September 29, 2023 Marine Investigation Report MIR-23-22

Engine Room Fire Aboard Passenger Vessel *Spirit of Norfolk*

Elizabeth River
Norfolk, Virginia
June 7, 2022

Abstract: This report discusses the June 7, 2022, engine room fire aboard the 169-foot-long small passenger vessel *Spirit of Norfolk* while the vessel was underway on the Elizabeth River near Naval Station Norfolk, Virginia. The crew determined the fire was too large to fight, the vessel lost propulsion, and the passengers and crew evacuated to a Good Samaritan vessel. The *Spirit of Norfolk* was towed to a nearby US Navy pier. The fire spread throughout the vessel before being extinguished 4 days later. There were no injuries, and no pollution was reported. Safety issues identified in this investigation were a lack of fire detection and fixed fire extinguishing systems in the engine room, and ineffective response communications. The National Transportation Safety Board is issuing three new recommendations to the US Coast Guard.

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Acronyms and Abbreviations

CFR	*Code of Federal Regulations*
MIRT	Marine Incident Response Team
NTSB	National Transportation Safety Board
PFD	personal flotation device
recon	reconnaissance
SERT	Salvage Emergency Response Team
UC	unified command

Glossary

Amidships: The middle of a vessel's hull, either longitudinally or laterally.

Boundary cooling: The use of water deluge to keep bulkheads and decks cool to prevent the spread of fire through conduction and to prevent structural collapse, all while taking care to not flood the ship with firefighting water, which would risk sinking or capsizing the vessel.

Fire boundary: Any physical barrier, fitting, bulkhead, or deck utilized to limit the passage of flame and smoke identified during a fire casualty.

Fire control plan: A vessel's fire control plan shows escape routes, areas of refuge, embarkation stations, the location of fire protection and emergency equipment, and structural fire protection boundaries.

Structural fire protection: A component of an overall vessel fire-protection strategy that uses passive design features in a vessel's structure to slow the expansion of a fire from one compartment to another. Structural fire protection uses fire-resistant materials and insulation installed on the horizontal and vertical surfaces of a compartment, on doors/hatches, and in pipe and cable openings to slow the transfer of heat and smoke, thus providing additional time for evacuation and firefighting to contain and extinguish a fire.

Unified command: A type of incident command used when there is more than one agency with incident jurisdiction. Under a unified command, each participating partner maintains authority, responsibility, and accountability for its personnel while jointly managing and directing incident activities. In a unified command, agencies work together through the designated members of the unified command to analyze information and establish a common set of objectives and strategies.

Watertight: Capable of preventing the passage of water in any direction under the pressure of water likely to occur in intact (normal operating) and damaged conditions.

Executive Summary

What Happened

On June 7, 2022, about 1204 eastern daylight time, the US Coast Guard received a report of an engine room fire aboard the 169-foot-long passenger vessel *Spirit of Norfolk* while it was underway on the Elizabeth River near Naval Station Norfolk, Virginia. The vessel was on a 2-hour sightseeing cruise with 108 persons on board. The crew determined they could not enter the smoke-filled engine room to fight the fire, the vessel lost propulsion, and the passengers and crew evacuated to one of the Good Samaritan vessels on scene. The *Spirit of Norfolk* was towed to a US Navy pier. The fire spread throughout the vessel before being extinguished 4 days later. There were no injuries, and no pollution was reported.

What We Found

We found that the fire originated in the *Spirit of Norfolk*'s engine room, most likely due to the ignition of combustible materials stored near the exhaust pipe of the operating port generator. Due to regulatory exemptions, the *Spirit of Norfolk* was not required to have an engine room fire detection system; the lack of a fire detection system in the engine room delayed the discovery of the fire and allowed for its growth. The *Spirit of Norfolk* was also exempt from requirements for engine room fixed gas fire extinguishing systems, which would have given the crew a safe method of fighting the fire.

We also found that actions of the *Spirit of Norfolk* crew and Good Samaritan vessels and crew resulted in a timely and effective evacuation with no injuries. However, we found that the communications between the firefighting teams and the unified command were ineffective: the unified command was unaware that the firefighting teams were unable to locate the engine room emergency hatch. When the fire attack team opened the engine room door instead of the hatch, the fire was able to spread. Members of the unified command and firefighting personnel declined postcasualty interviews, so the National Transportation Safety Board did not receive critical information about the response. Lessons learned from this casualty could improve contingency planning for maritime firefighting.

We determined that the probable cause of the fire on the *Spirit of Norfolk* was likely the ignition of combustible material stored near the exhaust piping from the operating port generator. Contributing to the severity of the fire was the lack of a fire detection and fixed fire extinguishing system in the engine room. Also contributing to the severity were ineffective communications between the unified command and

firefighting teams that led to the fire attack team opening the engine room door, allowing the fire to spread.

What We Recommended

Because the *Spirit of Norfolk* was exempt from small passenger vessel requirements for engine room fire detection and fixed fire extinguishing systems, we recommended that the Coast Guard require that existing exempted Subchapter K small passenger vessels that were in operation as of March 10, 1996, be fitted with a fire detection system and a fixed gas fire extinguishing system in their engine rooms. Lastly, we recommended that the Coast Guard use the circumstances of this casualty to improve contingency plans related to fighting fires on vessels.

1 Factual Information

1.1 Casualty Narrative

1.1.1 Synopsis

On June 7, 2022, about 1204 local time, the US Coast Guard received a report of an engine room fire aboard the 169-foot-long small passenger vessel *Spirit of Norfolk* while it was underway on the Elizabeth River near Naval Station Norfolk, Virginia.[1] The vessel was on a 2-hour sightseeing cruise with 108 people (passengers, crew, and staff) on board. The crew determined they could not enter the smoke-filled engine room to fight the fire, the vessel lost propulsion, and the passengers and crew evacuated to one of the Good Samaritan vessels on scene. The *Spirit of Norfolk* was towed to a US Navy pier. The fire spread throughout the vessel before being extinguished 4 days later. There were no injuries, and no pollution was reported.

1.1.2 Precasualty Events

The *Spirit of Norfolk* was a small passenger vessel that conducted public dining and sightseeing cruises, as well as private charters, on the Elizabeth River in downtown Norfolk, Virginia (see Figure 1).

[1] (a) All times in this report are eastern daylight time. (b) The Coast Guard regulates passenger vessels of less than 100 gross tons as "small passenger vessels." See section1.4.2, Small Passenger Vessel Regulations, for more information on the vessel's classification. (c) Visit ntsb.gov to find additional information in the public docket for this NTSB accident investigation (case number DCA22FM022). Use the CAROL Query to search safety recommendations and investigations.

Figure 1. *Spirit of Norfolk* precasualty. (Source: Hornblower Group)

On the morning of June 7, 2022, the captain, who was also the director of marine operations for vessels operating in Norfolk, was conducting an orientation for a newly hired captain (new-hire captain). The captain offered the new-hire captain the opportunity to pilot the *Spirit of Norfolk* for the 1100 cruise (the casualty cruise), and the new-hire captain accepted. At 1113, the vessel departed the dock with the new-hire captain at the wheel and throttles and the captain in the pilothouse.

The 2-hour sightseeing trip of the Hampton Roads harbor had 108 people on board: 91 passengers (of which 36 were children), 7 crew, and 10 hospitality staff. The vessel's crew consisted of the captain, the new-hire captain, two first mates, and three deckhands.

At 1135, two deckhands began their round of the engine room, which was done twice an hour when the vessel was underway. According to one of the deckhands, they did not notice anything out of the ordinary, and he estimated that they exited the engine room at 1140.

1.1.3 Event Sequence

At 1159, the *Spirit of Norfolk* was abeam the Naval Station Norfolk, and the new-hire captain began to turn the *Spirit of Norfolk* around for its return leg of the trip. He brought the rudder to amidships and slowed both the port and starboard

main engines in preparation to use the engines and the inbound current to turn the vessel to port.

Before the vessel began to turn, when the new-hire captain moved the throttle controllers, he noticed that the port engine rpm readout had dropped to zero. At the same time, an alarm indicating that the throttle controller "lost connection to port main engine" activated, and the console throttle lights were flashing red and green, indicating an error. The captain directed a senior deckhand to check the engine room, but before hearing back from the deckhand, he and the new-hire captain saw smoke from the portside engine room exhaust ventilation opening.

At 1203:58, the captain contacted Coast Guard Sector Virginia using channel 16 on the VHF radio and informed them of the emergency, their location, and the number of people on board. (Figure 2 shows the vessel's route and the location the fire was reported.)

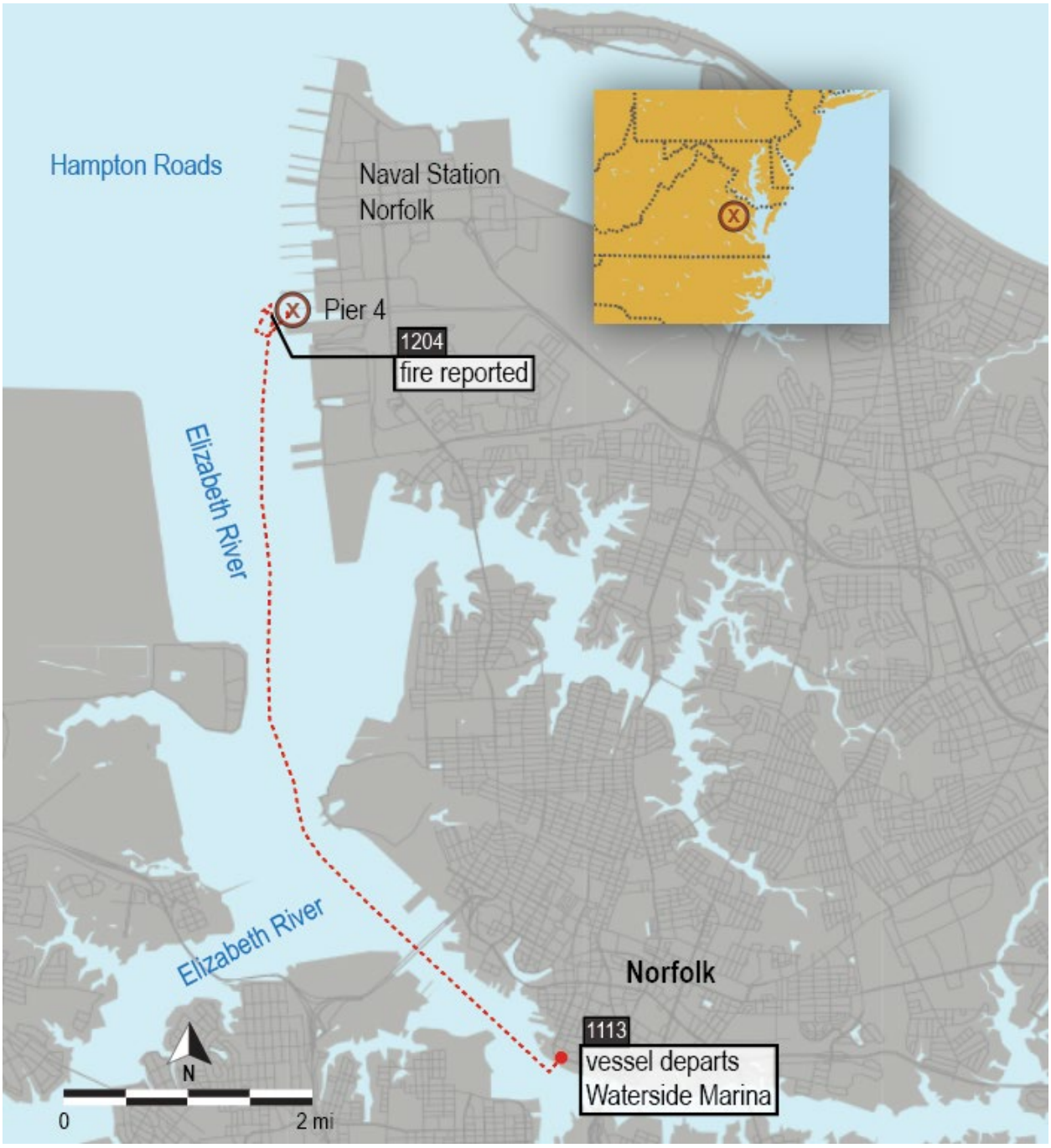

Figure 2. Trackline of the *Spirit of Norfolk*. Data from the vessel's automatic identification system. (Background source: Google Maps)

