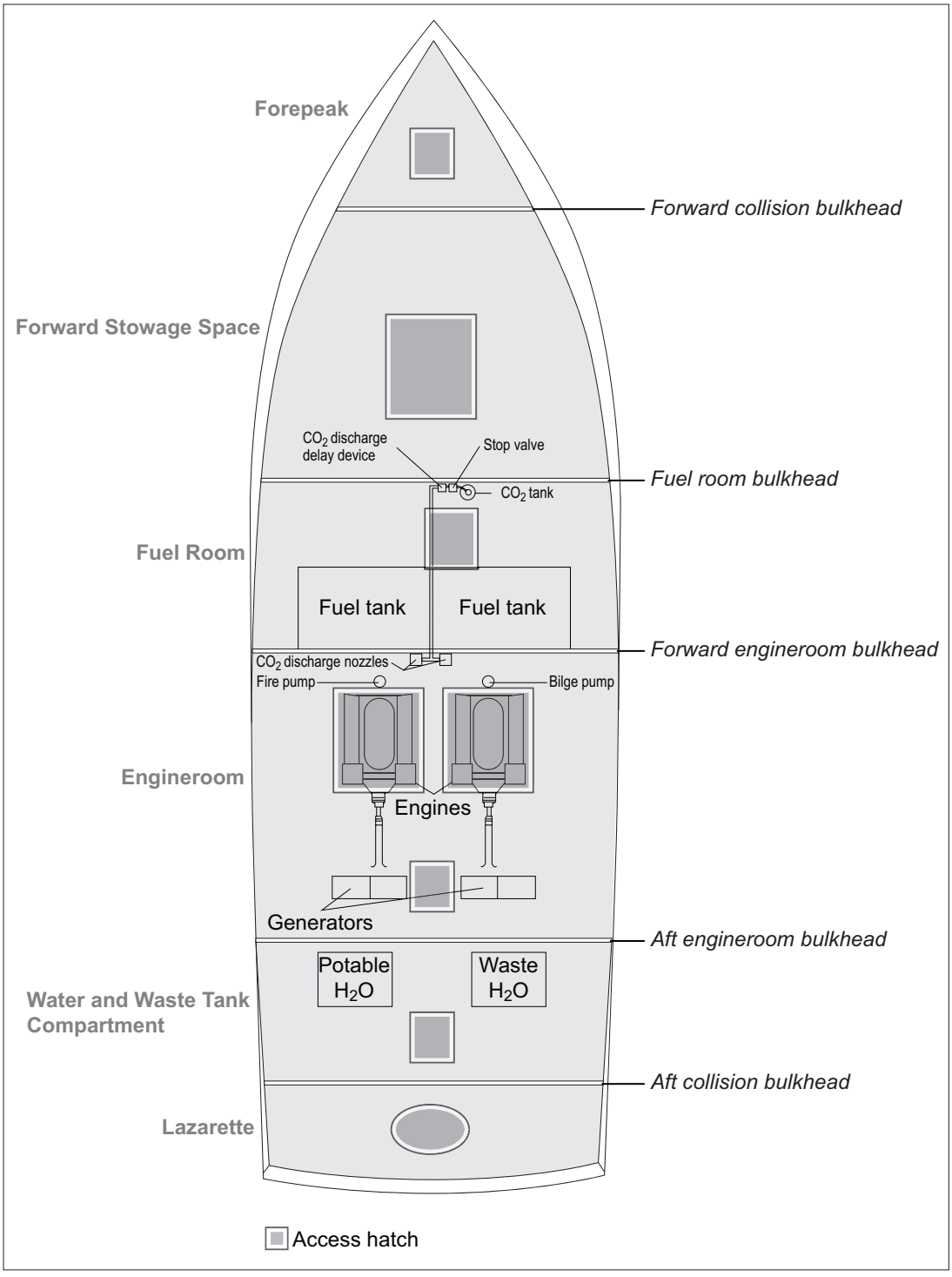

Figure 4. Belowdecks plan of *Express Shuttle II*, showing compartments and equipment (fuel tanks, engines, generators, fixed fire suppression apparatus, potable water and wastewater tanks). The collision bulkheads were watertight partitions installed to protect the vessel from flooding in case of damage to the bow or stern. Shaded areas indicate hatches (covered openings) in the main deck that provided access to the hull compartments.

Ring Power Corporation supplied the Safety Board with the following information regarding the model 3408 Caterpillar engine:

- Average internal operating temperature with engine running at full speed = 1,100° F.
- Average temperature on engine surface = 180° F.
- Pressure in fuel lines = 1,800 psi at valve openings.

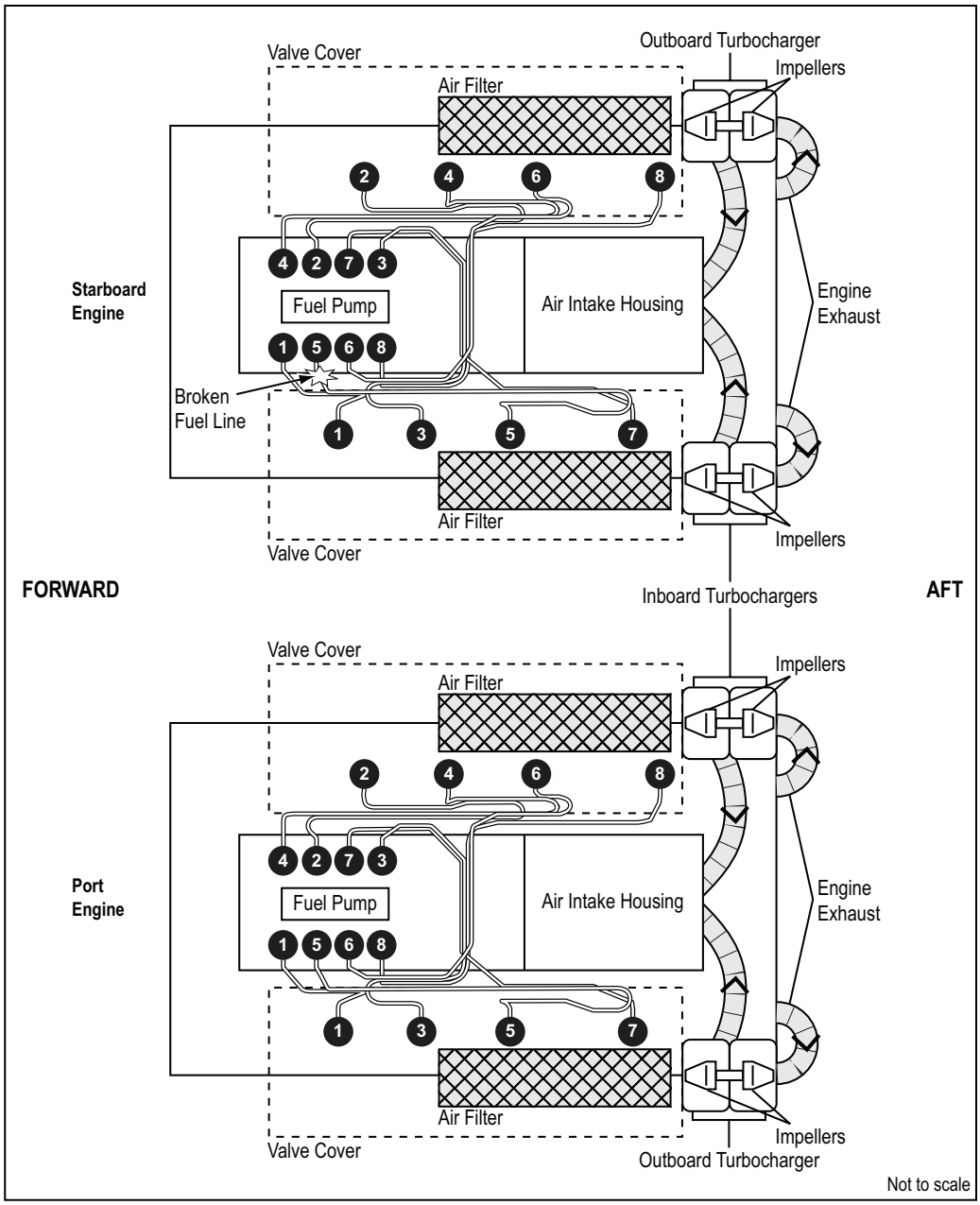

Figure 5. Layout of the *Express Shuttle II*'s engines. Arrow points to the broken fuel delivery line identified during the accident investigation (see "Wreckage" and "Tests and Research" sections).

According to a Ring Power Corporation representative, external temperatures on the *Express Shuttle II*'s model 3408 engines were maintained at an average of 180° F by cooling water that was regulated by thermostat. One section of the exhaust manifold pipe that connected directly to the turbocharger inlet was not water-cooled, however, and temperatures in that section of the pipe could reach over 1,000° F, according to the Ring Power representative.

Electrical power was produced by two Kubota alternating-current generators, one behind each engine (refer to figure 4). Each generator's output was rated at 16 kilowatts. The master on the day of the fire told Safety Board investigators that normally, the vessel operated only one generator at a time. He was not certain which generator was operating at the time of the accident. None of the crewmembers reported any electrical problems on the vessel either before or during the fire.

Fixed Fire Suppression System

Federal regulations at 46 CFR 181.400(a) require a space that contains propulsion machinery (the engine compartment) in a small passenger vessel to be equipped with a fixed gas fire-extinguishing system.[15] The gases approved for use as extinguishing agents are CO_2, halon, and new agents such as FM200 that were developed as clean alternatives to halon (the United States banned the manufacture of halon in 1994 because of environmental concerns, but existing halon systems are still allowed).[16]

The fire suppression system (figure 6) in the engineroom of the *Express Shuttle II* was a custom-engineered, manually operated CO_2 system installed when the vessel was built. According to original drawings in the files of the Coast Guard Marine Safety Office (MSO) in Tampa, the MSO in Portland, Maine, approved the design of the *Express Shuttle II*'s fire suppression system. All components of the fire suppression system were below the main deck and could be accessed only through one of the hatches. A 100-pound cylinder of CO_2 gas was located in the fuel room, forward of the fuel tanks. The system was equipped with a safety outlet that would release gas if excess pressure built up inside the cylinder at any time. Galvanized piping ran about 10 feet from the gas cylinder through the engineroom bulkhead to two nozzles in the engineroom. One nozzle was directed toward each engine.

Fixed fire-extinguishing systems are inspected as part of the annual Coast Guard inspection of small passenger vessels. (See "Certification and Inspection" section for more information.)

[15] Exceptions are spaces so open to the atmosphere that a fixed gas fire-extinguishing system would be ineffective, or spaces where the amount of CO_2 required in a fixed fire-extinguishing system can be supplied by one portable or semiportable extinguisher (46 CFR 181.400[b]).

[16] Detailed information about fixed fire-extinguishing systems for small passenger vessels is found on the website of the Department of Homeland Security, U.S. Coast Guard, Lifesaving and Fire Safety Standards Division <www.uscg.mil/hq/g-m/mse4/firefixedtboat.htm>.

