Issued February 18, 2022 MIR-22/05

Engine Room Fire aboard Towing Vessel *Miss Dorothy*

On March 17, 2021, about 0045 local time, the towing vessel *Miss Dorothy* was pushing 14 barges upbound on the Lower Mississippi River, about 20 miles north of Baton Rouge, Louisiana, near mile 249, when a fire broke out in the engine room.[1] The eight crewmembers aboard briefly attempted to fight the fire but were unsuccessful and evacuated to the barges. They were rescued by a Good Samaritan vessel, which then secured the tow against the bank. The fire was extinguished several hours later by first responders and the crew aboard the Good Samaritan vessel. No pollution or injuries were reported. Damage to the vessel was estimated at $2.4 million.

Figure 1. *Miss Dorothy* operating on the Mississippi River in 2018. (Source: Warren Underwood, MarineTraffic.com)

[1] (a) In this report, all times are central standard time, and all miles are statute miles. (b) Visit ntsb.gov to find additional information in the public docket for this NTSB investigation (case no. DCA21FM018). Use the CAROL Query to search investigations.

Casualty type	Fire/Explosion
Location	Lower Mississippi River, mile 249, near Baton Rouge, Louisiana 30°34.33′ N, 91°18.35′ W
Date	March 17, 2021
Time	0045 central standard time (coordinated universal time –5 hrs)
Persons on board	8
Injuries	None
Property damage	$2.4 million est.
Environmental damage	None
Weather	Visibility 10 mi, clear, winds south-southeast 7 mph, air temperature 72°F, water temperature 54°F, morning twilight 0649, sunrise 0713
Waterway information	River, width 2,000 ft, current 5–6 mph