After receiving the orders from the captain, the senior deckhand and another deckhand went to the engine room door (on the centerline of the vessel in the bulkhead separating the engine room from the galley). The senior deckhand opened the quick-acting watertight door to the engine room and saw the compartment was

full of thick black smoke and flames. He recalled "smoke on the ceiling and a flame on the outboard side of the port main," and that it was "too dark…to make any type of entry." He called the captain to report the fire. The chief mate, who arrived soon after, determined that, based on the amount of smoke, it would be unsafe to enter the engine room to use the fire extinguishers that the deckhand had grabbed. The senior deckhand closed and secured the door.

From the pilot house, the captain shut down the powered ventilation fan to the engine room. (The ventilation system was not fitted with dampers or other means for shutting off the natural air flow to or from the engine room.) The captain also used a handheld radio to direct the crew to secure both the port and starboard engine remote fuel oil shut-off valves, located on the main deck of the vessel. Crewmembers told investigators that, once the fuel valves were secured, the electrical power for the vessel stopped, and the engine noise ceased.[2]

The restaurant manager instructed the crew to move passengers to the open portion of the third (top) deck (the vessel's "area of refuge") and directed the disc jockey to announce that all passengers were to move to the third deck. (For more information on the vessel's general arrangement, see Figure 7, section 1.4.1.)

1.2 Response

1.2.1 Vessel Evacuation

At 1209, after receiving the captain's report of the fire, Coast Guard Sector Virginia broadcast an urgent call to all vessels alerting them of the fire and asking them to assist if possible. At 1211, the captain of the *Spirit of Norfolk* used VHF radio channel 13 to broadcast a request for assistance from any towing vessels in the area. Multiple vessels responded, including the small passenger vessel *Victory Rover*; towing vessels *Challenger*, *Condor*, *Fort Bragg*, *GM McAllister*, *Rosemary McAllister*, *Surrie Moran*, *Wendy Moran*, *Marci Moran*, *Patricia Moran*, and *Z One*; crew boat *Ohio River*; *CG29274* (a Coast Guard 29-foot response boat-small II); and Norfolk Fire Department Fireboat 1.

Meanwhile, some of the smoke drifted onto the open third deck where passengers were mustered. The crew directed that all persons move to the enclosed

[2] The Coast Guard was the lead federal agency in this investigation. Throughout the investigation, the National Transportation Safety Board and Coast Guard investigators conducted joint interviews.

deck below (the second deck), where crewmembers distributed personal floatation devices (PFDs). The crew ensured all passengers donned the PFDs and then organized the passengers into a line for evacuation.

At 1213, the crew from the responding towing vessel *Rosemary McAllister* began spraying a water curtain over the *Spirit of Norfolk* with its fire monitor. At 1216, the small passenger vessel *Victory Rover*, which was also underway with sightseeing passengers in the area, responded and came alongside the *Spirit of Norfolk*.

The captain of the *Spirit of Norfolk* requested that the approaching towing vessels put water into the engine room's ventilation openings on the port and starboard sides to prevent the fire from spreading (see Figure 3).

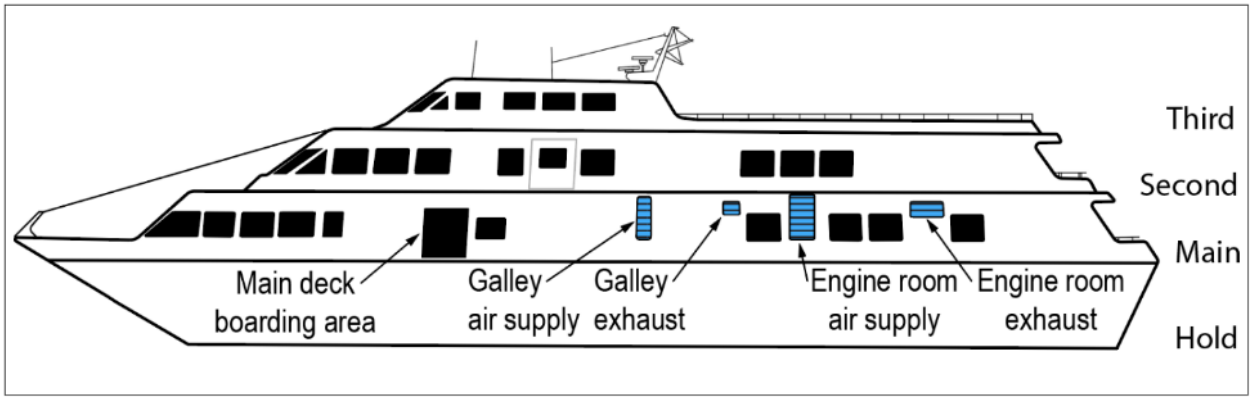

Figure 3. Profile view of the *Spirit of Norfolk*. Ventilation openings are shaded blue.

The *Challenger* sprayed water into the engine room exhaust ventilation opening on the starboard side, and the *Condor* captain used his fire monitor to put water onto the port side of the vessel by the engine room and create a mist to cool the air near the engine room (see Figure 4).

Figure 4. The *Condor* spraying water to cool the *Spirit of Norfolk*. (Source: Coast Guard)

The *Victory Rover* captain had the *Condor* hold the *Victory Rover* alongside the *Spirit of Norfolk* on the port side to evacuate passengers through the main deck entrance (see Figure 5).

Figure 5. A child is lifted over the rails and handed to a crewmember of the *Victory Rover*. (Source: Justin Wagner via StoryfulOriginal)

During the evacuation, the *Spirit of Norfolk* captain became concerned about the fire coming out of the port engine room vent, so he attempted to use the electrically driven main fire pump from the pilothouse to spray water at the portside engine room exhaust ventilation opening. However, because the crew had already secured the remote fuel shut off valves per the captain's orders, electrical power for the vessel, including the fire pump, stopped before the crew could use the hose to fight the fire.

At 1232, the captain reported that 106 persons had been transferred to the *Victory Rover*, and then the captain and the new-hire captain swept the vessel, walking through the decks and the public spaces below the main deck. At 1238, the Naval Station Norfolk commanding officer gave permission for the *Spirit of Norfolk* to dock at Pier 4.

After finishing the sweep, the captain took the vessel's fire control plan from its storage location on the main deck at the stern and placed it outside the

superstructure on the second deck so it would be readily visible to responders. The captain and the new-hire captain then boarded a Good Samaritan vessel, the crew boat *Ohio River*, at 1240.

At 1246, with no one on board, the *Spirit of Norfolk* was towed to Pier 4 with the assistance of the *Challenger*, *GM McAllister*, and *Rosemary McAllister*. The *Victory Rover* took the *Spirit of Norfolk* passengers to Town Point Park in downtown Norfolk, docking at 1253, where they were met by Norfolk Fire and Rescue and Coast Guard personnel. The Coast Guard personnel counted 106 people from the *Spirit of Norfolk*, concluding that (accounting for the captain and new-hire captain who were aboard the *Ohio River)* no passengers or crew were missing. No one was injured.

1.2.2 Firefighting Efforts

Local municipalities, including Chesapeake, Hampton, Newport News, and Norfolk, and fire boats from Hampton, Newport News, and Virginia Beach, responded to Pier 4 with equipment and personnel. The Navy fire department and emergency response units also responded.

During the firefighting efforts, the municipal fire departments on scene communicated on the same channel, but, due to differences in their equipment, did not have access to the Navy's channels. The unified command (UC), which was formed to coordinate firefighting and response operations, identified this issue and determined each agency would communicate with its own reconnaissance (recon) team personnel on their standard channels.

Following the casualty, the National Transportation Safety Board (NTSB) reviewed firefighting response documents submitted to the Coast Guard Marine Board of Investigation; documents included municipal fire department incident reports, a submission from the City of Norfolk containing answers to written questions submitted to the City of Norfolk fire department by the Coast Guard, and a memo from the Naval Station Norfolk commanding officer in response to written questions submitted by the Coast Guard. The Navy and Norfolk fire departments declined Coast Guard and NTSB requests to interview firefighters and members of the UC.

1.2.2.1 Initial Efforts

At 1245, Navy and local on-scene fire chiefs formed the UC. The UC command post was located on Pier 4, about 200 feet aft of the *Spirit of Norfolk*. At 1300, the Port of Virginia Marine Incident Response Team (MIRT) executive director arrived on scene. He provided "liaison support and information" to the UC, but he did not join the UC.

At 1307, as the *Spirit of Norfolk* approached the pier, a fire truck sprayed water into the engine room exhaust ventilation opening on the starboard side, but, despite the added water, heavy smoke continued to come from the vessel. More water was sprayed into the engine room exhaust ventilation opening; the MIRT executive director estimated that each stream was capable of supplying up to 1,000 gallons a minute.

At 1330, the Coast Guard deputy sector commander arrived on scene. She told the UC she was on scene to aid as a vessel expert and could facilitate Coast Guard resources; she also did not join the UC. At 1335, the *Spirit of Norfolk* was secured with its starboard side to the pier. The *Spirit of Norfolk* captain arrived at Pier 4 about the same time and told the fire chiefs at the command post the location of the fire control plan. He also described to a firefighter the location of the vessel's emergency engine room escape hatch (designed for egress from the engine room in an emergency) as another means for the firefighters to access the engine room. (It is unclear if this firefighter was part of either team that later boarded the vessel.) The emergency escape hatch led from the engine room up to the main deck, providing firefighters another means to access the engine room. The hatch was 15 feet deep (forward) and 10 feet to the right (starboard) on the main deck at the stern. Its location was indicated by a placard (Emergency Exit, Keep Clear) on the wall about a foot from the hatch, but the hatch itself was on the floor, with most of it covered with a piece of carpet matching the rest of the deck. (See Figure 7, the vessel's general arrangement plan, for the hatch location.)