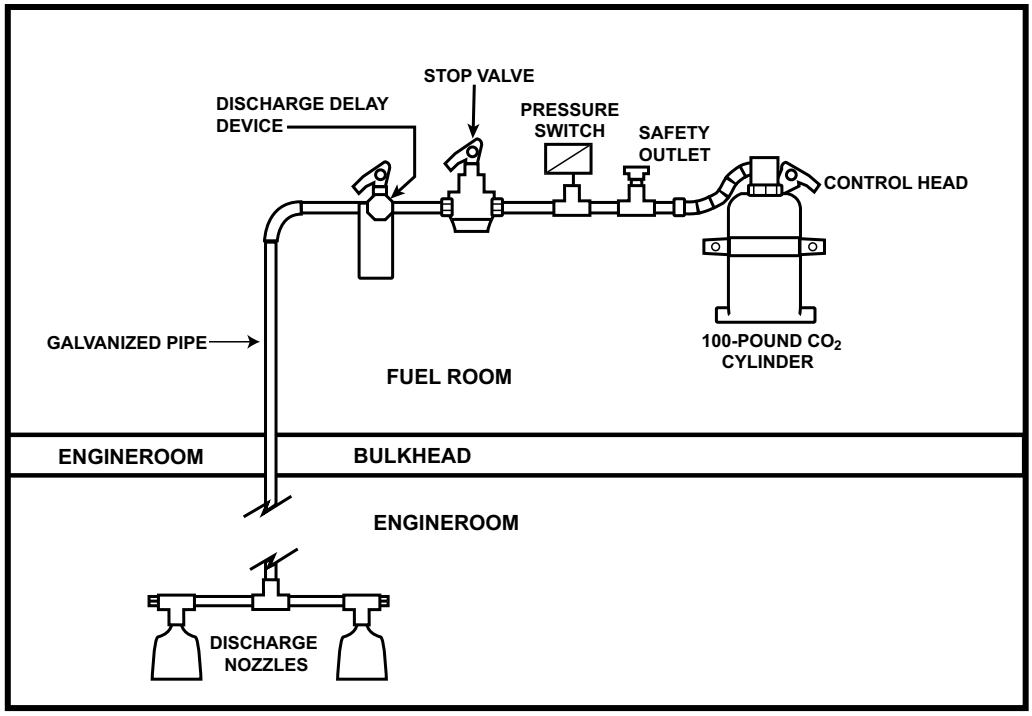

Figure 6. Components of *Express Shuttle II*'s fixed fire suppression system. CO_2 gas could be discharged by releasing the control-head lever on the cylinder. The pressure of the gas would activate a pressure switch that would close the air vents in the engineroom and shut down the engines. The gas would then travel through a stop valve and on to a discharge-delay device, which would postpone the release of gas to the engineroom for 30 seconds. Gas could be discharged immediately by releasing the lever on the discharge-delay device.

Fire Detection System

The *Express Shuttle* was required by Federal regulations to have an approved fire detection system.[17] Because of the size, complexity, and cost of many total systems produced by individual manufacturers, the Coast Guard permits owners of small passenger vessels to install detection systems comprising components from various manufacturers so long as each component and the system as a whole is approved by an MSO. In the case of the *Express Shuttle II*, the vessel was equipped, according to the original drawings, with a custom-designed fire and smoke detection system consisting of a control panel manufactured by Aqualarm and components manufactured by other companies. The system was installed when the vessel was built and, according to letters between the vessel builder and the Coast Guard, was approved by the MSO in Portland.[18]

[17] According to 46 CFR 181.400(c), engine spaces in small passenger vessels must be equipped with "a fire detection system of an approved type . . . , except when a fixed gas extinguishing system that is capable of automatic discharge upon heat detection is installed or when the space is manned." Because the *Express Shuttle II*'s fire suppression system (described above) was manually activated, the vessel was required to have an approved fire detection system.

[18] The letters are on file at MSO Tampa.

After the *Express Shuttle II* fire, the Coast Guard determined that the Aqualarm panel was approved by Underwriters Laboratory (UL) for electronic components but not for use in fire detection systems. As a result, the agency ceased approving Aqualarm devices for vessel fire detection systems.

None of the system components—control panel, detectors, wires—was found after the fire, which precluded investigators from reconstructing the system that had been installed in the vessel. Instead, investigators developed a probable system configuration from control panel and wiring diagrams on file at MSO Tampa. Investigators also relied on interviews with the technician who repaired the system 2 weeks before the fire, and with the port captain who had been present at annual Coast Guard inspections of the *Express Shuttle II*.

According to the diagrams, the control panel for the fire detection system was located in the pilothouse, to the right of the wheel. The panel was connected to a 12-volt battery power supply. The connection was protected from overloading by a 10-amp fuse fitted onto the 12-volt power supply wire directly below the alarm panel. The control panel contained an indicator light for each of the six fire detection zones on the vessel: (1) lazarette (aftmost hull compartment), (2) engineroom, (3) fuel room, (4) forward storage space, (5) forepeak, and (6) galley (figure 7). The galley was a space at the rear of the passenger cabin on the main deck where soft drinks were served.

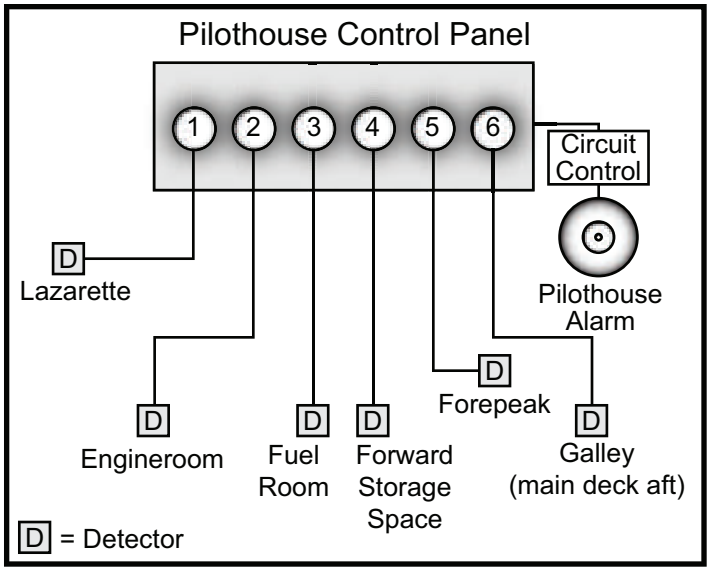

Figure 7. Schematic of *Express Shuttle II*'s fire detection system.

The engineroom was equipped with at least one heat detector.[19] All the other zones had combination heat and smoke detectors. The combination detectors were UL-approved, two-wire, 12-volt devices with built-in auxiliary relays.[20] The system was designed so that if a detector activated, the light for that zone would flash on the control panel and an alarm would sound in the pilothouse. The alarm was a 100-decibel, 12-volt horn/siren.

According to the diagrams in the vessel file, each detector was wired individually to the control panel (the service technician verified that design to Safety Board investigators). Coast Guard regulations (46 CFR 161.002-10[c]) require circuits that extend from a control unit to "the fire detectors in each zone" to be electrically supervised (meaning that if a circuit is interrupted, the alarm will sound). In most designs for detector systems, supervision is provided by an end-of-line resistor installed at the detector. If the flow of electricity is disrupted (for example, by a broken power cable or a nonfunctioning detector), the control panel will register the change and trigger the alarm. The original documentation contained no indication that end-of-line resistors had been installed on the *Express Shuttle II*'s fire detection system.

Certification and Inspection

Certification. The *Express Shuttle II* was certificated and inspected as a small passenger vessel by the Coast Guard under the small passenger regulations at 46 CFR 175-185. The vessel's COI, valid for 5 years, was issued on July 17, 2000. After the vessel's last drydock examination on July 8, 2003, its COI was amended to reflect the date of the examination. MSO Tampa was the local Coast Guard office in charge of inspecting the *Express Shuttle II*.[21]

The Coast Guard COI permitted the *Express Shuttle II* to operate off the Florida coast of the Gulf of Mexico from the Fenholloway River (Apalachee Bay) in the north to Cape Romano in the south, not more than 20 miles from a safe refuge. The COI allowed the *Express Shuttle II*'s passengers to transfer only to and from the *Royal Casino I* and only using the shuttle's portside midship transfer station. Transfers were not allowed when sea conditions exceeded a 2-foot wave chop or when rolling seas or sea swells exceeded 2 feet.

The total number of persons allowed on the *Express Shuttle II* was 152, consisting of 149 passengers and three crewmembers. The COI permitted the vessel to carry adult passengers only.

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[19] The diagrams found in the Coast Guard's vessel file show two detectors in the engineroom, with a potential configuration for five detectors. However, the Paradise of Port Richey port captain told investigators that he recalled only one heat detector in the engineroom.

[20] Auxiliary relays can be used to open or close doors or shut off electrical equipment, such as fans, when the system detects a fire. In the case of the *Express Shuttle II*, the auxiliary relays were not wired to any equipment.

[21] MSO Tampa is responsible for inspecting over 300 small passenger vessels in its jurisdiction.

Inspection. Two Coast Guard inspectors from MSO Tampa conducted the vessel's last required annual inspection 2 weeks before the accident, on October 5, 2004. One of the inspectors told Safety Board investigators that the inspection took about an hour and a half. The inspectors boarded the vessel and checked its documentation, talked to the crew, and inspected its lifesaving equipment. Both inspectors entered the engineroom. They did not ask specifically about recent engine repairs. One inspector said that only if the engine had been removed for an overhaul or other major work would they ask about repairs. Both inspectors said that their inspections did not ordinarily include inquiries about preventive maintenance.

The inspectors followed the Coast Guard 840 inspection book for small passenger vessels and identified 14 items requiring corrective action. Two problem areas were corrected at the time of inspection. The inspectors then submitted their report to MSO Tampa, which prepared a letter to Paradise of Port Richey listing the 12 remaining items requiring correction "to the satisfaction of the cognizant Coast Guard OCMI." The fire occurred before the letter could be sent. However, a review of its contents revealed that none of the 12 items to be corrected related to the vessel's fuel lines or fuel line brackets.[22]

Fire Detection System. The Paradise of Port Richey port captain said that the Coast Guard inspections usually included the *Express Shuttle II*'s smoke- and heat-detection system. During the Coast Guard inspection of October 5, 2004, however, an outside service company ("third party") was on board repairing the fire detection system. Paradise of Port Richey had called for the repair because the detector in the galley had been damaged. During the repair work, a second detector, in the fuel room, was found to be nonfunctional. The service company completed the repairs and then tested both the alarm panel (it was equipped with a test button) and the detectors (by directing smoke at them from a small smoke canister). One of the Coast Guard inspectors stated that because of the third party's presence, the inspectors did not test the fire detection system. A representative of the service company told investigators that Paradise of Port Richey had contracted the company only to repair the smoke and heat detectors, not to inspect the system.

Fire Suppression System. The required annual inspection of the *Express Shuttle II*'s fire suppression system was done by a third party, which would then submit its inspection report to the Coast Guard as part of the inspection record. "A qualified servicing facility" is permitted by 46 CFR 176.810(b) to inspect, maintain, and test portable fire

[22] The required corrections were to install a placard near the aft ladder listing the maximum number of passengers allowed on the second deck, install a light cover in the engineroom, remove child lifejackets (list states, "vessel representative will remove"), install strainers for the bilge lines, repair three lifefloats and replace their taglines, label the lifejacket storage location with size and amount, secure wires and remove dead-ended wires, reseal cleat backing plates, provide a support beam for (or repair) second deck overhead, repair and properly mount engine battery switches, and provide safety shields for the port and starboard power takeoffs.

extinguishers and fixed gas extinguishing systems.[23] According to the Coast Guard inspection record, the *Express Shuttle II*'s CO_2 cylinder had last been weighed in May 2004 and its last hydrostatic pressure test had been in July 2000. The May 2004 inspection was done by a local third-party firm, Suncoast Fire and Safety.

Wreckage

On October 21, Safety Board investigators examined the damage to the *Express Shuttle II* at a marina in Tarpon Springs. The fire had destroyed the vessel's top deck and main deck and severely damaged the belowdecks area (figure 8), including both engines and both generators. The investigators found it necessary to remove charred debris from the engines before they could conduct their postaccident examination.

Figure 8. Wreckage of *Express Shuttle II* as it appeared when Safety Board investigators examined it 4 days after the fire.

Structural Damage

The fire burned through most of the main deck, especially in the area of the engine compartment (figure 9). Wooden structural components of the main deck were heavily charred and fiberglass components were brittle, with most of the resin burned out of the

[23] Required tests of CO_2 systems include weighing the gas cylinders (they must be recharged if their weight loss exceeds 10 percent of the charge); testing time delays, alarms, and ventilation shutdowns according to the manufacturer's instruction manual; and making sure hoses and nozzles are clean.

fiberglass matrix. All items on the main and upper decks (chairs, tables, and other items) were completely destroyed. All decking over the engine space, including the stringers supporting the decks, was destroyed. The destroyed sections of the upper deck had collapsed onto the main deck and fallen into the bilge and engine compartment. The only remaining upright structure was a charred section of the port cabin bulkhead. The inside of the hull below the main deck was charred but intact.

Figure 9. Debris over the engine compartment that investigators had to remove before they could examine the *Express Shuttle II*'s engines and generators**.**

Engine Compartment Damage

The engine compartment was heavily damaged by the fire. Both engines and both generators were destroyed, and most of the aluminum engine components (such as valve covers) were melted.[24] The starboard engine sustained more damage than the port engine (figure 10). The inboard sides of the engines showed intense heat damage, particularly near the starboard engine valve cover. Both engines were protected from impact damage by their overhead heat shields, which had collapsed on top of them.