At 1345, the crew of the *Fort Bragg* directed water into the vessel's portside engine room ventilation duct openings, which were emitting smoke. The UC decided to send a recon team onto the vessel to locate the engine room emergency escape hatch, retrieve the fire control plan, and identify all locations of the fire. The MIRT executive director briefed the UC on where to look for the emergency hatch.

1.2.2.2 Reconnaissance Efforts

About 1410, a four-person recon team, made up of two Norfolk firefighters and two Navy firefighters, was briefed for boarding by their respective chiefs. With the main deck passenger embarkation entrance on the waterside, the recon team boarded the vessel using a fire truck ladder laid horizontally on the second deck rails at the starboard side near the stern of the *Spirit of Norfolk,* before proceeding down to the main deck (see Figure 6). Both the recon and the fire attack teams wore full protective gear, including self-contained breathing equipment.

Figure 6. Firefighters boarding the *Spirit of Norfolk*. (Source: Coast Guard)

The recon team reported "visible conditions" on the main deck but could not locate the engine room emergency escape hatch. They then proceeded one deck below (to the hold level) to assess the situation. They made their way aft in the galley to the engine room door. A member of the team opened the door and noted "rollover, preflashover conditions," meaning that flames were spread across the overhead of the engine room. After surveying the extent of the fire, the recon team closed and secured the door and disembarked from the vessel. By 1420, the recon team had retrieved the fire control plan and was off the vessel.

Based on the recon's team assessment of the conditions, the UC sent a fire attack team on board the vessel with a hose for placing foam into the engine room.[3] The MIRT executive director showed the command post personnel the fire control plan retrieved by the recon team, but he was not aware that the recon team had not located the emergency hatch. He told NTSB and Coast Guard investigators that he understood from his visits to the command post that the fire attack team was going to apply foam into the engine room through the emergency escape hatch.

[3] Foam works by forming a blanket on burning liquid. The foam blanket excludes oxygen and stops the burning process. The water in the foam is slowly released as the foam breaks down, which provides a cooling effect on the liquid. (International Fire Service Training Association, 2000)

In response to a Coast Guard Marine Board of Investigation inquiry to the Norfolk Fire Department, the City of Norfolk reported that personnel on scene did not recollect discussions in the UC addressing ramifications of opening the engine room watertight door, including the impact of breaking the fire boundary, risks to firefighters, and the potential effects of releasing the accumulated firefighting water throughout the vessel, rescue, or backdraft.

About 1437, a four-person fire attack team made up of three firefighters from the recon team and a captain from the Norfolk Fire Department (who replaced another Norfolk Fire Department captain from the recon team) boarded the vessel to deploy foam to put out the fire. Visibility on board the vessel had decreased, and the main deck above the engine room was hotter than when the first team had boarded.

Unable to find the emergency escape hatch, they went to the engine room door at the aft end of the galley. As a member of the team turned the wheel on the watertight door to the engine room, the door "exploded open causing…a minor back draft" into the galley. A Norfolk Fire Department report described that "thousands of gallons of rapid water came rushing" out from the engine room, separating the team and trapping a team member behind the door. On shore, responders heard a loud noise and saw the vessel "shift to port hard…appear[ing] like it was going to roll."

About 1458, the fire attack team called a Mayday, and the UC gave an order to evacuate the vessel. With the vessel listing to port, the *Surrie Moran* captain said he was "instructed to hold the ship to the pier due to the severe list so firefighters could get off *Spirit of Norfolk*." At 1506, the fire attack team departed the vessel. No firefighting team injuries were reported to the NTSB.

1.2.2.3 Firefighting Efforts After the Firefighter Evacuation

After the evacuation, the Coast Guard deputy sector commander, acting for the Coast Guard captain of the port, told the UC to cease all onboard firefighting operations until a written stability assessment and a plan for the removal of contaminated bilge water was provided.

From 1500 to 1751, the towing vessels on scene continued to spray the *Spirit of Norfolk* with water, off and on, for boundary cooling. The Coast Guard sector commander arrived on scene at Pier 4 about 1600, and a senior salvage and firefighting engineer from DONJON-SMIT (a commercial marine salvage and firefighting response company) arrived at 1715.

About this time, the MIRT executive director noted smoke billowing from the vent openings. The UC directed firefighters to put firefighting foam into the engine

room and galley exhaust ventilation openings on the starboard side of the vessel in an attempt to reach the engine room and lower parts of the vessel. Firefighters continued to apply foam periodically until, after several hours, foam operations were ceased because of a concern that the vessel could capsize or sink with the addition of the water in the foam solution.

About 2000, the Coast Guard sector commander called a meeting to formally establish a UC that included other organizations in addition to the fire departments. The UC added Hornblower (responsible party), the commanding officers of the Naval Station Norfolk and Coast Guard Sector Virginia, and the Virginia Departments of Environmental Quality and Emergency Management. Members agreed that, until the Coast Guard Salvage Emergency Response Team (SERT) calculated and assessed the vessel's stability, firefighters would not apply any more water into the vessel but instead would continue to cool the hull exterior with water. They also agreed to have the SERT provide stability assessments for the response effort and to develop plans for removing firefighting water from the vessel, conducting an underwater survey of the vessel, and its eventual towing.

1.2.2.4 Ongoing Firefighting and Dewatering Efforts

Shoreside and waterside boundary cooling continued for the rest of June 7 and into the morning of June 8. At 0800, the UC developed a plan to get dewatering equipment on the vessel, start dewatering the vessel to remove the estimated 150,000 gallons of firefighting water, continue cooling the vessel, and firefight if necessary. At 0946, the salvage and firefighting engineer sent his stability calculations for the vessel to the Coast Guard SERT for approval to begin dewatering the vessel; the SERT approved the dewatering plan at 1420.

Boundary cooling efforts (exterior decks and sides) also continued through the day. As a result, water was still entering the vessel through the ventilation openings and main deck windows.

At 1620, dewatering began. DONJON-SMIT personnel ran hoses from portable water tanks on the pier to pumps they had placed in the galley and in the engine room through the emergency escape hatch. Within the hour, the first 21,000-gallon tank on the pier was full of water, and firefighting foam and dewatering efforts had to stop until a barge to receive the water and a tankerman to manage the dewatering efforts would arrive. Due to the process for City Cruises to identify and contract a barge and tankerman, the barge did not arrive until 0006 on June 9. The tankerman arrived at 0400 and connected the hoses to the barge. By 0600, the deck was no longer awash. At 1600, the UC estimated that 191,000 gallons of water had been pumped off the *Spirit of Norfolk*.

On June 11 at 0959, the UC declared the fire "out," 4 days after it started. At 1025, the Coast Guard approved the plan to tow the vessel from Naval Station Norfolk to Colonna's Shipyard in Norfolk.

1.3 Injuries and Fatalities

No fatalities or injuries were reported.

1.4 Vessel Information

Table 1. Vessel Particulars.

Vessel	*Spirit of Norfolk*
Type	Passenger (small passenger vessel)
Owner/Operator	Hornblower Cruises and Events LLC (Commercial)
Flag	United States
Port of registry	Norfolk, Virginia
Year built	1992
Official number (US)	982944
IMO number	8861618
Classification society	N/A
Length	169.0 feet (51.5 m)
Beam	38.0 feet (11.6 m)
Draft (casualty)	6.3 feet (1.9 m)
Gross/Net tonnage	1,151 / 99 register tons
Engine power; manufacturer	2 × Scania DI16-42M combined 1,150 hp (858 kW)
Persons on board	108

1.4.1 General

The 169-foot-long steel-hulled small passenger vessel *Spirit of Norfolk* was delivered in 1992 (see Figure 7). The vessel was owned and operated by Hornblower

Cruises and Events LLC. The vessel operated out of the Waterside Marina, located on the Elizabeth River in downtown Norfolk, Virginia. All cruises were conducted within the Hampton Roads area of Virginia. The *Spirit of Norfolk*'s maximum capacity was 661 persons, consisting of 600 passengers, 8 crewmembers, and 53 "other persons in crew."

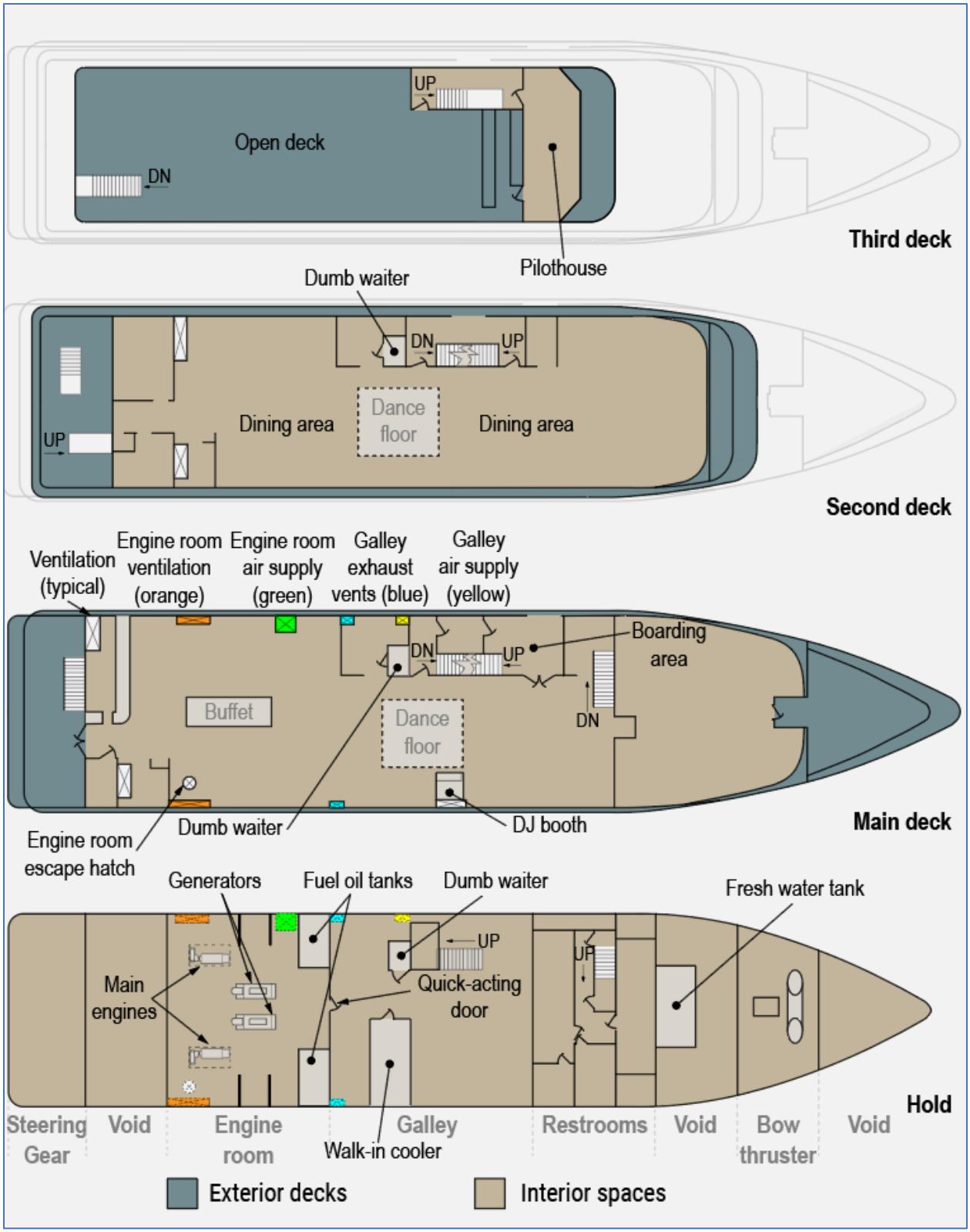

Figure 7. General arrangement plan of the *Spirit of Norfolk*.