The vessel's fire pump, forward of the port engine, was significantly damaged by fire and debris, and its drive belt had burned off. The vessel's only bilge pump and its drive belt off the starboard engine sustained similar damage.[25]

[24] Most aluminum alloys start to melt at about 1,000° F.

[25] As noted earlier, the bilge pump could also function as an emergency fire pump.

Figure 10. Looking aft toward the *Express Shuttle II*'s engine space after the fire. The starboard engine (left) was more severely damaged than the port engine (right).

The electrical systems for both engines were severely damaged by the fire. Virtually all the electrical wiring insulation had burned off. However, investigators found no evidence of arcing in the remains of the wiring.

Starboard Engine. Investigators found that the fire destroyed the aluminum impeller[26] on the compressor (air inlet) side of the engine's inboard turbocharger (figure 11), but that the impeller on the exhaust side of the turbocharger was intact. Both impellers on the outboard turbocharger were also intact. The fuel filters on the inboard side of the engine were destroyed, and the aluminum inboard valve covers were melted.

[26] An impeller is a wheel with curving internal blades—"vanes"—radiating out from the hub. A marine turbocharger has two impellers (inlet and exhaust) connected by a shaft. Hot engine exhaust directed into one end of the turbocharger causes the impeller to spin and draw cooler ambient air from the engine compartment into the other end. The hot exhaust gases are kept out of the inlet chamber by a sealed bearing around the impeller shaft and a steel barrier between the turbocharger's two chambers. The "Vessel Information" section, above, including figure 5, gives further details about turbochargers.

Figure 11. Photograph showing destruction on starboard engine's inboard turbocharger.

Investigators found that the steel delivery line leading from the fuel pump to cylinder 5 of the starboard engine had broken at the end nearest the fuel pump, at the upper end of the metal sleeve, or ferrule, attaching the line to the fuel pump (figure 12). Investigators found no evidence, such as dents or punctures, which might indicate that the break was caused by falling fire debris. Investigators further discovered that the entire length of the cylinder 5 fuel line was without support clamps.

Investigators found one support clamp in the debris, on top of the inboard side of the starboard engine block between cylinders 5 and 7. The screw was loosened almost completely, to the extent that the end threads were flush with the outer surface of the end plate. No fuel lines were fastened to the clamp. Investigators found a total of seven other clamps supporting the fuel delivery lines on both sides of the starboard engine, but none of the clamps was secured to the engine block (figure 13).

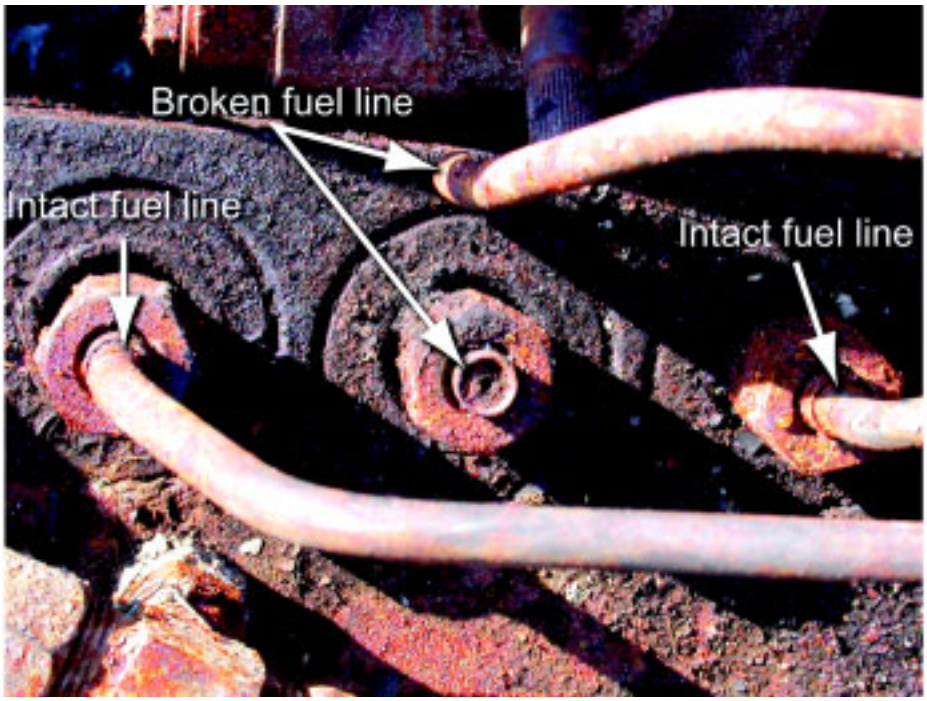

Figure 12. Closeup showing where the fuel line (center) to cylinder 5 of the starboard engine broke away from its attachment at the fuel pump.

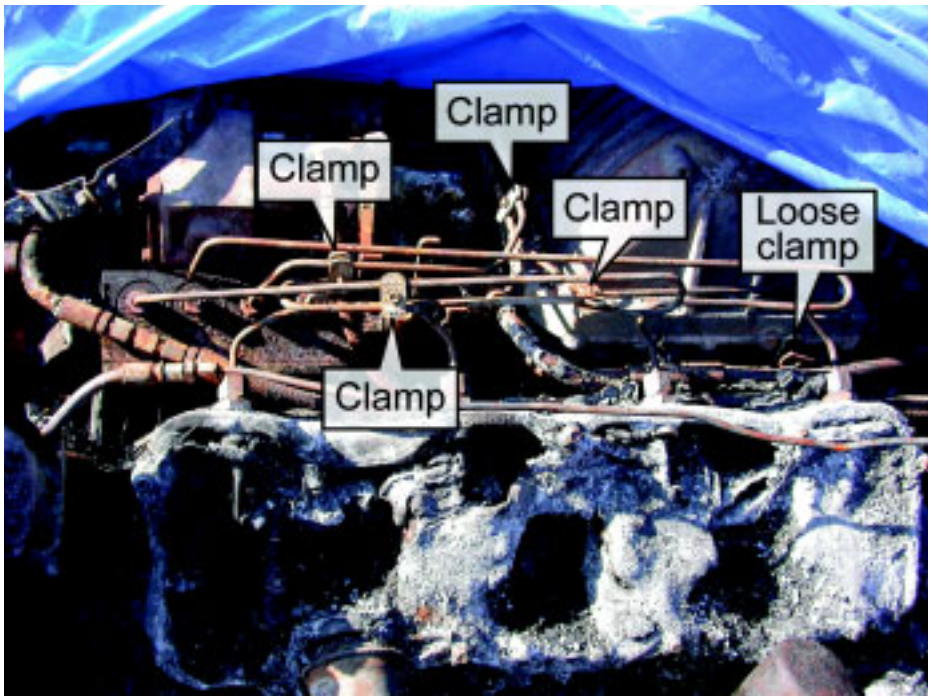

Figure 13. Photograph of fuel lines on the inboard side of the starboard engine block showing lines clamped together, and the loose clamp found between cylinders 5 and 7.

As noted earlier, the Caterpillar service manual for its high-performance marine engines (including the 3408) contains the warning: "Be sure the fuel injection line clamps are installed in the correct location." The manual's instructions for removing the fuel lines are: "Remove the bolts that hold brackets to the engine. Remove the fuel injection lines as a unit. Put plugs and caps over all openings." The directions for installing the fuel lines are: "Remove the plugs and caps. Install the fuel injection lines as a unit." Instructions for installing the fuel line brackets are: "Install the bolts that hold brackets to the engine." The manual gives specific instructions, including torque values, for disconnecting and tightening the fuel line nuts and clamps. An illustration in the manual shows fuel delivery lines clamped to each other and to the engine block; clamping locations and numbers of clamps are not specified.

The fuel supply lines for the starboard engine were removed by a Safety Board metallurgist on scene and transported to the Board's materials laboratory in Washington, D.C., for analysis. See "Tests and Research" section for a discussion of the laboratory results.

Port Engine. The outboard side of the engine showed minimal heat damage, but on the inboard side, all aluminum components were melted or damaged. Though all four turbocharger impellers were intact, the aluminum intake housings and cowlings were melted. Investigators found no broken or damaged fuel lines on either side of the port engine. The fuel lines were clamped to each other as well as to the engine block.

Waterway Information

The Pithlachascotee ("Cotee") River flows for more than 20 miles through Pasco County, Florida, into Miller's Bayou at the town of Port Richey and then empties westward into the Gulf of Mexico. The river mouth is 7 miles north of the Anclote River and the town of Tarpon Springs, the headquarters of the sponge-fishing fleet on the west coast of Florida.[27]

An extensive shoal area lies off the mouth of the Pithlachascotee River. The Gulf of Mexico is shallow (1 to 5 feet deep) from the shoreline out to the 3-nautical-mile line. Between there and the 9-nautical-mile limit of Florida state waters, the gulf ranges from 6 1/2 to 14 feet deep.[28]

A dredged navigation channel in the Pithlachascotee River runs 2.7 miles from the Gulf of Mexico to a turning basin just below the U.S. route 19 highway bridge, about a mile from the river's mouth. The controlling depth of the channel in August 2003 was 4.9 feet (5.4 feet at midchannel).[29] Two 90° turns in the channel near the river's mouth

[27] National Oceanic and Atmospheric Administration, National Ocean Service, *United States Coast Pilot*, vol. 5 (Atlantic Coast: Gulf of Mexico, Puerto Rico, and Virgin Islands), 2004, p. 340.

[28] National Oceanic and Atmospheric Administration, National Ocean Service, Coast Survey, U.S. Gulf Coast, Florida, Chart 11409, *Anclote Keys to Crystal River*, 1999.

[29] *United States Coast Pilot*, vol. 5, p. 341.

were known to local mariners as the S-turn. The Paradise of Port Richey marina was located near the highway bridge (see figure 2).

Company Operations

Paradise of Port Richey, the owner of the *Express Shuttle II*, began operating the SunCruz Port Richey Casino in 1995. At the time of the accident, Paradise of Port Richey had two casino boats, the *Royal Casino I* and the *Monte Carlo* (not then in service, however). As described earlier, shuttle boats carried passengers from the company marina to the casino boats, which operated in the Gulf of Mexico outside Florida waters, where gambling was legal. The casino owned three other shuttle boats besides the *Express Shuttle II*—the *Express Shuttle*, the *Royal Express II*, and the *Royal Express*—not all of which operated at any one time. Characteristics of all the company's boats are listed in table 2.

Table 2. Characteristics of boats owned by Paradise of Port Richey.

Vessel	Length (ft)	Gross Tons	Required Crew	Maximum Passengers	Others*
Royal Casino I	139.5	99	6	375	34
Monte Carlo	110.5	98	7	315	30
Express Shuttle II	65	43	3	149	0
Express Shuttle	64.5	82	3	144	3
Royal Express II	62.3	75	2	88	0
Royal Express	45	9	2	49	0

*Other persons in crew, or persons in addition to crew, such as casino employees.

Day-to-Day Operations

At the time of the accident, the company had two shuttle boat masters on its payroll and three deckhand supervisors, who worked mostly on shore. A port captain managed day-to-day company operations.

The casino scheduled shuttle departures from the Port Richey dock four times a day, 7 days a week—at 0930, 1100, 1530, and 1900. Customers could stay a few hours or until the last return trip, which was at 0030 (Monday through Thursday) or 0100 (Friday to Sunday). Other return trips were scheduled at 1500, 1730, and 2100. The masters told investigators that they worked either the day shift or the night shift 5 or 6 days a week, but that they did not have a set weekly schedule. The master on the day of the fire told investigators that he would play a short, recorded safety announcement when the vessel departed the dock.[30]

[30] Federal regulations at 46 CFR 185.506, in part, require that, before getting under way on a voyage or as soon as practicable thereafter, the master will ensure that "suitable public announcements are made informing all passengers" where emergency exits and lifejackets are located and how lifejackets should be donned.

Port Captain. The port captain told investigators that he had started with the company as a vessel master, serving in that capacity for about 4 years. He held a Coast Guard merchant mariner's license, issued in May 2001, as "master of steam or motor vessels of not more than 500 gross registered tons (domestic tonnage) upon oceans." After taking a year off, he returned to the company and was promoted to port captain. He had held that position for about 4 years at the time of the accident. His responsibilities included upkeep and maintenance of vessels and oversight of vessel safety, daily operations, and personnel. He told investigators that in the mornings, he transported the gambling boat crew offshore in one of the shuttle boats and sometimes filled in for one of the regular shuttle masters. He said that over the years, he had replaced the fuel lines on "both sides, both engines" of the *Express Shuttle II*.

Deckhand Supervisor No. 1. Deckhand supervisor No. 1 told Safety Board investigators that he had about 3 years of maritime experience, including more than 1 year with Paradise of Port Richey. His job consisted of checking the engines in the morning, including oil and water levels, and he was also responsible for checking the cleanliness of the vessel before the first trip of the day. He said that he had worked on one of the company's casino boats as an engineer. He stated that he was present for the repair performed by Ring Power Corporation 4 days before the fire.

Deckhand Supervisor No. 2. Deckhand supervisor No. 2 told investigators that he had worked for the company for about 6 months. Before that, he had been assistant manager of a retail store. He said that he had been hired by the company as a deckhand and had received all his training on the job. His responsibilities included making certain that the vessel engines were supplied with oil and water, that the boat appeared clean, and that the necessary consumables (such as food, drinks, and toilet paper) were on board.

Deckhand supervisor No. 2 said that he had never repaired a fuel line but had watched others do the work. He performed the morning maintenance checks on the *Express Shuttle II* the day of the fire and said that he "didn't notice anything unusual" when he checked the engineroom.

Slots Supervisor. This employee's job title reflected his responsibility for repairing the slot machines on the casino boat. He told investigators that he had worked for Paradise of Port Richey about 5 years. He said that he had no other maritime experience and had received all his training on the job, starting as a deckhand on the *Royal Casino I* and working his way up to supervisor. At the time of the accident, his tasks on the company's shuttle vessels included changing the engine oil and making repairs, from changing light bulbs to helping repair fuel lines. He told investigators that he had repaired two fuel lines on the *Express Shuttle II* during his employment with the company.

Vessel Maintenance

Paradise of Port Richey did not have a formal preventive maintenance program for its vessels, and Coast Guard regulations do not require small passenger vessels to have

such a program. Company personnel told investigators that maintenance checks were performed on the *Express Shuttle II* every morning before it began the day's trips. Shoreside personnel would check such items as general vessel condition, oil and water levels, bilge levels, and drinking water supply. Any item requiring additional maintenance was noted on the checklist. The checklist was signed by the employee who performed the check and then by the master operating the vessel that day. At the end of the day, the master would complete the checklist and forward it to the port captain.

According to the master on the day of the fire, the shuttle boats maintained an inventory of spare fuel lines on board. The port captain said that if a fuel line failed while a vessel was under way, the crew would change the line and the master would note the repair on the daily vessel checklist. The *Express Shuttle II*'s checklist for October 16, 2004, the day before the fire, stated, "Changed fuel line starboard side," and noted the Caterpillar part number.

The port captain kept a maintenance log for each company vessel in the company's office. Safety Board investigators examined the *Express Shuttle II*'s maintenance log for the year before the fire, between October 15, 2003, and October 14, 2004. The log's six handwritten pages contained no entries for the replacement or repair of fuel lines.

All eight Paradise of Port Richey employees interviewed by Safety Board investigators said that they had changed or been present while someone else changed a failed fuel line on the *Express Shuttle II*.[31] One master told investigators that he did not use Caterpillar instructions or procedures for changing the fuel lines, but instead relied on his "years of experience of working on engines." Deckhand supervisor No. 1 said that he had changed a "couple of fuel lines" but could not remember for which engine or which fuel lines. When asked by investigators whether he used a torque wrench, he said that he used "just wrenches and things" and did not know the torque ratings of the fuel line fittings. He said that he just tightened them down until they felt tight.

The port captain told investigators that a copy of the Caterpillar service manual was kept on board the *Express Shuttle II* (the copy was lost in the fire). The disassembly and assembly part of the manual contains a section entitled, "Remove and Install Fuel Injection Lines." The procedures describe how to remove and install fuel injection lines as a unit, but do not address how to remove or install a single fuel injection line. A note at the end of the section states, "If it is necessary to loosen any of the fuel injection line clamps, retorque the screws to 2.26 N*m (20 lb in)."[32]

The port captain was responsible for deciding when outside vendors should be called for repair work. Major engine work was done by the local Caterpillar agency (Ring Power Corporation). According to the port captain's maintenance log and invoices supplied by Paradise of Port Richey, Ring Power Corporation rebuilt the *Express Shuttle II*'s port engine in February 2004. As noted earlier, the *Express Shuttle II*'s fire

[31] The chief executive officer was also interviewed; he did not work on the company's vessels.

[32] N*m = Newton-meter (international system unit); lb in = pound-inch (or, inch-pound). One inch-pound = 0.113 N*m. One foot-pound (measure used elsewhere in this report) = 1.356 N*m.

suppression equipment was maintained by a local service firm. Another local firm repaired the fire detection system when necessary, as on the day of the vessel's last annual Coast Guard inspection.

Meteorological Information

Weather data recorded at Tampa International Airport, 26 miles from Port Richey, show that at the time of the accident, the air temperature was about 80° F, with clear skies, good visibility, and variable light winds. The sea temperature was also about 80° F, according to data recorded at Clearwater, Florida, 21 miles south of Port Richey.

Toxicological Testing

The Coast Guard requires drug and alcohol testing in the event of a serious marine incident.[33] As stated at 46 CFR 4.06(b), "the marine employer shall take all practicable steps to have each individual engaged or employed on board the vessel who is directly involved in the incident chemically tested for evidence of drug and alcohol use."

The master and both deckhands submitted urine samples for drug analysis after the accident. Results were negative for the five drugs of abuse (marijuana, cocaine, opiates, amphetamines, and phencyclidine) that Federal regulations at 46 CFR 16.113 and elsewhere require screening for in postaccident testing. None of the crewmembers underwent postaccident alcohol testing. The Paradise of Port Richey port captain told investigators that he was unaware that it was the company's responsibility to conduct breath tests for alcohol after an accident. He stated that on-scene Coast Guard investigators reminded him to have the crew drug-tested but did not inform him to test for alcohol use.

In 1999, Coast Guard Headquarters instructed that each OCMI and each captain of the port (COTP), "upon notice that a serious marine incident has occurred, should immediately direct the involved marine employers to ensure that drug and alcohol testing is conducted."[34] The directive further required that "each OCMI/COTP should conduct alcohol breath tests anytime there is concern that proper alcohol testing would not otherwise be accomplished." As required by the Coast Guard Authorization Act of 1998,

[33] A serious marine incident is defined at 46 CFR 4.03-2 as (a) a marine casualty or accident that results in any of the following: (1) one or more deaths, (2) injury that requires medical treatment beyond first aid and renders the individual unfit to perform routine duties, (3) property damage exceeding $100,000, (4) actual or constructive total loss of an inspected vessel, or (5) actual or constructive total loss of any uninspected vessel that exceeds 100 gross tons; (b) discharge of 10,000 or more gallons of oil into U.S. waters; (c) the release of a reportable substance into the environment of the United States. Because the fire resulted in the total loss of the *Express Shuttle II*, and because the vessel was valued at over $100,000, the accident qualified as a serious marine incident.

[34] Commandant (G-MOA) policy letter 1-99, "Post Casualty Chemical Testing Following a Serious Marine Incident," February 11, 1999.

the Coast Guard has established procedures to ensure that alcohol testing is conducted no later than 2 hours after a serious marine incident. The final rule was published on December 22, 2005, with an effective date of June 20, 2006.[35] The new regulations for alcohol testing appear at 46 CFR 4.06-3.

Survival Factors

Emergency Response

At 1028, according to the Coast Guard situation report on the *Express Shuttle II* fire, an HH-60J "Jayhawk" helicopter on a training mission from Coast Guard Air Station Clearwater received a distress call on VHF-FM channel 16[36] that a vessel was on fire at the mouth of the "Cotee" River. On receiving the call, the helicopter diverted to the accident site. At 1033, the helicopter pilot reported to Coast Guard Group St. Petersburg that all crewmembers were off the vessel and that a "good Samaritan" and a tugboat were assisting at the scene. At 1034, Coast Guard Station Sand Key, located about 20 miles south of the accident site in Clearwater (refer to figure 2), notified Pasco County fire and rescue of the vessel fire. At 1040, the Coast Guard launched a 25-foot patrol boat to the scene from Station Sand Key.

At 1034, the same time the Coast Guard was notifying Pasco County of the fire, the Port Richey Fire Department (PRFD) received a 911 call reporting a fire on board a casino shuttle. Because the caller did not give an exact location, the first responding PRFD engine company drove to the Paradise of Port Richey dock. The PRFD captain told investigators that the firefighters saw a column of black smoke and a circling helicopter near Harborpointe, the westernmost part of Port Richey that is accessible by road. The PRFD captain said that while en route to the fire, he requested a fire engine from Pasco County.

According to its incident report, the PRFD engine company arrived on scene at 1042 and the PRFD fire captain assumed the incident command post. The fire captain told investigators that the *Express Shuttle II*'s entire deck structure was burning and that the vessel appeared to be aground (figure 14). A Coast Guard Auxiliary boat closed the channel to traffic because the burning *Express Shuttle II* created a navigation hazard.

[35] *Federal Register*, vol. 70, no. 245 (December 22, 2005), pp. 75954-75961.

[36] Channel 16 (156.8 megahertz), which the Coast Guard monitors continuously, is the international calling and distress frequency.

Figure 14. When firefighters arrived at the scene, the entire deck structure of the *Express Shuttle II* was on fire and a thick plume of black smoke rose hundreds of feet into the air.

By this time, a Pasco County sheriff's office boat, the *Marine 3*, had arrived on scene and was circling the burning vessel. The PRFD captain told investigators that he contacted the *Marine 3* via the emergency radio system established by Pasco County as part of a mutual aid agreement between area emergency agencies. He was advised that the *Express Shuttle II*'s crew had already been rescued from the burning vessel and that a Port Richey police boat was also on its way. The *Express Shuttle II* master told investigators that he called ahead for an ambulance, which was waiting at the dock of a commercial establishment when the company boat arrived with deckhand No. 1.

About 1050, two firefighters from the Pasco County fire and rescue station 3 miles away arrived with another fire engine. The firefighters from the PRFD and Pasco County connected a hose to the nearest hydrant and set up operations on a private citizen's lawn, passing hoses and equipment over a garden and a wall to the beach and setting ladders along the wall to access the beach. Because the burning boat was only 100 yards from shore and the tide was low, the firefighters waded through the mud and boarded a small police boat that took them to the *Marine 3* (figure 15).

Figure 15. Firefighters laid hoses from shore to a Pasco County sheriff's office boat, then walked through mud to a police boat that took them to the sheriff's boat. The sheriff's boat shuttled them and their equipment close enough to the *Express Shuttle II* for them to direct water onto the fire. Later, they fought the fire with foam pumped from the tanks of fire engines on shore.

From the *Marine 3*, they directed water onto the burning vessel until it was cool enough to board, then the *Marine 3* shuttled the firefighters to and from the burning vessel in shifts. Once on board the burning vessel (the largest number of firefighters on the vessel at one time was four), firefighters directed water to any fire they could see belowdecks. The PRFD captain told investigators that the firefighters were uncertain whether the vessel's fuel tanks were involved in the fire. The Pasco County fire captain said that because the master of the *Express Shuttle II* had not dropped his anchor, the burning boat began floating upriver on the incoming tide. The fire captain tied the vessel's anchor to a piling, and a towboat hooked itself to the vessel to keep the hazard away from other boat traffic.

At that point, two Pasco County fire battalion chiefs arrived with more fire apparatus and assumed control of the operation. They began fighting the fire with foam, discharged from the tank of one of the fire engines. The PRFD reported that firefighters contained the fire at 1118. At 1137, the Coast Guard helicopter reported that the fire was under control and returned to its base at Air Station Clearwater. At 1140, the Coast Guard patrol boat from Station Sand Key (Clearwater) arrived on scene.

The firefighters continued applying foam to the vessel. The Pasco County fire captain estimated that the foam had subdued the fire by about 1500; the PRFD captain

estimated that it took until 1530 or 1545. By that point, the vessel was a total loss (figure 16). After the state fire marshal arrived on scene, the *Express Shuttle II* was towed out of the channel and to a marine repair yard in Tarpon Springs (see figure 2).

Figure 16. By the time the fire was extinguished, the *Express Shuttle II* was a total loss.