1.4.2 Small Passenger Vessel Regulations

The *Spirit of Norfolk* was regulated as a small passenger vessel. The Coast Guard first established Subchapter T—Small Passenger Vessels on September 5, 1957, to regulate vessels of 65 feet or less in length. In 1963, Subchapter T was revised to include vessels (known as Subchapter T-L vessels) that were more than 65 feet long and had a gross tonnage of less than 100 tons. When the *Spirit of Norfolk* was built and began operating in 1992, it was subject to Subchapter T under Title 46 *Code of Federal Regulations* (*CFR*).

In 1996, the Coast Guard significantly changed the organization of the regulations for vessels, revising Subchapter T to apply to small passenger vessels certificated to carry 150 or fewer passengers, and creating Subchapter K for those small passenger vessels certificated to carry more than 150 passengers. However, Subchapter K exempted existing vessels (that is, vessels that had already been operating as of March 10, 1996) from certain construction, arrangement, and installation requirements (including engine room fire detection and fixed fire extinguishing requirements for vessels constructed of steel or aluminum). These exempted vessels—including the *Spirit of Norfolk*—instead had to comply with the regulations that were applicable to the vessel on March 10, 1996: Subchapter T regulations, before the 1996 revision.[4]

The Coast Guard's Marine Information for Safety and Law Enforcement system of marine inspection records for the year 2020 identified more than 100 vessels that, like the *Spirit of Norfolk*, are subject to Subchapter K (carrying more than 150 passengers) but are exempt from the Subchapter K fire detection and fixed fire extinguishing system requirements (in operation before March 10, 1996, and constructed of steel or aluminum).

1.4.2.1 Fire Detection and Extinguishing System Exemption

Subchapter K requires new vessels to be equipped with an approved fire detection system and a fixed gas fire extinguishing system for any spaces containing propulsion machinery.[5] (See Appendix D: Fixed Fire Extinguishing Systems.) However, an existing vessel with a hull made of noncombustible material, such as steel or aluminum, was exempt from the Subchapter K fire detection and

[4] 46 *CFR* section 114.110(c).

[5] 46 *CFR* 118.400(a) and (c).

extinguishing (suppression) system requirements.[6] The *Spirit of Norfolk* was not built or retrofitted with fire detection and extinguishing systems in the engine room.

An engine room fire detection system may include heat sensors, smoke detectors, fire detectors, rate of temperature rise sensors, and flame detectors—which, in combination, provide early indications of smoke and fire.

1.4.2.2 Structural Fire Protection and Ventilation Requirements

Title 46 *CFR* 177.10-5(a) (Subchapter T) required the *Spirit of Norfolk* to meet the structural fire protection requirements of 46 *CFR* 72.05 of Subchapter H.[7] These requirements included standards for bulkheads or decks classed according to the degree of fire protection they afford: bulkheads and decks separating the engine room and the passenger area are required to prevent the passage of smoke and flame for 1 hour. (See Appendix C: Structural Fire Protection Requirements.) The overhead of the engine room was covered with thermal insulation to meet this requirement; the engine room's port and starboard sides (integral with the hull), aft bulkhead (forward of the void), and forward bulkhead (aft of the galley) also acted as structural fire boundaries.

These hull structure requirements also included ventilation specifications, which are found in 46 *CFR* 72.05-50(i) and require that engine room ducts be fitted with manually or automatically operated dampers or other suitable means for shutting off the passage of air (in the event of fire).

The *Spirit of Norfolk*'s engine room ventilation system had one electrically driven air supply fan in the forward section of the engine room on the port side, and two exhaust ventilation ducts (see Figure 3). Although the electrically driven fan motors could be secured remotely from the pilothouse, none of the ventilation trunks were fitted with dampers (closures within the trunk), nor was the vessel designed or equipped with a means to close the ventilation openings to the engine room, such as via the use of fitted covers, or manually operated louvers.

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[6] Existing vessels that had a hull or machinery space boundary made of combustible material such as wood or fiber-reinforced plastic (fiberglass), which the Coast Guard considered a higher risk category, were required to be retrofitted with fixed fire extinguishing and detecting systems. (*Federal Register,* vol. 59, no. 9 (January 13, 1994), p. 2046)

[7] 46 *CFR* 177.10-5: "Vessels contracted for on or after July 1, 1961, which carry more than 150 passengers shall meet the requirements of subpart 72.05 of Subchapter H (Passenger Vessels) of this chapter."

During the casualty, air continued to enter the engine room, and fire and smoke continued to exit the engine room from both the port and starboard exterior exhaust hull ventilation openings after the captain secured the air supply fan (see Figure 8).

Figure 8. Smoke from the engine room starboard exhaust ventilation opening. (Source: Coast Guard)

1.4.3 Certification

The *Spirit of Norfolk*'s Coast Guard-issued certificate of inspection, valid for 5 years, was issued on February 20, 2020. Annual re-inspections were required and completed on April 21, 2021, and May 10, 2022. The vessel's last drydock and internal examinations were completed on February 21, 2022. Sector Virginia was the local Coast Guard office responsible for inspecting the *Spirit of Norfolk*.

1.4.3.1 Lifesaving Equipment

The *Spirit of Norfolk* was certificated for a Lakes, Bays, and Sounds route limited to the Chesapeake Bay and Delaware Bay and their tributaries, including the Chesapeake and Delaware Canal, and could travel no more than 1 mile from shore when operating with passengers. Because of this limited route, the vessel was not required to carry any life rafts and did not have any on board. The vessel was required to carry 3 ring buoys, 661 adult life preservers (also called PFDs), and 67 child life preservers. The PFDs were stored in lockers forward on the main deck, forward and aft on the second deck, and aft on the third deck.

The automated safety orientation that aired over the *Spirit of Norfolk*'s public address system informed passengers that the captain may ask them at any time to don a life preserver and direct them to a safety zone on the vessel. Additionally, the captain and crew advised passengers where the life preserver donning and fire emergency egress diagrams and instructions were located. Passengers were told to always follow the captain's instructions.

1.4.3.2 Fire Protection Equipment and Regulations

The *Spirit of Norfolk* had the firefighting equipment required by its certificate of inspection: the vessel was outfitted with one fire pump, five 50-foot-long hoses of 1.5-inch diameter, and ten 10-pound portable fire extinguishers. Hose stations were located in the galley on the bulkhead separating the galley from the engine room, two on the main deck, and one each on the second and third decks.

1.4.4 Engine Room

The *Spirit of Norfolk*'s engine room was located below the main deck of the vessel. It was typically accessed through a watertight door from the galley. The engine room also had an escape hatch in the overhead of its aft starboard corner that led to the interior of the main deck starboard of the buffet area. The engine room had two partial transverse bulkheads extending from the port and starboard sides of the hull (see Figure 7).

1.4.4.1 Main Propulsion Engines

The vessel's main propulsion consisted of two Scania main diesel engines that were installed in 2020. Each engine was connected to a propeller shaft through a gear box.

An electronic throttle controller transmitted engine commands from the throttle in the pilothouse to the engines, controlling speed and direction. The electronic throttle controller was in the engine room on a bulkhead forward of the port main diesel engine.

1.4.4.1.1 Main Propulsion Engine Maintenance

The vessel's crew conducted general maintenance for the main diesel engines, which included changing the air and lube oil filters, changing the lube oil, and monitoring the lube oil and coolant levels in the engines. Repairs and more extensive maintenance were completed by a contractor.

Before starting the engines for a voyage, crewmembers would check the coolant and lube oil levels. After starting the engines, the crew ensured they were within parameters and conducted a test of the throttle control from the pilothouse.

The engine room was not crewed while the vessel was underway, so crewmembers conducted a round of the engine room about every 30 minutes, during which they would look for any indications of equipment failure or unusual gauge measurements and record temperature and pressure gauge readings on a log sheet.

1.4.4.2 Electrical

Two Caterpillar 3406 diesel generators, rated at 290 kilowatts each, provided the electrical power for the vessel. A main electrical distribution switchboard, located in the aft part of the engine room between the port and starboard main diesel engines, powered the vessel.

1.4.4.3 Fuel System

The fuel oil system included two 5,200-gallon storage tanks serving the two main diesel engines and the two diesel generators. At the time of the fire, the vessel had about 4,300 gallons of fuel on board, evenly distributed between the two tanks. The fuel was gravity fed to each of the operating engine's fuel pumps as needed during their operations. Both fuel tanks had remote fuel shut-off valves that could be secured from outside the engine room on the deck above with a reach rod in case of an emergency. Each engine had its own fuel oil isolation valve and filters.

During the postfire exam, investigators found that the fuel oil shut-off valves for the port and starboard fuel tanks were secured.

1.4.4.4 Hydraulic Steering System

The hydraulic steering system consisted of a 100-gallon sump to store the hydraulic fluid and two electrically driven hydraulic pumps in the forward port side of the engine room that provided the system pressure to position the vessel's two rudders. The rudders' actuating equipment was in the aftmost space within the hull of the vessel. A switch in the engine room controlled the electrical power for the steering system's hydraulic pumps.

1.4.5 Engine Room Fire Damage Investigation

The fire damage investigation focused on the engine room because the mate reported that he observed fire toward the aft port side of the engine room and, at the time he reported observing the fire, none of the other areas of the vessel exhibited any fire involvement.

Fire damage was observed throughout the engine room compartment, with the most severe damage concentrated at ceiling height where structural members were deformed and, in some instances, fractured due to thermal expansion. The overhead thermal damage was mostly uniform throughout the engine room. The thermal damage to the engine room exhibited a gradient of thermal damage from the overhead toward the deck, with the most severe damage overhead. The gradient of thermal damage also exhibited a sharp line of demarcation below which the thermal damage abruptly stopped (see Figure 9).

Figure 9. Portside engine room bulkhead exhibiting demarcation line (*dashed blue*) between thermally damaged and undamaged area.

The electronic throttle controller, mounted to the bulkhead forward of the port main engine, was destroyed (see Figure 10). (The port engine's drop to 0 rpm and the throttle controller alarm was the new-hire captain's first indication there was a problem in the engine room.)