Firefighting Equipment

The Coast Guard inspection record for October 5, 2004, states that the *Express Shuttle II* had four portable fire extinguishers and one 1 1/2-inch-diameter fire hose, in addition to the fixed fire suppression system described earlier. The inspection record states that the vessel's fire pumps were tested but does not indicate the number of pumps. As noted earlier, the vessel had one fire pump and one bilge pump that could also serve as an emergency fire pump.

Lifesaving Equipment

The *Express Shuttle II* was required by its COI to carry lifesaving equipment for 152 persons. The equipment included 152 adult lifejackets and four lifefloats. The vessel was not required to carry child lifejackets because children were not allowed as passengers, according to the COI. According to as-planned drawings for the vessel, lifejackets were stowed in bins or inside benches throughout the passenger spaces. On the upper deck, lifejackets were stowed in a locker behind the pilothouse.[37]

[37] Coast Guard regulations at 46 CFR 180.78 state, "life jackets must be stored in convenient places distributed throughout accommodation spaces," and "each stowage container for life jackets must not be capable of being locked. If practicable, the container must be designed to allow the life jackets to float free." Further, "each life jacket kept in a stowage container must be readily available."

The vessel's required number of lifefloats could accommodate a total of 88 people (22 people to each lifefloat).[38] Lifefloats are buoyant apparatus that have a line attached around the outside. Survivors in the water can hold onto the line. The apparatus is not designed to support survivors out of the water.

Tests and Research

The fuel supply lines for the *Express Shuttle II*'s starboard engine were removed and sent to the Safety Board's materials laboratory in Washington, D.C., for examination. The examination, which representatives of Paradise of Port Richey, Caterpillar, Inc., and Ring Power Corporation attended, found reddish-brown oxidation on the surfaces of the low-alloy steel fuel lines and clamps. The Safety Board's materials engineer's report stated that the oxidation was "consistent with exposure to heat and fire and subsequent extinguishing media."

The Safety Board materials engineers measured the location of each clamp on the fuel injection lines from the starboard engine and the material hardness of the fuel injection line for engine cylinder 5 (it was within the specified range). The engineers examined in detail the fracture area on the fuel line at the ferrule's upper edge (figure 17).

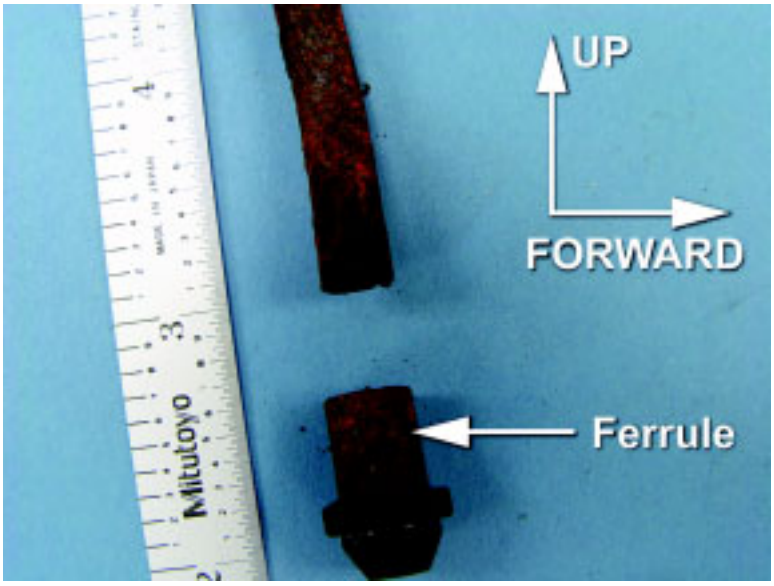

Figure 17. Closeup of the fracture area on fuel injection line 5 of the vessel's starboard engine. Up and forward arrows are in relation to the starboard engine.

[38] According to 46 CFR 180.205(c), "Each vessel certificated to operate on a limited coastwise route in warm water must be provided with life floats of an aggregate capacity that will accommodate at least 50% of the total number of persons permitted on board."

In their report, the Safety Board's engineers characterized the fracture mechanism as "macroscopically brittle"[39] and stated that the fracture area on the steel fuel line exhibited features "consistent with fatigue fracture across approximately 95 percent of the fracture surface" (figure 18). The metal fatigue originated mostly at a single area on the inboard surface of the fuel line. The remainder of the fatigue had multiple origins on the outboard surface of the line. As shown in figure 18, the outer circumference of the fracture surface on the fuel line showed numerous ratchet marks, indicating fatigue cracking in different, slightly offset planes in the metal. The materials engineers observed "no evidence of crimping damage from the ferrule" on the fuel line next to the fracture.

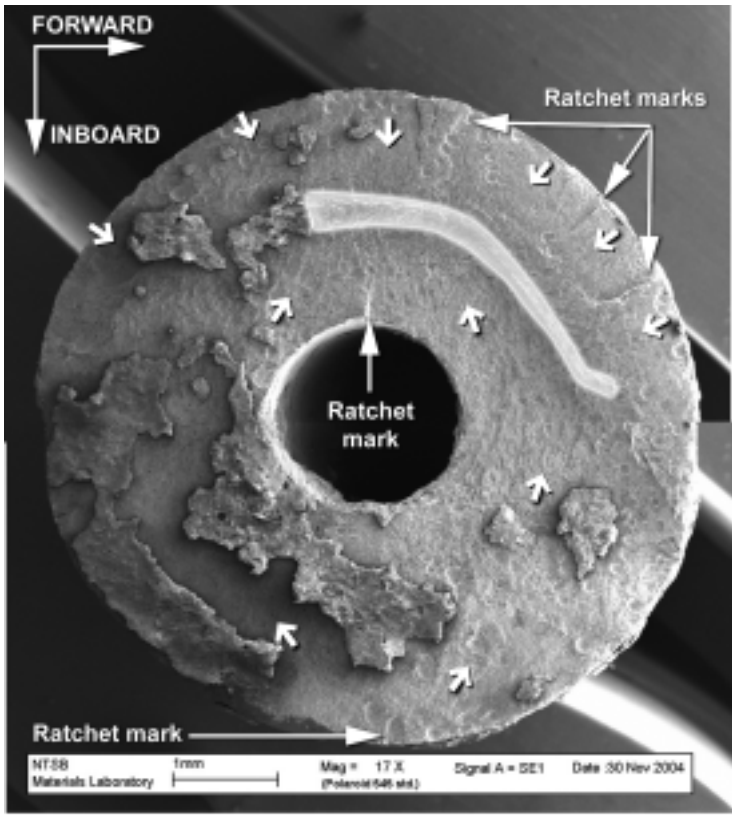

Figure 18. Scanning electron microscope view of the fracture surface on fuel injection line 5 (perspective is upward through the line, which was perpendicular to the engine at the fracture location). Shaded area indicates the "final fast fracture region," that is, the last region to give way. Unlabeled arrows indicate the approximate direction of fatigue propagation. Fatigue originating at the inboard surface of the fuel injection line traveled around the center and formed a ratchet mark on the opposite side (arrow at center). Ratchet marks form where cracks in offset planes meet and generally indicate multiple fracture origins.

[39] *Macroscopic* means visible to the naked eye. A *brittle fracture mechanism* such as fatigue can occur in ductile materials (those that can be shaped, bent, or drawn out) and will result in a fracture that does not permanently deform the adjacent material.

The Safety Board's laboratory report stated that the fuel injection line to cylinder 5 of the starboard engine failed because of metal fatigue at the base of the ferrule on the fuel-pump end of the line. According to the materials engineers' analysis, the fracturing was typical of fatigue associated with excessive vibration. The engineers' report noted that "improper clamping can lead to excessive vibration," and found that "the total lack of clamping led to excessive vibrations that caused the line to fatigue and fail."

The Safety Board materials engineers also found indications of "vibrational contact" between two other fuel injection lines (Nos. 1 and 3) on the starboard engine. The lines were worn through more than 20 percent of their diameters, "another indication of incorrect clamping or other installation problems," according to the engineers' report.

Other Information

Federal Regulations Pertaining to Vessel Maintenance

Federal regulations governing small passenger vessels (46 CFR subchapter T [parts 175-185]) do not contain detailed instructions or requirements for vessel maintenance. Regarding machinery on small passengers vessels, 46 CFR 182.100 states the following:

> This part contains requirements for the design, construction, installation, and operation of propulsion and auxiliary machinery, piping and pressure systems, steering apparatus, and associated safety systems. Machinery and equipment installed on each vessel must be suitable for the vessel and its operation and for the purpose intended. All machinery and equipment must be installed and maintained in such a manner as to afford adequate protection from causing fire, explosion, machinery failure, and personnel injury.

Passenger Vessel Association

The Passenger Vessel Association (PVA) is a voluntary organization that serves the interests and concerns of more than 400 vessel owners and operators, or about 65 percent of the domestic passenger vessel industry in the United States. Association members operate more than 1,100 passenger vessels nationwide, carrying up to 200 million passengers annually. PVA members offer services including dinner cruises, tour and excursion services, car and passenger ferries, private charters, whale-watching trips, overnight cruises, and gaming vessels. At the time of the *Express Shuttle II* fire, Paradise of Port Richey was a PVA member company.

The PVA has a safety and security committee dedicated to improving the safety of passenger vessel operations. The PVA publishes training videos and manuals to enhance crew training and safety among its members (among the training materials are a video and accompanying manual on marine firefighting that are available for a small fee) and maintains a website (www.passengervessel.com). In June 2005, in response to a

recommendation from the Safety Board,[40] the PVA added to its website preventive maintenance documents that vessel owners and operators can download and adapt for their own use. The documents consist of worksheets on which to list engine specifications and track engine maintenance; record repair and maintenance purchases, general repairs and maintenance, inspection and maintenance of lifesaving equipment, and maintenance of heating and air conditioning systems; and track vessel painting. The documents also include daily and weekly checklists.

[40] See "Preventive Maintenance" section of this report's analysis for further information.

Analysis

General

The following analysis first identifies factors that readily can be eliminated as causal or contributory to the fire that destroyed the *Express Shuttle II*. The analysis then discusses how and where the fire started, followed by a consideration of the major safety issues identified during the investigation:

- Preventive maintenance
- Crew response to fire emergency
- Fire detection systems

Exclusions

At the time the fire broke out, the weather was mild and did not hamper detection of the fire or interfere with firefighting efforts. Crewmembers of the *Express Shuttle II* had just begun the day's work and were well rested. All crewmembers tested negative for illicit drugs. The Safety Board therefore concludes that the following were not factors in the fire on board the *Express Shuttle II*: weather, operator fatigue, or illicit drugs. None of the crewmembers was tested for alcohol. However, investigators found no indication that the crewmembers' actions before or during the fire were affected by the use of alcohol. Therefore, although crewmembers were not given postaccident tests for alcohol, the Safety Board concludes that alcohol was probably not a factor in the accident.

The Safety Board considers improving postaccident drug and alcohol testing in the marine industry so important that in 2002, it placed the issue on its "Most Wanted" list of transportation safety improvements. The "Most Wanted" list is intended to increase the public's awareness of, and support for, action to adopt safety steps that can help prevent accidents and save lives. The Safety Board is pleased that new Coast Guard regulations, effective June 20, 2006, make it mandatory for crewmembers to be tested for alcohol within 2 hours of a serious marine incident. The regulatory changes should contribute significantly to the timeliness of postaccident alcohol testing.

Cause and Origin of Fire

The fire damaged the *Express Shuttle II* so severely that before Safety Board investigators could examine the vessel's machinery, they had to remove layers of burned debris that had fallen into the engine compartment when the upper decks collapsed. Both

engines and generators were nearly destroyed; however, evidence indicated that the fire originated on the inboard side of the starboard engine near the broken fuel line to cylinder 5, as described below.

The engine parts near the broken fuel line on the starboard engine sustained the greatest fire and heat damage. The air filter and intake impeller on the inboard starboard turbocharger, facing the broken fuel line, were both destroyed (refer to figure 5 for engine layout). Other components on the inboard side of the starboard engine near the broken fuel line were damaged or destroyed as well, including all the aluminum components. In the engine area immediately below the broken fuel line, the aluminum valve covers were melted and the fuel filters were destroyed.

The damage lessened moving from the inboard side of the starboard engine outward to the vessel's starboard side. The outboard side of the starboard engine, while seriously burned, did not sustain the same amount of damage as the inboard side. For example, both the intake and exhaust impellers on the starboard engine's outboard turbocharger were found intact after the fire.

Moving outward in the other direction from the inboard side of the starboard engine, the inboard side of the port engine (the side closest to the starboard engine) was less damaged than the inboard side of the starboard engine. Further, the fire and heat damage to the port engine was more severe on the inboard side than on the outboard side. For example, all aluminum components on the inboard side of the port engine were destroyed, such as the aluminum pipe from the inboard turbocharger to the air intake housing, while the corresponding pipe from the outboard turbocharger remained largely intact.

Damage to the vessel's generators was also more severe near the inboard side of the starboard engine. The most serious damage to the starboard generator was on the forward end (nearest the starboard engine) and inboard sides. On the port generator, the aluminum components on the inboard side were melted, and the rest of the generator was seriously damaged but not completely destroyed. The Safety Board concludes that the pattern and extent of damage indicate that the fire started on the inboard side of the *Express Shuttle II*'s starboard engine.

The fuel delivery line to cylinder 5 of the starboard engine had broken off at its attachment to the fuel pump. After examining the fractured line, the Safety Board materials laboratory determined that the line failed because of metal fatigue at the base of the ferrule that attached the line to the fuel pump. Although the laboratory examination found severe contact wear in two other fuel injection lines on the starboard engine, the only fracture was in the line that delivered fuel to the starboard engine's No. 5 cylinder. The Safety Board therefore concludes that the initial source of fuel for the fire was diesel fuel from a fractured fuel line to cylinder 5 on the starboard engine.

Fracturing in the line was determined to be typical of fatigue associated with excessive vibration. The Safety Board's materials engineers determined that excessive vibrations caused the line to cylinder 5 "to fatigue and fail," and that the vibrations

resulted from the line's "lack of clamping." The Board's postaccident examination of the *Express Shuttle II* found that the fuel line to cylinder 5 was not clamped to the starboard engine block or to another fuel line, and that none of the other fuel injector lines to the starboard engine was clamped to the engine block (though some lines were clamped to each other). An unattached clamp found lying near the broken fuel line, on top of the engine block between cylinders 5 and 7, indicated that it had not been fastened properly. The Safety Board therefore concludes that the fuel line to cylinder 5 on the starboard engine failed as a result of metal fatigue from excessive vibrations caused by the failure to clamp the line.

The Caterpillar service manual contains several warnings that "fuel leaked or spilled onto hot surfaces or electrical components can cause a fire." The diesel fuel in the *Express Shuttle II*'s fuel delivery lines was under a pressure of about 1,800 psi at the valves. When fuel under pressure is released by an equipment failure, the result is usually an atomized spray of fuel over a broad area. According to a Ring Power Corporation representative, the engine surging reported by the master just before the starboard engine stopped would be consistent with raw fuel being ingested into the turbocharger's fresh air inlet. It is thus highly probable that the fuel from the broken fuel line was released as a spreading mist that contacted numerous engine parts, including the inboard starboard turbocharger (where it would have been ingested into the ambient air intake). Misted fuel mixes easily with air and ignites more readily than pooled fuel. Investigators evaluated whether electrical components or hot surfaces near the fractured fuel line could have ignited the fuel mist, leading to the ignition and propagation of the fire.

Because of the severe damage to the engineroom, investigators could not fully examine the engine's electrical system or electrical components and therefore could not eliminate them as an ignition source. Investigators, however, found no evidence of electrical arcing in the area of the starboard engine that suffered the heaviest damage, and crewmembers reported no electrical problems with the vessel either before or during the fire.

According to Ring Power Corporation, the *Express Shuttle II*'s engines, including the turbocharger housings, were water-cooled to an average surface temperature of 180º F. However, not all the vessel's external engine parts were cooled. One example, according to a Ring Power representative, was a section of the pipe connecting the exhaust manifold to the turbocharger inlet. Because the pipe carried hot exhaust from the engine, whose internal operating temperature was about 1,100° F, temperatures on the uncooled surface of the exhaust pipe could have exceeded 1,000° F. According to the material safety data sheet provided by the fuel supplier, the No. 2 diesel fuel used on the *Express Shuttle II* will autoignite (ignite by heat without spark or flame) at a temperature of 637° F. If the misted fuel from the fractured fuel line had contacted the uncooled section of the exhaust pipe, the hot surface could easily have raised the fuel to its autoignition point. The Safety Board therefore concludes that the fire on the *Express Shuttle II* most likely ignited when diesel fuel from the ruptured fuel line sprayed onto hot engine parts.

Preventive Maintenance

Express Shuttle II

From interviews with company personnel, Safety Board investigators determined that the fuel lines on the *Express Shuttle II* had failed numerous times in the months before the fire. Invoices from Ring Power Corporation show that since January 2004, Paradise of Port Richey had purchased a total of 13 replacement fuel lines on 11 different dates (refer to table 1). The replacement fuel lines were intended for the *Express Shuttle II*'s starboard engine, according to the evidence.

The large number of fuel line failures should have alerted company personnel who ordered replacements for the damaged parts that there was a problem on the *Express Shuttle II*. If company personnel had researched the fuel line failures by consulting the engine manufacturer's service manual, they would have seen the warning about improperly installed fuel line clamps and recognized that the failing fuel lines posed a fire hazard. The warning, which appeared in two places in the manual, read as follows:

> Incorrectly installed clamps may allow the fuel injection lines to vibrate and become damaged. The damaged lines may leak and cause a fire.

Paradise of Port Richey did not have a preventive maintenance program. An effective preventive maintenance program contains such elements as procedures for reporting maintenance and repair needs, retaining and reviewing maintenance and repair records, conducting vessel inspections and repairs according to manufacturers' guidelines, verifying and testing repairs, and overseeing the maintenance and repair process. It also contains procedures that promote effective interaction between the personnel who operate vessels and the staff who perform vessel maintenance.

Employees indicated that rather than following a regular schedule for vessel maintenance and repair, Paradise of Port Richey waited until a fuel line fractured before repairing it. Safety Board investigators found that the company did not keep accurate records of such repairs. Although items to be repaired were noted on a daily checklist, the maintenance log kept by the port captain contained no entries for the repair or replacement of fuel lines on the *Express Shuttle II*. Thus, the company had no formal system that would have allowed it to identify an ongoing maintenance problem. Repair records alert vessel operators of abnormal conditions, such as a high failure rate of systems or components. If Paradise of Port Richey had recorded the fuel line failures and addressed the failures with the manufacturer, the company would have realized that it had a recurring serious problem and that its repair procedures were inadequate.

Company personnel were trained on the job and relied on their experience to perform maintenance tasks such as engine repairs, rather than having been trained by using manuals or attending training school. Not only did Paradise of Port Richey employees lack formal training, they also did not consult the Caterpillar service manual

when repairing the engines. Consequently, the employees did not follow the engine manufacturer's recommended procedures regarding fuel line clamps, did not tighten the fuel lines according to the manufacturer's recommended torque, and did not use the appropriate tools.

If the company had kept adequate repair records, it should have known that the fuel lines on the *Express Shuttle II* were failing repeatedly during the year before the fire. Further, if the company had had procedures in place for dealing with engine failures, in particular, if its procedures had required consulting and following the manufacturer's recommendations, it should have recognized that improper clamping could have been causing the lines to fail, and that improperly clamped lines could lead to a fire. The company might then have been able to remedy the situation and prevent the fire. The Safety Board therefore concludes that the frequent need to replace fuel lines on the *Express Shuttle II* should have alerted the company that it had a problem with the fuel lines, which, if addressed, would have shown that the fuel lines were not being properly installed. The Safety Board further concludes that if Paradise of Port Richey had followed a formal, written preventive maintenance program, the underlying cause of the failure of the fuel lines could have been identified and eliminated, thereby avoiding the failure that led to the fire that destroyed the *Express Shuttle II*.

Consequently, the Safety Board believes that Paradise of Port Richey should develop and implement a preventive maintenance and inspection program for systems affecting the safe operation of its vessels, including the hull and the mechanical and electrical systems. Paradise of Port Richey could establish a preventive maintenance and inspection program with the help of materials published by the PVA. As noted earlier, the PVA's website contains a number of sample forms, such as worksheets, that companies can adapt for their own use in scheduling vessel maintenance, recording work done, and listing parts, paint, and other equipment purchased.

The Caterpillar service manual did not contain a specific procedure for repairing or replacing a single fuel line, as was done in the months and days before the fire. In the Safety Board's opinion, a more detailed explanation of the procedure for replacing single fuel lines could reduce misunderstandings or mistakes by vessel maintenance personnel. The manual also did not give details of where the fuel line clamps were to be installed. Therefore, the Safety Board concludes that the Caterpillar engine service manual was deficient because it did not include the steps required to replace a single fuel line and did not clearly indicate the correct location of fuel line clamps. Consequently, the Safety Board believes that Caterpillar, Inc., should revise the service manual for its marine engines to give specific instructions on how to replace a single fuel line and on where fuel line clamps should be located.

Previous Accidents

The Safety Board has addressed the issue of preventive maintenance in a number of recent accidents involving small passenger vessels. Three of those accidents are described below.

Port Imperial Manhattan. On the evening of November 17, 2000, the U.S. small passenger vessel *Port Imperial Manhattan*, a commuter ferry operated by NY Waterway, was en route from Manhattan to Weehawken, New Jersey, with three crewmembers and eight passengers on board when a fire broke out in the engineroom. Crewmembers attempted to extinguish the fire with portable extinguishers, with no success. The fire burned out of control, causing the vessel to lose power and forcing the crew and passengers to abandon the interior spaces. The crew and passengers were rescued by another NY Waterway passenger vessel, and the burning vessel was towed to Manhattan, where the New York City Fire Department extinguished the fire. One passenger was treated for smoke inhalation. No deaths resulted from the accident. The estimated cost of repairing the vessel was $1.2 million.

From its investigation, the Safety Board determined that the fire on the *Port Imperial Manhattan* was caused by a loose connection in an electrical junction box in the engineroom, which allowed the insulation and surrounding materials to ignite, which then ignited the hydraulic oil tank.[41] An open access door allowed the fire to spread to other areas of the vessel. The Safety Board concluded that if NY Waterway had had an effective preventive maintenance program, the loose electrical connection would have been detected before it caused the fire.

Seastreak New York. On September 28, 2001, the U.S. small passenger vessel *Seastreak New York* was en route from Highlands, New Jersey, to New York City with 198 passengers and six crewmembers on board. As the vessel passed Sandy Hook Point, New Jersey, about 0630, a fire broke out on the No. 3 engine in the starboard engineroom. Flames forced the deckhand who discovered the fire to flee the engineroom. Access hatches, ventilation, and fuel for the main engines in the starboard engineroom were secured. The fixed CO_2 fire suppression system was then activated. The *Seastreak New York* proceeded to a nearby Coast Guard station, using its port engines, and disembarked its passengers without incident. When firefighters arrived on board at 0700, they discovered that the vessel's CO_2 suppression system had extinguished the fire. No injuries resulted from the fire, but damages amounted to an estimated $81,000.

The Safety Board determined that the fire was caused by a lube oil hose that had not been properly secured and that, as a result, contacted the hot exhaust manifold.[42] The heat caused the hose to become brittle and break, which allowed lube oil to contact the exhaust manifold and ignite, resulting in the fire that damaged the *Seastreak New York*. Cited as a contributing cause of the fire was "the lack of inspection and maintenance procedures by Circle Navigation Company [the vessel operator] that might have discovered the improper installation."

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[41] National Transportation Safety Board, *Fire On Board the Small Passenger Vessel* Port Imperial Manhattan, *Hudson River, New York, November 17, 2000*, Marine Accident Report NTSB/MAR-02/02 (Washington, DC: NTSB, 2002).

[42] National Transportation Safety Board, *Fire on Board the Small Passenger Vessel* Seastreak New York, *Sandy Hook, New Jersey, September 28, 2001*, Marine Accident Report NTSB/MAR-02/04 (Washington, DC: NTSB, 2002).

Panther. On December 30, 2002, the U.S. small passenger vessel *Panther*, a 31-foot open wood-and-fiberglass boat operated by Everglades National Park Boat Tours, was on its third tour of the day in the Ten Thousand Island area of Everglades National Park, Florida, with 33 passengers (including five children) plus a master on board. Midway through the tour, shortly after 1430, the vessel sank in about 12 feet of water in Indian Key Pass, about 3 1/2 miles from the National Park Service visitor center near Everglades City. Three nearby vessels responded to the accident and rescued the master and all passengers from the water. No fatalities resulted from the accident, but one passenger suffered a serious injury. Damage to the *Panther* was estimated at $60,000.