Figure 10. Bulkhead forward of port main engine with low-lying damage towards the outboard side. Demarcation line (*dashed blue*) and original location of electronic throttle controller (*red*) shown.

The hull outboard of the port main engine had metal storage shelves. A photograph from a marine survey on June 2, 2022, showed numerous cardboard boxes and plastic totes (see Figure 11). The captain told investigators that they've "always" had shelves there and "always" kept spare items on those shelves, including plumbing parts, filters, air filters, HVAC pumps, and a starter for one of the generators. The photo from the marine survey also showed that the insulated exhaust pipe from the port generator was routed through the top shelf of the storage rack and next to the materials on the shelf.

Figure 11. Photo from survey on June 2, 2022, showing port main engine (*foreground*) and storage shelf. The white port generator exhaust pipe is visible behind some of the boxes on the shelves. (Source: Knox Marine Surveyors & Consultants)

The area outboard of the port main engine exhibited fire damage from the overhead level down to the deck; the shelf contents in the area were completely consumed by the fire (see Figure 12).

Figure 12. Fire damage on the bulkhead aft and outboard of port main engine. The metal frames of the storage shelves are visible against the bulkhead.

The on-scene examination of the port main engine did not reveal any anomalies of the fuel or lubrication systems. In addition, the turbochargers did not exhibit signs of failure. The two fuel tanks in the port and starboard forward corners of the engine room exhibited fire damage. The port fuel tank walls were bowed outward but appeared to remain intact. The starboard fuel tank exhibited outward bowing as well as a tear along one of the seams that extended from the overhead down to the deck.

Examination of the hydraulic steering system revealed three failure points in the hydraulic oil distribution system, one in the hose from the hydraulic pump and two in the iron pipes leading to the hydraulic rams in the steering gear compartment aft of the engine room. One fractured iron pipe was located at ceiling height outboard of the port main engine. The other fracture was also located at the overhead but in the area near the hydraulic power unit.

1.5 Damage

The vessel, valued at $5 million, was a total constructive loss. The vessel sustained fire damage throughout all the decks, and the exterior had thermal discoloration and charring. The engine room exhaust ventilation system exhibited soot around the ventilation openings and patches of charred and burned-off paint above the openings. On the port side exterior, an area of charred/burned-off paint was at a height on the hull that corresponded with the location of the engine room ventilation air supply and exhaust openings (see Figure 13).

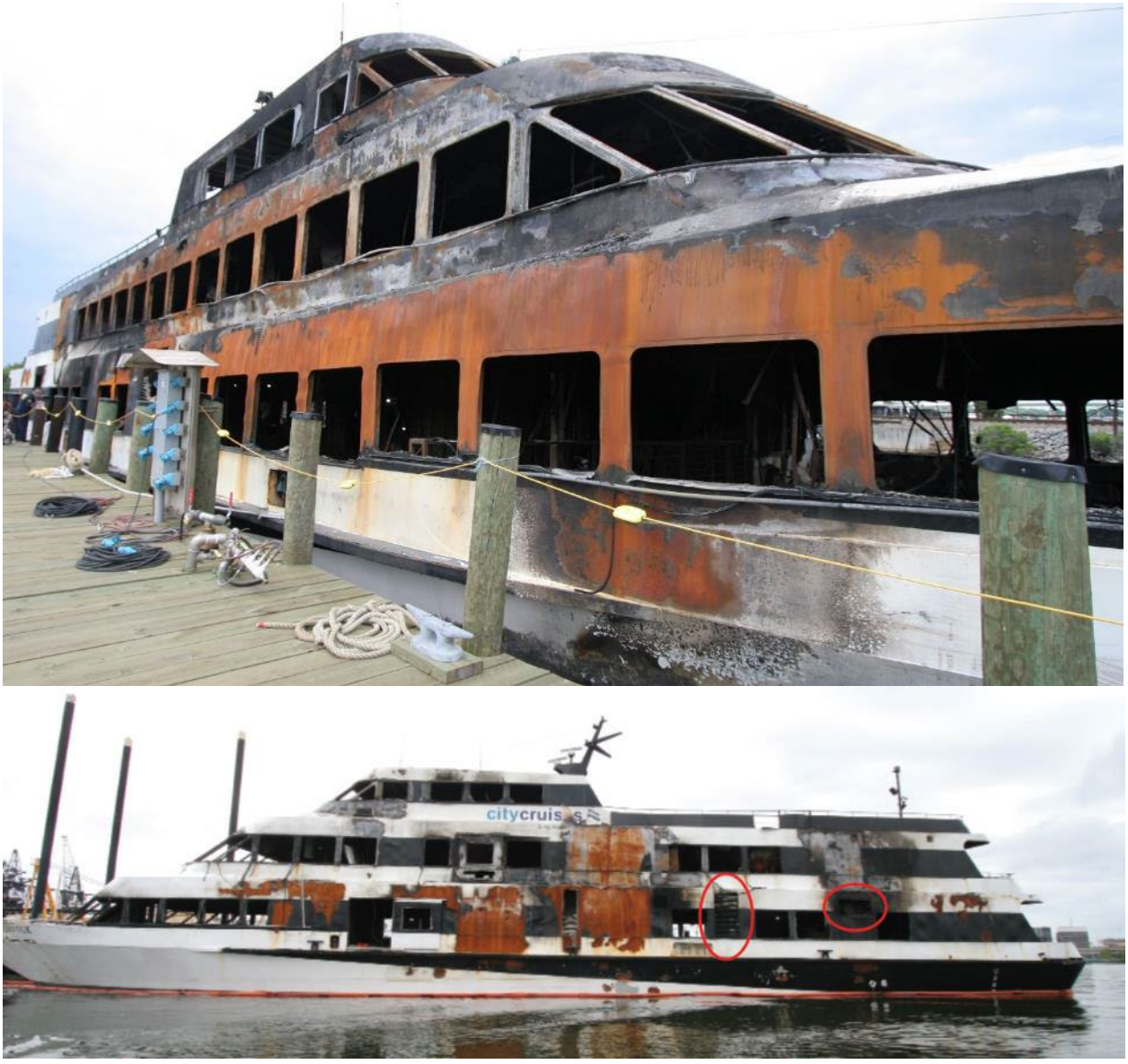

Figure 13. Exterior damage to the *Spirit of Norfolk*, starboard side (*upper*), and port side (*lower*) The engine room ventilation openings are circled in red.

The interior of the main and second decks, and interior stairwells were completely consumed by the fire (see Figure 14, Figure 15). Exterior areas on the stern of the main deck were not fire damaged but did exhibit some sooting. The pilothouse was completely consumed by fire. Below deck, the engine room and galley sustained extensive fire damage.

Figure 14. Main deck interior looking aft.

Figure 15. Photo of the engine room escape hatch on the main deck after the fire.

1.6 Waterway and Environmental Information

The *Spirit of Norfolk* was transiting the Elizabeth River, which is part of Norfolk Harbor. Norfolk Harbor comprises a portion of the southern and eastern shores of Hampton Roads and both shores of the Elizabeth River and its Eastern, Southern, and Western Branches, on which the cities of Norfolk, Portsmouth, and Chesapeake are located. The fire occurred near the northern end of the Elizabeth River, near the Norfolk Harbor entrance and Hampton Roads, where the project depth is 50 feet.

The fire occurred during daylight hours in good visibility. At 1155, Norfolk International Airport, about 8.5 miles southeast of where the *Spirit of Norfolk* was located when the fire started, recorded winds from the south-southeast at 13 mph with no gusts, partly cloudy conditions, and an air temperature of 82°F. For June 7, 2022, the Norfolk water temperature was 73.8°F, and wave heights were less than 1 foot.

1.7 Operations

1.7.1 Vessel Emergency Plan

The City Cruises Emergency Response Plan described the action the vessel's captain and crew should take if a fire occurred on the vessel. The plan included instructions to the captain and crew for abandoning ship, including having all passengers and crew don PFDs, sweeping the vessel to make sure all passengers and crew are accounted for, requesting assistance from nearby vessels, and "evacuat[ing] passengers to the safest platform possible." Water evacuation was listed as a last resort because the vessel did not carry any lifeboats, life rafts, buoyant apparatus, or a rescue boat.

The *Spirit of Norfolk* captain and shoreside personnel knew that 108 passengers and crew were on board; it was the company's practice to communicate the passenger count to a representative of the owner or managing operator of the vessel before departing on a voyage.

1.8 Key Personnel Information

Seventeen City Cruises employees were on board the *Spirit of Norfolk*, including the captain, the new-hire captain, two first mates (referred to as the chief mate and the first mate), three deckhands, and the hospitality staff. The hospitality staff consisted of the restaurant manager, bartender, cook, sous chef, server, two server assistants, two photographers, and a disc jockey. The crewing required by the Coast Guard certificate of inspection when carrying fewer than 300 passengers was a captain, a credentialed mate or senior deckhand, and three deckhands, including a senior deckhand.

The captain, who held a credential as master of self-propelled vessels not including auxiliary sail of less than 100 gross register tons upon inland waters, also served as City Cruises' director of marine operations for the vessels operating in Norfolk. He began working for City Cruises as a deckhand and began serving as the captain on City Cruises' vessels after obtaining his credential in 2011. He became the director of marine operations in 2016. As the director of marine operations, he oversaw the operation and maintenance of vessels.

The new-hire captain held a credential as a master of self-propelled vessels not including auxiliary sail of less than 100 gross register tons upon near coastal waters. He had reported for his first day of orientation as a new employee on June 7, and, as

part of his onboarding, was piloting the *Spirit of Norfolk* under the supervision of the captain.

1.8.1 Toxicological Testing

Coast Guard drug and alcohol testing regulations require that individuals engaged or employed on board a vessel directly involved in a serious marine incident, such as the engine room fire on board the *Spirit of Norfolk*, be tested for evidence of drugs and alcohol. All crewmembers, except for the new-hire captain were tested; the responding Coast Guard investigator did not require the new-hire captain to be tested. The crewmembers, except the captain and new-hire captain, were drug and alcohol tested within about 5 hours after the fire. The captain was alcohol tested about 4 hours after the fire and provided a sample for drug testing at 1425 on June 8, about 27 hours after the fire.[8] All results were negative.

1.9 Postcasualty Actions

1.9.1 City Cruises

In 2022, Hornblower Cruises and Events installed Coast Guard–approved fixed fire extinguishing and detection systems in the vessel that replaced the *Spirit of Norfolk*, the *Spirit of Mount Vernon*. On August 14, 2023, City Cruises told the NTSB that they have committed to a multi-year project to retrofit fixed fire extinguishing and fire detection systems in conjunction with scheduled drydock and maintenance periods. By the end of 2023, the company will complete the installation of fixed engine room fire extinguishing systems in four other vessels within their fleet. The fire detection systems for those four vessels will be installed later.

1.9.2 Coast Guard

On June 1, 2023, the Coast Guard published Safety Alert 07-23, "Critical Insight From Ongoing Investigations Into Small Passenger Vessel Fires," in response

[8] The Coast Guard requires toxicological testing after a serious marine incident, 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 $200,000, (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 US waters; or (c) release of a reportable substance into the environment of the United States.

to ongoing Coast Guard and NTSB investigations, including the *Spirit of Norfolk*, to provide the maritime industry with best practices on board vessels.

The safety alert highlighted five issues, including two that were relevant to this casualty: (1) storing combustibles such as cardboard boxes and plastic storage bins as far away as possible from potential sources of ignition, including the vessel's engines and machinery; and (2) using hazard tape or other floor marking tapes to clearly delineate the location of engine room escape hatches when the hatches are covered with the same patterned carpet as the floor, making the location hard to distinguish.

2 Analysis

2.1 Introduction

On June 7, 2022, the small passenger vessel *Spirit of Norfolk* was underway on a sightseeing tour in clear weather near Norfolk, Virginia. The vessel had 108 persons on board. During the tour, crewmembers discovered an engine room fire. Unable to fight the fire, the crew evacuated passengers to a Good Samaritan vessel. There were no injuries. The *Spirit of Norfolk* was towed to a nearby Navy pier, where the fire continued to spread throughout the vessel before being extinguished 4 days later.

This analysis discusses the following safety issues:

- Lack of fire detection and fixed fire extinguishing systems in the engine room (sections 2.3 and 2.4)
- Ineffective response communications (section 2.5)

The investigation established that the following factors did not contribute to the fire's cause:

- *Weather and waterway conditions*. The *Spirit of Norfolk* was underway on the Elizabeth River in Norfolk, Virginia, during clear weather conditions, with calm winds and seas. There was no evidence that weather or waterway conditions impacted the crew or vessel on the day of the fire.
- *Crew impairment due to alcohol or other drugs*. Postcasualty toxicology results for tested crewmembers were negative for the presence of alcohol or other drugs.
- *Steering gear hydraulic system failure*. One of the failures in the steering gear hydraulic system was near the origin of the fire in the engine room. The NTSB examined the fractures in the hydraulic system and determined that the fractures occurred at elevated temperatures, likely after the system was fully engulfed in the fire; therefore, hydraulic oil was not an initial source of fuel for the fire.

Thus, the NTSB concludes that none of the following were safety issues for the casualty: (1) weather and waterway conditions, (2) crew impairment due to alcohol or other drugs, or (3) a steering gear hydraulic system failure.

2.2 Origin and Potential Cause of the Fire

The first indication of an abnormal condition in the engine room was when the new-hire captain noticed the loss of rpms to the port engine, followed immediately by an alarm indicating loss of port engine control. The rpm drop was consistent with a failure of the electronic throttle controller (attached to the bulkhead forward of the port main engine); therefore, it is likely that the controller was damaged early in the event. Following the loss of rpms to the port engine, the captain sent the senior deckhand to the engine room to determine the cause. Around that time, the captain and the new-hire captain saw smoke coming from the portside engine room exhaust ventilation opening. The deckhand reported that, when he opened the engine room door, he saw gray smoke and flames outboard of the port engine before closing the door again.

The NTSB assessed the damage in the engine room and identified a line of demarcation, consistent with a water line resulting from the firefighting efforts introducing water into the engine room. Any thermal damage found below the line of demarcation would indicate damage that occurred early in the event. The area outboard of the port main engine exhibited fire damage below the overall line of demarcation extending down to the deck, indicating this damage occurred before firefighting efforts began. The NTSB also observed similar low-lying fire damage on the bulkhead forward of the port main engine—near where the throttle controller for both main engines was located. A photograph taken on June 22, 2022, showed metal shelves attached to the hull outboard of the port main engine. Fire completely consumed these shelves from the overhead down to the deck; thus, this area had also been on fire before the firefighting response.

Therefore, based on crewmember observations and the NTSB's damage assessment, the NTSB concludes that the fire originated in the *Spirit of Norfolk*'s engine room, near the outboard side of the port main engine.

The NTSB examined the fuel system that served the engines and generators for a potential leak or ignition source. The fuel distribution system to all engines was found intact, except for the starboard fuel tank. The starboard fuel tank exhibited a fractured seam resulting from the exposure to the engine room fire. The NTSB also reviewed the vessel's maintenance and repair history but did not find any preexisting deficiencies with the port main engine that may have led to the fire, nor were any component failures identified during postcasualty examination of the port main engine.

Because the damage assessment indicated the fire likely started outboard of the port main engine, the NTSB focused on the shelves attached to the port hull in this area. The photograph from the June 2022 marine survey showed the presence of combustible items, including cardboard boxes and plastic tubs, stored on the shelves. The captain told investigators that they "always" kept spare items on those shelves, including plumbing parts, filters, air filters, HVAC pumps, and a starter for one of the generators, so it is likely those items were still present at the time of the fire. Further, the insulated exhaust pipe from the port generator was routed through the top shelf of the storage rack and next to the materials on the shelf.

Although the survey photograph showed the pipe was insulated, the fire damage precluded an assessment of the pre-fire condition of the insulation. The insulation may have shifted or been damaged, and any gaps, discontinuities, or other conditions could have allowed heat transfer from the exhaust to the adjacent combustible materials, which could have then ignited. Therefore, the NTSB concludes that although a definitive ignition source cannot be determined, the most likely cause of the fire was the ignition of combustible materials stored near the exhaust pipe of the operating port generator.

The NTSB and Coast Guard have investigated previous vessel fires resulting from hot engine exhaust pipes located near, or coming into contact with, combustible materials, including aboard the commercial fishing vessel *Raffello* (NTSB 2017) and the vehicle carrier *Alliance St. Louis* (NTSB 2018). On June 1, 2023, the Coast Guard published Safety Alert 07-23, "Critical Insight From Ongoing Investigations Into Small Passenger Vessel Fires." The Safety Alert included best practices to assist in the prevention of vessel fires like that on the *Spirit of Norfolk*, including storing combustibles such as cardboard boxes and plastic storage bins as far away as possible from potential sources of ignition, including the vessel's engines and machinery.

2.3 Fire Detection

After the new-hire captain noted the unresponsive controls, the captain directed the senior deckhand to check the engine room. When the senior deckhand and another deckhand arrived at the engine room, the engine room compartment was already filled with smoke, and the senior deckhand decided not to enter the smoke-filled space to fight the fire with the vessel's portable fire extinguishers.

In the case of a fire emergency, early warning is essential to a successful response. An engine room fire detection system may include heat sensors, smoke detectors, rate of temperature rise sensors, and flame detectors—which, in

combination, provide early indications of smoke and fire. Because a fire detection system senses products of combustion, which are hot and rise, to activate an alarm, a fire detection system mounted to the engine room overhead will detect the products of combustion and provide timely warning. The *Spirit of Norfolk* did not have a fire detection system for its engine room, nor was one required. By the time crew became aware of the fire, the engine room was filled with smoke, and they were unable to enter to fight the fire. The NTSB concludes that the lack of a fire detection system in the engine room delayed detection and allowed for the growth of the fire, which precluded crew firefighting efforts.

When the Coast Guard revised small passenger vessel regulations in 1996 (creating Subchapter K, pertaining to small passenger vessels permitted to carry more than 150 passengers), they required a fire detection system for any spaces containing propulsion machinery—such as an engine room. However, the Subchapter K regulations exempted vessels from the fire detection system requirements if they (1) had begun operation before the revised regulations and (2) had noncombustible hulls (such as steel). Because the *Spirit of Norfolk* was built of steel in 1992, Subchapter K exempted it from the requirement for fire detection systems.

The NTSB has identified more than 100 vessels in operation today, that, like the *Spirit of Norfolk,* are exempt from the Subchapter K fire detection and fixed fire extinguishing requirements because they began operation before March 10, 1996, and have steel or aluminum hulls. As with the *Spirit of Norfolk*, most small passenger vessels have uncrewed engine rooms—meaning no one is in the space to continuously monitor the fire-safe condition.

The engine room is the location of many fire ignition sources, including hot surfaces and electrical equipment, as well as easily ignitable fuels such as diesel and lubricating oils. In our investigation of the 2018 fire on the passenger vessel *Island Lady*, the NTSB examined sources of fires on US-flag-inspected passenger vessels and found that engine rooms were the source of almost 76% of small passenger vessel fire (NTSB 2018). Moreover, as the age of a vessel increases, the potential for failure or breakdown in system components increases. As they age, engine hoses deteriorate, electrical parts fail, and the overall condition of engine room systems and equipment decline.

For more than 20 years, the NTSB has been concerned with the increased risk of engine room fires, and their ability to grow undetected on small passenger vessels.

In 2000, a fire broke out on board the commuter ferry *Port Imperial Manhattan*.[9] The ferry had been built of aluminum in 1987 and was therefore exempt from the requirement for fixed fire detection and extinguishing systems. In our investigation, the NTSB found that "because the vessel had no fire detection system in the engine room, crewmembers were unaware of the fire until it was fully evolved in the engine room" (NTSB 2002). The report concluded that "the lack of fire detection systems in the engine rooms of existing small passenger vessels in commuter and ferry service presents an unacceptable risk to passengers and crewmembers."

In 2006, the NTSB investigated an engine room fire aboard the commuter ferry *Massachusetts*. The ferry, built of aluminum in 1988, was also exempt from the requirement for fixed fire extinguishing and detection systems. The NTSB concluded that "contributing to the extent of the damage was the absence of a fixed fire detection and suppression system, which precluded the crew from receiving timely notification of the fire and which allowed the blaze to spread throughout the engine room" (NTSB 2007).

As with the *Spirit of Norfolk*, the vessels involved in these NTSB investigations were exempt from the fire detection requirements. The NTSB, therefore, concludes that the exemption for engine room fire detection systems on Subchapter K small passenger vessels that were in operation as of March 10, 1996, presents an increased risk to passengers and crewmembers of undetected fires.

The NTSB believes that passengers traveling on all small passenger vessels, regardless of the vessel's age, size, hull type, or passenger load, should be afforded similar levels of safety. Based on the *Port Imperial Manhattan* and *Massachusetts* investigations, the NTSB issued Safety Recommendation M-07-1, which asked the Coast Guard to:

> Require that all small passenger vessels certificated to carry more than 49 passengers, regardless of date of build or hull material, be fitted with an approved fire detection system and a fixed fire suppression system in their engine rooms.

In the initial response to Safety Recommendation M-07-1 in 2008, the Coast Guard provided details of the cost-benefit analysis it had conducted in determining that the recommended action would not pass the required Administrative Procedures

[9] The *Port Imperial Manhattan* was classified as a small passenger vessel under Coast Guard regulations.

Act and Office of Management and Budget review.[10] The Coast Guard reviewed the 32 incidents involving fires in the engine room occurring between 1996 and 2007 on those small passenger vessels that would be affected by this recommendation. The review found that the property damage costs due to fires were significantly less than the estimated costs of retrofitting those vessels with the recommended fixed fire protection systems. There were no deaths and only a few minor injuries associated with those incidents.