The Safety Board's investigation of the *Panther* accident discovered serious deficiencies in vessel maintenance, including interior wood rot, questionable operational status of the starboard bilge pump and high-level bilge alarm, and serious hull damage.[43] The Board determined that the probable cause of the *Panther*'s sinking was flooding through a hull breach resulting from an earlier grounding that the vessel's owner had neglected to address. The Board concluded that the timely arrival of other vessels to the scene prevented loss of life in the accident.

Previous Recommendations

Passenger Vessel Association. As a consequence of its investigation of the *Port Imperial Manhattan* fire, the Safety Board made the following safety recommendation to the PVA on July 3, 2002:

> M-02-16
>
> Provide your members with guidelines for developing a preventive maintenance program for all systems affecting the safe operation of their vessels, including the hull and the mechanical and electrical systems.

In its June 2005 edition of *Foghorn* magazine, the PVA announced that it had developed and made available on its website a preventive maintenance program (checklists, guidance documents, etc.). The announcement included a strong endorsement of the preventive maintenance program by the PVA president. On August 4, 2005, the Safety Board wrote to the PVA commending it for its efforts and classifying Safety Recommendation M-02-16 as "Closed—Acceptable Action."

Coast Guard. The Safety Board's report on the *Port Imperial Manhattan* fire discussed the lack of Federal regulations regarding preventive maintenance for small passenger vessels:[44]

> The Coast Guard does not have specific regulations requiring a preventive maintenance program for small passenger vessels. The Federal regulators of other

[43] National Transportation Safety Board, *Sinking of the U.S. Small Passenger Vessel* Panther *Near Everglades City, Florida, December 30, 2002*, Marine Accident Report NTSB/MAR-04/01 (Washington, DC: NTSB, 2004).

[44] *Fire On Board the Small Passenger Vessel* Port Imperial Manhattan, pp. 27-28.

> transportation modes recognize the importance of preventive maintenance to the safety of operations and require that operators have a systematic program for performing inspections and maintenance. The Federal Aviation Administration has promulgated for all airplane operators comprehensive maintenance requirements, which include provisions for inspections, repairs, and preventive maintenance. The Federal Motor Carrier Safety Administration requires that every motor carrier systematically inspect, repair, and maintain, or cause to be systematically inspected, repaired, and maintained, all motor vehicles subject to its control. In addition, the Federal Railroad Administration has extensive inspection and maintenance requirements for locomotives, train cars, crossing signals, and tracks.
>
> Because no authority other than the Coast Guard exercises oversight over domestic small passenger vessels, the Safety Board believes that the Coast Guard should require that companies operating domestic passenger vessels develop and implement a preventive maintenance program for all systems affecting the safe operation of their vessels, including the hull and the mechanical and electrical systems.

As a result of its investigation of the *Port Imperial Manhattan* fire, the Safety Board issued the following safety recommendation to the Coast Guard on July 3, 2002:

> M-02-5
>
> Require that companies operating domestic passenger vessels develop and implement a preventive maintenance program for all systems affecting the safe operation of their vessels, including the hull and mechanical and electrical systems.

On November 21, 2003, the Coast Guard Commandant responded that his agency disagreed with Safety Recommendation M-02-5:

> We do not concur with this recommendation. Small passenger vessels are subject to a comprehensive set of regulations that are designed to promote vessel safety. The operators of these vessels are responsible for maintaining the vessel in compliance with all applicable regulations at all times. Additionally, the Coast Guard allows vessel operators to participate in the Streamlined Inspection Program (SIP)[45] that enables the owners to more effectively manage the oversight of inspection requirements. We believe that the recommended requirements would be unnecessarily burdensome and duplicative of existing requirements. We intend to take no further action on this recommendation and request that it be closed.

The Safety Board generally agrees that small passenger vessel regulations are comprehensive in that they list the vessel components and devices that are subject to inspections and tests and stipulate the standards with which these devices must comply to allow for the safe operation of a vessel. However, regarding the upkeep of the vessel, the regulations state only that repairs and maintenance must be accomplished in compliance

[45] The SIP is a program set up by the Coast Guard that allows certain vessel operators to inspect their own vessels.

with existing standards. The regulations do not promote or require a vessel owner or operator to develop a systematic program for addressing repairs and maintenance. The continuing occurrence of small passenger vessel accidents that stem from maintenance failures demonstrates the need for vessel owners or operators to develop such programs. Preventive maintenance programs should not be considered "burdensome" to vessel operators but rather a means of improving the quality, reliability, and safety of a vessel and its operation. Such a program would help maintain the safety of a vessel between periodic Coast Guard inspections, which at present are often the only time a vessel's condition and its safety systems are inspected and tested.

The Commandant's reply states that participation in the Coast Guard's SIP "enables the [vessel] owners to more effectively manage the oversight of inspection requirements." Under the SIP, vessel owners and operators work with Coast Guard representatives to develop company and vessel action plans. Procedures for developing and approving those plans (46 CFR 8.530) specifically require a description of the company's safety program, environmental protection program, and training infrastructure. They do not, however, specifically require a description of the company's preventive maintenance program. Although participating in the SIP has good potential for improving overall vessel safety, it is not clear how the SIP can ensure proper preventive maintenance on safety-critical vessel systems. According to the Coast Guard's latest figures, only 29 small passenger vessels had enrolled in the program as of October 2003 (representing 0.29 percent of the 10,125 small passenger vessels the Coast Guard inspects). Those figures indicate that the SIP has generally been ignored by the small passenger vessel industry.

On April 7, 2005, based on the correspondence received from the Coast Guard, the Safety Board classified Safety Recommendation M-02-5 "Open—Unacceptable Response." The *Express Shuttle II* fire further demonstrates the need for vessel owners and operators to develop preventive maintenance programs. The *Express Shuttle II*'s operating company did not follow a regular maintenance schedule, did not keep adequate repair records, did not recognize that the vessel was experiencing a large number of failed fuel lines, did not follow the manufacturer's guidelines for clamping and tightening the fuel lines, and most important, did not recognize that the failing fuel lines exposed the vessel and its occupants to the risk of fire. The Safety Board remains convinced that regulatory requirements addressing the maintenance of safety-critical equipment on small passenger vessels are essential. Moreover, the PVA's action in establishing readily accessible materials that vessel owners can use to establish preventive maintenance programs demonstrates industry acceptance of the importance of preventive maintenance. The Safety Board therefore believes that the Coast Guard should reconsider requiring operators of inspected small passenger vessels to develop and implement preventive maintenance programs for safety-critical vessel systems, including the hull and the mechanical and electrical systems. Consequently, the Board reiterates Safety Recommendation M-02-5.

Crew Response to Fire Emergency

After the engines failed, the first indication of the fire on board the *Express Shuttle II* was the white smoke the deckhands saw coming from belowdecks. The deckhands tried to identify the source of the smoke by lifting a small access hatch to the engine space. They did not first notify the master or take the precaution of having a fire extinguisher at the ready before opening the hatch. The deckhands' opening the hatch served only to feed the fire with oxygen. From what the deckhands told investigators, it is even possible that they left the hatch open.

After one of the deckhands informed the master of the smoke in the engineroom, the crew continued to take actions that exacerbated the fire and the smoke conditions. First, the deckhands opened the larger hatch over the starboard engine, whereupon flames shot out. Then, after the master came down to the cabin, he and one of the deckhands again opened the larger hatch while the other deckhand stood by with the portable extinguisher. That action fed more oxygen to the fire and allowed smoke to fill the cabin.

Even if the deckhand had been able to discharge the portable extinguisher, he would not have been close enough to the fire for the extinguisher to be effective. A portable extinguisher has a limited range and must be directed at the base of the fire to be effective. The deckhands' actions demonstrate that they were not properly trained in the use and limitations of the various types of fire extinguishers. Neither deckhand could tell investigators what kind of portable extinguisher they had used in fighting the fire on the *Express Shuttle II*.

The master's actions demonstrate that he too lacked training in using the *Express Shuttle II*'s firefighting apparatus. On discovering the extent of the fire, he left the cabin to retrieve the fire hose, then realized that the fire pump could not be activated if the engines were not running. It is possible that the master could have used that time to discharge the fixed CO_2 fire suppression system, whose controls were located in the fuel room. However, by the time the master realized that the fire hose could not be used, the cabin had filled with smoke, and the crew had to evacuate.

Coast Guard regulations require owners, charterers, masters, or managing operators to "instruct each crewmember, upon first being employed and prior to getting underway for the first time on a particular vessel and at least once every three months," about their duties in an emergency (46 CFR 185.420). The regulations at 46 CFR 185.524 require masters to "conduct sufficient fire drills to make sure that each crew member is familiar with his or her duties in case of fire." Neither deckhand on the *Express Shuttle II* had undergone any emergency training, including fire drills, even though they had worked 1 and 2 months, respectively, for Paradise of Port Richey. The master told investigators that he did the required fire drills "at least once a month, and when we get new deckhands, I do it more often." He said that he made sure the deckhands knew how to turn on the fire hose and where to direct passengers in case of fire. However, he said that he had never conducted a drill with either of the deckhands who were on the *Express Shuttle II* the day of the fire "because they were new." The master said the emergency drills were

documented in a logbook that stayed with the vessel, and that the company did not keep a duplicate record of the drills in the office. Because the fire destroyed the logbook, the Safety Board could not determine when the company had last conducted the required emergency drills. The Safety Board therefore concludes that on the day of the fire, the *Express Shuttle II* sailed without the owner, operator, or master having previously instructed the deckhands as to their duties in emergencies such as fires, as required by Coast Guard regulations.

The Safety Board has investigated past accidents on small passenger vessels where crew training in fire emergency procedures was a safety issue. In its report on the *Port Imperial Manhattan* fire, for example, the Safety Board found that the crewmembers on the vessel

> did not use proper firefighting techniques; thus, they were ineffective in controlling or extinguishing the fire. They did not take appropriate actions to prevent the heat and smoke of the fire from spreading to other parts of the vessel, which endangered their own safety and the safety of the passengers on board. In the Safety Board's opinion, the crewmembers' inability to appropriately respond to this emergency was the direct result of a lack of adequate training.

As a result of its investigation of the *Port Imperial Manhattan* fire, the Safety Board issued the following Safety Recommendation to the Coast Guard on July 3, 2002:

> M-02-9
>
> Establish firefighting training requirements for crewmembers on board small passenger vessels in commuter and ferry service.

On November 11, 2003, the Coast Guard responded that it partially concurred with Safety Recommendation M-02-9, but that it believed "the current requirements and recommendations are sufficient" and that it intended "to take no further action on this recommendation." However, Federal regulations do not require masters and deckhands on small passenger vessels to undergo formal firefighting training. Rather, the requirements at 46 CFR 185.420 and 185.524 stipulate that newly hired deckhands be instructed as to their duties in an emergency and that masters hold "sufficient fire drills" to familiarize crewmembers with their duties in case of a fire. The format and depth of the required instruction for new deckhands are left to the discretion of individual companies. The requirement for masters to hold "sufficient fire drills" is also subject to discretionary compliance. Moreover, because masters are not required to complete training in firefighting techniques, they may not be prepared to train others or to evaluate the effectiveness of fire drills.

According to fire safety professionals and training materials such as those offered by the PVA, effective marine firefighting requires crewmembers to know about the various fire classes (A = paper and other common combustible materials, B = flammable liquids and gases, C = electrical, D = combustible metals such as magnesium), the basic chemistry of fire (fuel, heat, oxygen, chemical reaction), and the proper use of various

extinguishing agents (water for cooling burning materials, dry chemicals or CO_2 for extinguishing a fire). Effective marine firefighting also requires practical knowledge of the sequence of steps crewmembers should follow in combating a fire on board a vessel. The first step is to locate the fire and report it. The next step is to prevent the fire from spreading by closing doors, portholes, ventilators, and other openings (hatches should not be opened). Finally, the fire should be extinguished by using appropriate agents and methods. Afterward, crewmembers should monitor the area in case the fire reignites.

Because the crewmembers of the *Express Shuttle II* did not use proper firefighting techniques, they were ineffective in controlling or extinguishing the fire. Crewmembers delayed in notifying the master of the fire, and the master did not respond immediately to their warning. When the master saw smoke coming from the engine space, he should have realized that the fire was already beyond the first stage.[46] The deckhands should have been instructed to secure the engineroom ventilation and close all access to the space containing the fire. Instead, crewmembers opened the hatches to the engineroom at least three times, feeding the fire with oxygen each time. The master made no attempt to activate the vessel's fixed CO_2 fire-extinguishing system, which neither deckhand even knew about. The deckhands had had no formal firefighting training and had participated in no fire drills during their employment with Paradise of Port Richey. The Safety Board therefore concludes that the crewmembers' firefighting efforts were ineffective in controlling or extinguishing the *Express Shuttle II* fire because they lacked adequate firefighting training and because the master did not take appropriate fire suppression measures.