As such, the Coast Guard did not believe the recommended rulemaking could be justified and stated that the Administrative Procedures Act thus prohibited the Coast Guard from taking the recommended action. Because the Coast Guard believed that it was prohibited from taking the recommended action, it considered its action on this recommendation complete.

In subsequent correspondence to the NTSB on October 18, 2016, the Coast Guard reiterated its cost-benefit analysis requirements for a new rulemaking. The NTSB replied that considering the risk to the traveling public from fire on older vessels, and because the Coast Guard did not plan to take any further action to address this risk, Safety Recommendation M-07-1 was classified Closed—Unacceptable Action.

The Coast Guard's cost-benefit analysis considered the costs of a fire detection *and* extinguishing system when determining that the costs of these systems outweighed the benefits. However, the NTSB believes that a fire detection system alone, even without a fire extinguishing system, provides the earliest opportunity to alert the crew to the danger posed by a fire, initiate firefighting action, and take other action to protect passengers. A fire detection system allows the crew the greatest opportunity to take appropriate action as early as possible. The NTSB believes that the cost of a fire detection system is much less than the cost of a fire extinguishing system and that a cost-benefit analysis of a fire detection system alone may show that the benefits of reducing risks to passengers outweigh the costs of a fire detection system. Therefore, the NTSB recommends that the Coast Guard require that existing exempted Subchapter K small passenger vessels that were in operation as of March 10, 1996, be fitted with a fire detection system in their engine rooms.

[10] All federal agencies are required by the Administrative Procedures Act, Executive Orders 12866 and 13563, and Office of Management and Budget Circular A-4, to perform a cost-benefit analysis of a new rulemaking.

2.4 Fire Extinguishing System

Firefighting measures by the crew included shutting down the powered ventilation supply to the engine room, securing the emergency port and starboard fuel oil shut off valves, and closing the quick-acting watertight door to the engine room from the galley. The crew did not have the option to secure the natural passage of air to the engine room because none of the ventilation trunks were fitted with dampers, nor was the vessel designed or equipped with a means to close the ventilation openings to the engine room, such as via the use of fitted covers or manually operated louvers. Were the *Spirit of Norfolk*'s engine room ventilation openings able to be closed, shutting off the supply of oxygen to the engine room, the intensity of the fire in the engine room would likely have diminished.[11]

Ventilation closures are a vital part of a fixed gas fire extinguishing system, which is the most effective firefighting method to fight engine room fires. Fixed fire extinguishing systems are designed to release gas only after powered ventilation is secured and all ventilation openings to the space are closed. If a fixed fire suppression agent is discharged into a space without effectively sealing it, oxygen will still be available to enter and sustain the fire, and the agent will escape out any opening, diluting the concentration and preventing it from being able to extinguish the fire.

The NTSB's investigation of the 2001 fire on board the small passenger vessel *Seastreak New York* illustrated the effectiveness of a fixed fire extinguishing system (NTSB 2002). Because the engine room on the *Seastreak New York* was fitted with a carbon dioxide fire extinguishing system, when crewmembers discovered the fire, they were able to secure ventilation, seal the engine room, activate the extinguishing system without having to enter the engine room, and extinguish the fire before it caused extensive damage to the vessel.

The *Spirit of Norfolk* and the *Seastreak New York* both had enclosed, unmanned engine rooms; both vessels were certificated to carry hundreds of passengers; both vessels were similarly crewed; and both vessels suffered an engine

[11] The 2021 engine room fire on the steel-hulled passenger and car ferry *Wenatchee* illustrated the importance of having the means to secure air and fuel. In our investigation, the NTSB found that "the crew effectively isolated all fuel supplies, shut down engine room ventilation systems, and closed the space's air dampers to starve the fire of fuel and oxygen—actions which successfully prevented the spread of the fire" (NTSB 2022).

room fire. However, the *Spirit of Norfolk* was destroyed by its fire, and the fire on the *Seastreak New York* caused only minor damage. The difference between the outcomes of these two fires was due to the *Seastreak New York* being outfitted with a fixed gas fire extinguishing system to protect its engine room, which the *Spirit of Norfolk* did not have. Had the *Spirit of Norfolk* been equipped with a fire extinguishing system to protect its engine room, the fire likely would have been quickly extinguished and the casualty mitigated. The NTSB, therefore, concludes that, if the *Spirit of Norfolk* had been equipped with an engine room fixed gas fire extinguishing system, including ventilation closures, the fire could have been extinguished.

Because the *Spirit of Norfolk* was built of steel and began operation before March 10, 1996, it was exempt from later requirements for a fixed gas fire extinguishing system in the engine room (as would have been required if it had begun operation after March 10, 1996). As discussed earlier, the NTSB previously recommended that the Coast Guard require that all small passenger vessels be fitted with an approved fire detection system and a fixed fire suppression system in their engine rooms (M-07-1). However, that recommendation was closed because the Coast Guard believed it could not issue the recommended requirement based on the required cost-benefit analysis. The *Spirit of Norfolk* casualty resulted in a total loss of the vessel, and a fixed gas fire extinguishing system would likely have significantly limited the risks to the passengers and crew and limited the damage to the vessel. Based on this casualty and the NTSB's previous investigations into fires on small passenger vessels, the NTSB concludes that the exemption for engine room fixed gas fire extinguishing systems on small passenger vessels that were in operation as of March 10, 1996, presents an increased risk of harm from an engine room fire to passengers and crewmembers.

The NTSB recognizes the Coast Guard's position that economic analysis factors prevented it from implementing M-07-1. That recommendation included all small passenger vessels that could carry more than 49 passengers. The fires investigated on board the *Massachusetts*, *Port Imperial Manhattan*, and *Spirit of Norfolk* occurred on higher passenger capacity vessels—all vessels that can carry more than 150 passengers. Because the risk of fatalities or injuries increases as the number of people carried increases, the NTSB recommends that the Coast Guard require that existing exempted Subchapter K small passenger vessels that were in operation as of March 10, 1996, be fitted with a fixed gas fire extinguishing system in their engine rooms.

2.5 Response

Multiple Good Samaritan vessels responded to the Coast Guard's call and assisted with the passenger evacuation, towing the *Spirit of Norfolk* to the pier, and fighting the fire. On board the *Spirit of Norfolk*, the crew organized the passengers for evacuation in accordance with the vessel's emergency evacuation plan, directing the passengers to areas of refuge and to put on lifejackets. Passengers and all but two of the crew were evacuated to the Good Samaritan vessel *Victory Rover* from the passenger embarkation/disembarkation area. The captain and the new-hire captain remained on board a few more minutes, sweeping the vessel for anyone who may have remained on board, before boarding the *Ohio River*. The NTSB concludes that the actions of the crewmembers and Good Samaritan vessels resulted in a timely and effective evacuation with no injuries.

The UC's original plan to fight the fire was to place foam into the engine room via the emergency hatch on the main deck. However, the recon team instead opened the engine room door to assess the fire and then closed the door upon leaving. About 40 minutes later, the fire attack team also did not find or use the hatch and attempted to place the foam line in the engine room via the engine room door. Because investigators were unable to interview the firefighting teams, the NTSB does not know why the teams were unable to either find or use the hatch as planned.

In the 40 minutes that passed between the recon team opening the engine room door and the fire attack team opening the door, shoreside firefighters continued to stream water into the starboard-side engine room vent, and towing vessels continued to stream water into the portside vent—filling the engine room. This resulted in a wall of about 4 feet of water that knocked members of the fire attack team back into the galley when they opened the engine room door.

When the fire attack team opened the engine room door, additional oxygen entered the engine room, feeding the fire. The fire had previously been contained to the engine room, a space with structural fire protection (including insulated overheads) designed to isolate the space and create a boundary in the event of a fire within. But with the engine room door open, the fire was able to spread beyond the engine room. The rushing water also prevented the fire attack team from closing the door and reestablishing the fire boundary. Therefore, the NTSB concludes that when the fire attack team was unable to close the engine room door, it allowed the fire to spread.

However, members of the UC, the Norfolk firefighters, the Coast Guard representative, and the MIRT executive director all believed that the fire attack team

was going to locate the emergency escape hatch and place the foam applicator into the engine room; none were aware that the fire attack team was unable to locate the hatch. Both firefighting teams should have communicated back to the UC when they were unable to find the hatch.

The firefighting teams that boarded the vessel wore breathing masks to protect against the smoke and would have relied on radios to communicate amongst themselves. But the City of Norfolk, on behalf of its firefighters, told investigators that the Navy and Norfolk firefighting teams had incompatible communication equipment, so members of the recon and fire attack teams were on different radio frequencies. As a result, members of the recon and fire attack teams were not able to effectively communicate with each other.

Due to the incompatible communication equipment and a lack of communication from the firefighting teams to the UC, the NTSB concludes that the communications between the firefighting teams and the UC were ineffective because the firefighting teams did not communicate to the UC that they did not find the engine room emergency hatch, and the UC did not monitor the teams' efforts to locate the hatch.

Navy and City of Norfolk fire departments declined firefighter interview requests from the Coast Guard and the NTSB, so the NTSB was unable to determine whether the fire attack team was aware how much firefighting water had accumulated in the engine room or of the structural fire protection that the engine room door provided. Similarly, the NTSB tried to assess the response communications to determine whether the UC was aware that the fire attack team could not locate the engine room hatch but was not able to interview members of the initial UC. Ultimately, the NTSB was unable to determine why neither firefighting team was able to locate the hatch or whether the firefighters and members of the UC were aware of the risks to opening the engine room door. Based on the lack of information made available during the investigation, the NTSB concludes that had the members of the UC and firefighting personnel agreed to postcasualty interviews, the NTSB would have received critical information about the response that likely would have helped to better understand the event sequence and identify additional improvements to pierside vessel firefighting strategies and tactics.

In the review of the response to the fire, the NTSB identified additional safety concerns:

- **Mooring a vessel for best access by responders.** When the *Spirit of Norfolk* was towed to Pier 4, it was moored starboard side to the pier, putting its only passenger boarding location on the waterside. While not

a factor in the casualty, docking the vessel with the passenger embarkation entrance on the waterside required the firefighters to access the vessel via a ladder, which impacted safety and ease of access.

- **Including personnel familiar with the vessel in the UC.** There were personnel on scene, including the *Spirit of Norfolk* captain, who could have helped the firefighting teams find the hatch. Similarly, the MIRT executive director had told members of the UC where the hatch was located and later showed members of the UC the hatch location on the vessel's fire control plan. However, neither of these on-scene experts were in the UC, thus they were unable to provide additional guidance in finding the hatch to the firefighters.

- **Accelerating the stability assessment and the arrival of tanks or barges for contaminated water.** Firefighting efforts were ongoing for about 5 hours before being halted in the evening of June 7 until the Coast Guard SERT approved the vessel's stability information; the stability evaluation was not completed and approved until June 8, a break in firefighting efforts of more than 16 hours (though boundary cooling was still applied). Firefighting efforts were also contingent on the dewatering plan approval and the arrival of tanks and barges to receive the firefighting water inside the *Spirit of Norfolk,* which was contaminated with diesel fuel, lube oil, and hydraulic fluid. The break in firefighting while the UC waited for the stability assessment and the holding tanks and a barge to hold the contaminated water delayed firefighting and allowed the fire to continue to burn.

- **Developing training plans to educate those land-based firefighting departments included in Coast Guard contingency plans.** Larger vessels are constructed to contain a fire within a compartment or space. The City of Norfolk reported that their firefighters were unaware of the risks inherent in opening the door to the engine room where the fire was contained (the accumulated firefighting water and breaking the fire boundary). Had the land-based firefighting teams been educated on marine vessel firefighting tactics, they might have avoided these risks.

The Coast Guard and the maritime community plan for events like the *Spirit of Norfolk* fire. Lessons learned (both positive and negative) from incidents like this one are essential for improving planning and coordination. As discussed previously, there were communications and tactical issues that could be improved upon. In addition, planners could benefit from examining the process for conducting stability assessments and calling in resources for removing firefighting water from a vessel. Therefore, the NTSB concludes that lessons learned from this casualty could be used to improve contingency planning for maritime firefighting.

Because the Coast Guard is responsible for the safety of the vessels, facilities and waterways, the Coast Guard is in the best position to lead efforts to update and improve firefighting response planning based on the lessons learned from the *Spirit of Norfolk* fire. Therefore, the NTSB recommends that the Coast Guard use the circumstances of this casualty and the NTSB's report findings and recommendations to improve contingency plans related to fighting fires on passenger vessels.

3 Conclusions

3.1 Findings

1. None of the following were safety issues for the casualty: (1) weather and waterway conditions, (2) crew impairment due to alcohol or other drugs, or (3) a steering gear hydraulic system failure.

2. The fire originated in the *Spirit of Norfolk*'s engine room, near the outboard side of the port main engine.

3. Although a definitive ignition source cannot be determined, the most likely cause of the fire was the ignition of combustible materials stored near the exhaust pipe of the operating port generator.

4. The lack of a fire detection system in the engine room delayed detection and allowed for the growth of the fire, which precluded crew firefighting efforts.

5. The exemption for engine room fire detection systems on Subchapter K small passenger vessels that were in operation as of March 10, 1996, presents an increased risk to passengers and crewmembers of undetected fires.

6. If the *Spirit of Norfolk* had been equipped with an engine room fixed gas fire extinguishing system, including ventilation closures, the fire could have been extinguished.

7. The exemption for engine room fixed gas fire extinguishing systems on small passenger vessels that were in operation as of March 10, 1996, presents an increased risk of harm from an engine room fire to passengers and crewmembers.

8. The actions of the crewmembers and Good Samaritan vessels resulted in a timely and effective evacuation with no injuries.

9. When the fire attack team was unable to close the engine room door, it allowed the fire to spread.

10. The communications between the firefighting teams and the unified command (UC) were ineffective because the firefighting teams did not

communicate to the UC that they did not find the engine room emergency hatch, and the UC did not monitor the teams' efforts to locate the hatch.

11. Had the members of the unified command and firefighting personnel agreed to postcasualty interviews, the National Transportation Safety Board would have received critical information about the response that likely would have helped to better understand the event sequence and identify additional improvements to pierside vessel firefighting strategies and tactics.

12. Lessons learned from this casualty could be used to improve contingency planning for maritime firefighting.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of the fire on the *Spirit of Norfolk* was likely the ignition of combustible material stored near the exhaust piping from the operating port generator. Contributing to the severity of the fire was a lack of a fire detection system and a fixed fire extinguishing system in the engine room. Also contributing to the severity were ineffective communications between the unified command and firefighting teams that led to the fire attack team opening the engine room door, allowing the fire to spread.

4 Recommendations

4.1 New Recommendations

As a result of this investigation, the National Transportation Safety Board makes the following new safety recommendations.

To US Coast Guard:

Require that existing exempted Subchapter K small passenger vessels that were in operation as of March 10, 1996, be fitted with a fire detection system in their engine rooms. (M-23-03)

Require that existing exempted Subchapter K small passenger vessels that were in operation as of March 10, 1996, be fitted with a fixed gas fire extinguishing system in their engine rooms. (M-23-04)

Use the circumstances of this casualty and the National Transportation Safety Board's report findings and recommendations to improve contingency plans related to fighting fires on passenger vessels. (M-23-05)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

JENNIFER HOMENDY
Chair

MICHAEL GRAHAM
Member

BRUCE LANDSBERG
Member

THOMAS CHAPMAN
Member

Report Date: September 29, 2023

Appendixes

Appendix A: Investigation

The US Coast Guard was the lead federal agency in this investigation. The National Transportation Safety Board (NTSB) was notified of this casualty on June 7, 2022, and investigators were on scene June 8, 2022. While on scene, investigators interviewed the seven crewmembers and viewed *Spirit of Norfolk* firefighting efforts from Pier 4 at Naval Station Norfolk.

From January 26 to February 2, 2023, the Coast Guard conducted a formal hearing into the casualty. During the hearing, Coast Guard and NTSB investigators heard from 23 witnesses who provided testimony into precasualty historical events, regulatory compliance, crewmember duties and qualifications, mechanical systems, emergency response, and Coast Guard oversight.

The Coast Guard, City Cruises, Marine Incident Response Team, Bay Power Solutions, and Bay Diesel were parties to the investigation.

Appendix B: Consolidated Recommendation Information

Title 49 *United States Code* 1117(b) requires the following information on the recommendations in this report.

For each recommendation—

(1) a brief summary of the Board's collection and analysis of the specific accident investigation information most relevant to the recommendation;

(2) a description of the Board's use of external information, including studies, reports, and experts, other than the findings of a specific accident investigation, if any were used to inform or support the recommendation, including a brief summary of the specific safety benefits and other effects identified by each study, report, or expert; and

(3) a brief summary of any examples of actions taken by regulated entities before the publication of the safety recommendation, to the extent such actions are known to the Board, that were consistent with the recommendation.

To the Coast Guard

M-23-03

Require that existing exempted Subchapter K small passenger vessels that were in operation as of March 10, 1996, be fitted with a fire detection system in their engine rooms.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in section 2.3, Fire Detection. Information supporting (b)(1) can be found on pages 35-36; (b)(2) can be found on page 36-38; and (b)(3) is not applicable.

M-23-04

Require that existing exempted Subchapter K small passenger vessels that were in operation as of March 10, 1996, be fitted with a fixed gas fire extinguishing system in their engine rooms.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in section 2.4, Fire Extinguishing System. Information supporting (b)(1) can be found on page 39-40; (b)(2) can be found on page 39-40; and (b)(3) is not applicable.

M-23-05

Use the circumstances of this casualty and the NTSB's report findings and recommendations to improve contingency plans related to fighting fires on passenger vessels.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in section 2.5, Response. Information supporting (b)(1) can be found on page 41-44; (b)(2) can be found on page 41-44; and (b)(3) is not applicable.

Appendix C: Structural Fire Protection Requirements

Table C-1. Structural fire protection requirements.

Section	Requirement	*Spirit of Norfolk*
46 *CFR* 72.05-10(a)	The hull, structural bulkheads, decks, and deckhouses shall be constructed of steel or other equivalent metal construction of appropriate scantlings.	Hull, structural bulkheads, decks, and the deck house were constructed of steel.
46 *CFR* 72.05-10(b)	The hull, superstructure, and deck houses shall be subdivided by suitable structural steel or other equivalent metal bulkheads into main vertical zones, the mean length of which shall not, in general, exceed 131 feet on any one deck.	Hull, including engine room, was divided into main vertical zones, the mean length of which did not exceed 131 feet on any one deck. Hull, superstructure, and deckhouses were divided by fire-resisting bulkheads.
46 *CFR* 72.05-10(d)	The minimum requirements for the bulkheads between the various spaces, where such bulkheads form the boundaries of main vertical zones, shall be as noted in table 72.05-10(d): Machinery space bulkheads adjacent to a galley or a storeroom (void) were to meet A-0.	Forward and aft bulkheads in the engine room were A-0.
46 *CFR* 72.05-10(f)	The minimum requirements for the decks between the various spaces, where such decks form the boundaries of stepped main vertical zones, shall be as noted in table 72.05-10(f).	Overhead of the engine room was A-60.
46 *CFR* 72.05-25(b)(2)	Doors in bulkheads required to be Class A-0 shall be of solid or hollow steel or equivalent metal construction capable of meeting the requirements of a Class A-0 bulkhead.	Quick-acting watertight door between the galley and the engine room was A-0.

Appendix D: Fixed Fire Extinguishing Systems

A fixed fire extinguishing system uses a gas or specially designed fluid to flood the protected area and extinguish a fire by rapidly removing heat after discharging through fixed nozzles as a gas (Coast Guard, "Fire Suppression Systems"). The gas or fluid is stored in pressurized cylinders.

Custom engineered systems are intended for crewed spaces on large vessels but include scaled-down systems for installation in uncrewed spaces such as engine compartments on Subchapter T vessels. The system manufacturer's distributor (not the vessel operator) designs these systems by entering a vessel's engine room dimensions into a computer program, which calculates the amount of agent, number of agent cylinders, pipe sizes, and number and size of nozzles, etc., needed to protect the specific engine room.

Pre-engineered systems are intended to be "off the shelf" suitable for installation by either a fire equipment distributor or the vessel's operator. They may be automatic, but many models are suitable for many Subchapter T applications because they are equipped with manual backup actuators and provisions for ventilation and engine shutdowns. Unlike custom engineered systems, a pre-engineered system can be installed in any uncrewed engine room of equal or lesser volume in accordance with the limitations described in its owner's manual.

A simple pre-engineered system consists of a single cylinder and valve attached to a bulkhead inside the engine compartment. The gas or fluid is discharged directly from the cylinder valve through the attached sprinkler head when the heat from a fire causes the sprinkler head to actuate.

If the machinery space of a Subchapter T vessel can be protected by the contents of one portable or semi-portable fire extinguisher, such an extinguisher may be used as a fixed gas fire extinguishing system (however, portable and semi-portable extinguishers may not be converted into fixed systems by replacing components). Per 46 *CFR* 118.400(b)(1), a "fixed gas fire extinguishing system, which is capable of automatic discharge upon heat detection, may only be installed in a normally unoccupied space with a gross volume of not more than 170 cubic meters (6,000 cubic feet)."

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US Coast Guard, "Fire Suppression Systems," n.d., https://www.dco.uscg.mil/CG-ENG-4/FESys/.

Casualty type	Fire/Explosion
Location	Elizabeth River, near Norfolk, Virginia 36°55.31′ N, 76°20.48′ W
Date	June 7, 2022
Time	1204 eastern daylight time (coordinated universal time –4 hours)
Injuries	None
Property damage	$5 million est.
Environmental damage	None

NTSB investigators worked closely with our counterparts from **Coast Guard Sector Virginia** and the **Coast Guard District 5 Formal Investigation Team** throughout this investigation.