In light of the evidence from the *Express Shuttle II* and previous vessel fires that it has investigated, the Safety Board believes that the Coast Guard should establish firefighting training requirements for crewmembers on board all small passenger vessels. The Safety Board recognizes that rulemaking by the Coast Guard to require firefighting training for crewmembers on all small passenger vessels will take time. Until such time as the Federal regulations are revised, the Safety Board believes that Paradise of Port Richey should develop and implement a training program in marine firefighting for its crewmembers. To do so, Paradise of Port Richey could use the training videos and written material related to basic firefighting and marine fire safety that have been developed by the PVA and that the organization makes available for a small fee.

The above recommendation to the Coast Guard builds on Safety Recommendation M-02-9, expanding it from commuter and ferry vessels to all small passenger vessels. On April 7, 2005, pending further action by the Coast Guard, the Safety Board classified Safety Recommendation M-02-9 "Open—Unacceptable Response." Because of the new recommendation stated above, Safety Recommendation M-02-9 is classified "Closed—Superseded."

[46] The first stage of a fire, known as the incipient stage, begins at the moment of ignition. During this stage, the flames are localized and the fire is fuel-regulated (regulated by the configuration, mass, and geometry of the fuel). In the incipient stage, the oxygen content is within normal range and normal ambient temperatures still exist. Source: National Fire Protection Association, *Fire Ignition and Development*, Catalog No. V-54 (Quincy, Massachusetts: NFPA, 1998).

Considering the time needed to promulgate new regulations regarding firefighting training for crewmembers on board small passenger vessels in commuter and ferry service, as recommended in Safety Recommendation M-02-9, on July 3, 2002, the Safety Board issued the following safety recommendation as an interim measure the Coast Guard could take:

> M-02-10
>
> Revise Navigation and Vessel Inspection Circular No. 1-91 so that it provides more in-depth guidance in training and drills for firefighting on board small passenger vessels.

The Coast Guard's response letter of November 24, 2003, stated that it did not concur with Safety Recommendation M-02-10 because NVIC 1-91 was intended only to give general guidance to marine employers and masters and that it intended to take no further action. On April 7, 2005, the Safety Board responded that NVIC 1-91 "provides the Coast Guard's only guidance to the small passenger vessel industry concerning fire training and qualifications of deckhands" and that the list of tasks in the NVIC "provides no guidance to deckhands on what they need to know in an emergency, what their responsibilities are . . . or reference to further information, guidance or instruction." Pending further action by the Coast Guard, the Board classified Safety Recommendation M-02-10 as "Open—Unacceptable Response." The Board continues to believe that NVIC 1-91 should provide detailed guidance, rather than only a list of tasks, regarding training and drills for firefighting on board small passenger vessels. The Board therefore reiterates Safety Recommendation M-02-10.

Fire Detection System

The small passenger vessel regulations at 46 CFR 181.400(c) require a space containing propulsion machinery to be equipped with a fire detection system of an approved type. The Coast Guard requires the components used in fire detection systems to be UL-approved for that purpose. The *Express Shuttle II* had a custom-designed and custom-built fire detection system that was installed in 1997, when the vessel was constructed. The system consisted of a control panel manufactured by Aqualarm and combination smoke/heat detectors wired directly to the panel (the engineroom had only a heat detector). The Aqualarm panel was UL-approved for electronic components but was not approved for use in fire detection systems. The Coast Guard became aware of this discrepancy as a result of the *Express Shuttle II* fire and no longer approves Aqualarm panels for use in fire detection systems.

Fire alarm panels are typically connected to detectors to which an end-of-line resistor is attached. If power is interrupted (for example, by a broken power cable or a nonfunctioning detector), the loss of power between the resistor and the panel activates an alarm. Circuits monitored in such a way are said to be electrically supervised (as required by 46 CFR 161.002-10[c]). No components of the *Express Shuttle II*'s fire detection

system were found after the fire. From wiring diagrams in the Coast Guard files for the vessel, Safety Board investigators determined that each fire detector was wired separately to the control panel, with no evidence of an end-of-line resistor. A repair technician verified that configuration.

The vessel's fire detection system thus did not meet Federal requirements for electrical supervision, in addition to having an alarm panel that was not UL-approved for fire detection systems. The Safety Board therefore concludes that *Express Shuttle II*'s fire detection system did not comply with Coast Guard regulations.

The Safety Board's investigation found that the *Express Shuttle II*'s fire detection system did not sound an alarm at any point during the fire. The master stated that he never heard an alarm or saw flashing lights on the alarm panel, which was located near him on the pilothouse console. Neither deckhand recalled hearing the alarm go off in the pilothouse. Because no components of the system were found after the fire, the Safety Board could not determine why the fire detector in the engineroom did not trigger an alarm. The evidence that no alarm sounded during the fire leads the Safety Board to conclude, however, that the vessel's fire detection system was not functioning at the time of the accident.

Early detection is critical to extinguishing a fire. The earlier a fire is detected and responded to, the better the chance of extinguishing it before it spreads out of control. If the deckhands had heard an alarm from the *Express Shuttle II*'s fire detection system, they would not have had to open and close the hatches to determine where the fire was and what was on fire (although they might have opened the hatches anyway because they had not been properly trained in how to react to a fire emergency). In fact, the actions of the deckhands exacerbated the fire by increasing the flow of oxygen into the engine space. If the alarm panel had given the master early notification of the fire, and if the master had received proper training in responding to a fire emergency, he could have activated the vessel's fixed CO_2 fire suppression system (the CO_2 system was never activated). The crew's efforts to fight the fire with a portable extinguisher were ineffective, and by the time the crew abandoned the vessel, the fire was climbing onto the upper deck. The Safety Board therefore concludes that the *Express Shuttle II*'s faulty fire detection system prevented early detection of the fire and precluded its early and effective suppression.

The Safety Board is concerned that other small passenger vessels might also be equipped with fire detection systems that do not comply with Federal regulations and that could put passengers and crewmembers at risk from undetected shipboard fires. The Board therefore believes that the Coast Guard should require that OCMIs, before issuing a COI to a small passenger vessel that is required to have a fire detection system, verify that all system components are approved for use in fire detection systems and that the circuits of the system are electrically supervised.

Emergency Response

The first person to reach the burning vessel was the operator of a passing recreational boat, who rescued all three crewmembers from the *Express Shuttle II* before anyone could be injured. Emergency responders to the fire included fire and rescue units from Port Richey and Pasco County, as well as the city police and county sheriff's department. Response was coordinated using the incident command system, with radio contact between responders maintained through a central dispatch system. Not only did the emergency responders work in a coordinated manner, they also overcame the logistical difficulties associated with the fire's relatively inaccessible location. The Safety Board therefore concludes that the emergency response to the fire was timely and appropriate.

Conclusions

Findings

1. The following were not factors in the fire on board the *Express Shuttle II*: weather, operator fatigue, or illicit drugs.

2. Although crewmembers were not given postaccident tests for alcohol, alcohol was probably not a factor in the accident.

3. The pattern and extent of damage indicate that the fire started on the inboard side of the *Express Shuttle II*'s starboard engine.

4. The initial source of fuel for the fire was diesel fuel from a fractured fuel line to cylinder 5 on the starboard engine.

5. The fuel line to cylinder 5 on the starboard engine failed as a result of metal fatigue from excessive vibrations caused by the failure to clamp the line.

6. The fire on the *Express Shuttle II* most likely ignited when diesel fuel from the ruptured fuel line sprayed onto hot engine parts.

7. The frequent need to replace fuel lines on the *Express Shuttle II* should have alerted the company that it had a problem with the fuel lines, which, if addressed, would have shown that the fuel lines were not being properly installed.

8. If Paradise of Port Richey had followed a formal, written preventive maintenance program, the underlying cause of the failure of the fuel lines could have been identified and eliminated, thereby avoiding the failure that led to the fire that destroyed the *Express Shuttle II*.

9. The Caterpillar engine service manual was deficient because it did not include the steps required to replace a single fuel line and did not clearly indicate the correct location of fuel line clamps.

10. On the day of the fire, the *Express Shuttle II* sailed without the owner, operator, or master having previously instructed the deckhands as to their duties in emergencies such as fires, as required by Coast Guard regulations.

11. The crewmembers' firefighting efforts were ineffective in controlling or extinguishing the *Express Shuttle II* fire because they lacked adequate firefighting training and because the master did not take appropriate fire suppression measures.

12. The *Express Shuttle II*'s fire detection system did not comply with Coast Guard regulations.

13. The vessel's fire detection system was not functioning at the time of the accident.

14. The *Express Shuttle II*'s faulty fire detection system prevented early detection of the fire and precluded its early and effective suppression.

15. The emergency response to the fire was timely and appropriate.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the fire on board the *Express Shuttle II* was a fractured, improperly installed fuel injection line on the inboard side of the starboard engine that allowed diesel fuel to spray onto the engine and ignite. Contributing to the cause of the fire was the failure of Paradise of Port Richey to have a preventive maintenance program, which could have identified the company's ongoing problem with the vessel's fuel lines before a failed line led to the fire. Contributing to the extent of the damage were the vessel's faulty fire detection system and the crew's failure to employ proper marine firefighting techniques.

Recommendations

New Recommendations

As a result of its investigation into the fire on board the *Express Shuttle II*, the National Transportation Safety Board makes the following new safety recommendations:

To the U.S. Coast Guard:

Establish firefighting training requirements for crewmembers on board all small passenger vessels. (M-06-10)

Require that Officers-in-Charge, Marine Inspection, before issuing a certificate of inspection to a small passenger vessel that is required to have a fire detection system, verify that all system components are approved for use in fire detection systems and that the circuits of the system are electrically supervised. (M-06-11)

To Paradise of Port Richey:

Develop and implement a preventive maintenance and inspection program for systems affecting the safe operation of your vessels, including the hull and the mechanical and electrical systems. (M-06-12)

Develop and implement a training program in marine firefighting for your crewmembers. (M-06-13)

To Caterpillar, Inc.:

Revise the service manual for your marine engines to give specific instructions on how to replace a single fuel line and on where fuel line clamps should be located. (M-06-14)

Previously Issued Recommendation Classified in This Report

To the U.S. Coast Guard:

M-02-9

Establish firefighting training requirements for crewmembers on board small passenger vessels in commuter and ferry service.

Safety Recommendation M-02-9 (previously classified as "Open—Unacceptable Response") is classified "Closed—Superseded" in the "Crew Response to Fire Emergency" section of this report.

Reiterated Recommendations

The National Transportation Safety Board also reiterates the following recommendations:

To the U.S. Coast Guard:

M-02-5

Require that companies operating domestic passenger vessels develop and implement a preventive maintenance program for all systems affecting the safe operation of their vessels, including the hull and mechanical and electrical systems.

M-02-10

Revise Navigation and Vessel Inspection Circular No. 1-91 so that it provides more in-depth guidance in training and drills for firefighting on board small passenger vessels.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

MARK V. ROSENKER
Acting Chairman

DEBORAH A. P. HERSMAN
Member

ELLEN ENGLEMAN CONNERS
Member

KATHRYN O'LEARY HIGGINS
Member

Adopted: April 4, 2006

Appendix A

U.S. Coast Guard Headquarters notified the Safety Board about the accident at 1601 on October 18, 2004. The Safety Board launched a three-person investigative team that arrived in Port Richey, Florida, on October 19 and began the investigation. The team documented the damage to the *Express Shuttle II* and interviewed company employees, emergency responders, fire officials, employees of the engine manufacturer's authorized local representative, and Coast Guard personnel. An engineer from the Board's materials laboratory joined the team in Florida on October 28. The on-scene investigation was completed on October 29.

The Safety Board investigated the accident under the authority of the Independent Safety Board Act of 1974, according to Safety Board rules. The designated parties to the investigation were the U.S. Coast Guard, the Florida Division of State Fire Marshal, Paradise of Port Richey (owner of the *Express Shuttle II*), Caterpillar, Inc. (engine manufacturer), and Ring Power Corporation (engine manufacturer's authorized local representative).

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