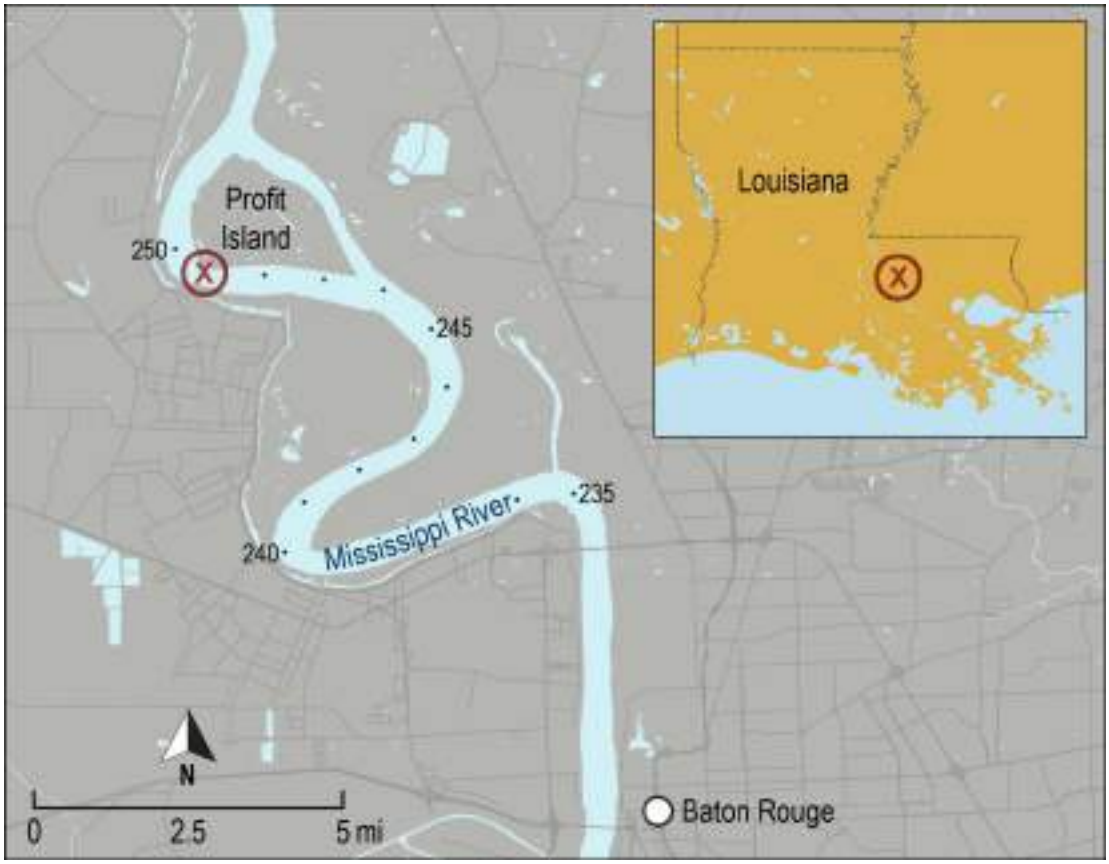

Figure 2. Area where the *Miss Dorothy* engine room fire occurred, as indicated by the red *X*. (Background source: Google Maps)

1. Factual Information

1.1 Background

The 155.8-foot-long *Miss Dorothy*, a twin-propeller towboat, was built in 1956 by Dravo Corporation in Neville Island, Pennsylvania. Originally named the *Eastern*, the vessel was leased, later purchased, and renamed in 2015 by its current owner and operator, Western Rivers Boat Management Inc. (WRBM). The company owned a total of 34 vessels that they operated on the Western Rivers out of their Paducah, Kentucky, headquarters. The *Miss Dorothy* had a valid US Coast Guard certificate of inspection issued in July of 2019. The vessel routinely transported stone, sand, gravel, and other aggregates south from facilities on the Cumberland River to points on the Mississippi River.

1.2 Event Sequence

About 0400 on March 16, the *Miss Dorothy* left a fleeting area located just north of the Sunshine Bridge at mile 168.5 of the Lower Mississippi River. The vessel was pushing 13 empty barges and one loaded equipment barge and was scheduled to make an 850-mile northbound trip to a loading facility on the Cumberland River. The crew consisted of a captain, a pilot, a mate (who was the lead deckhand), a chief engineer, a steersman, and three deckhands. Throughout the day, the captain and pilot rotated navigation watches (6 hours on, 6 hours off), with the captain taking the 0500–1100 and 1700–2300 (front) watches, and the pilot taking the 1100–1700 and 2300–0500 (back) watches. According to the crew, up until the time of the casualty, the voyage was unremarkable, and the vessel was in "great condition" with machinery in "great working order."

Later that evening, about 2200, a deckhand did a walkthrough of the engine room, and at 2300, the mate observed the engine room through the engine control room (ECR) window; neither crewmember saw anything abnormal. About 2315, the pilot relieved the captain from the navigation watch. After holding for traffic to pass, the *Miss Dorothy* continued upriver for about an hour and a half.

About 0045 on March 17, the *Miss Dorothy* was at mile 249, traveling about 5.5 knots and 800 engine rpm, when fire alarms sounded in the pilothouse and throughout the vessel. Within 30 seconds of the alarm sounding, the pilot could see smoke that "grew in intensity very quickly" coming from the engine room, and he immediately activated the vessel's general alarm.

The mate and a deckhand, who were also on watch, had just finished a round of the barges and were all the way forward on the main deck in the deck locker. When the

fire alarm sounded, they proceeded aft through the vessel's interior to investigate. While walking past the crew accommodations, they banged on doors to alert the crew and ensure all were awake. When the mate reached the ECR, he looked through the window to the engine room and saw smoke and flames emanating from the starboard main engine. He quickly returned to the chief engineer's stateroom and told him that there was a fire in the engine room. He also radioed the pilothouse to notify the pilot of the fire, although, due to unknown reasons, radio communications between the pilothouse and personnel fighting the fire were unreliable during the fire. The mate was quickly joined by the other deckhand on duty and other crewmembers as they awoke. The crew began running out fire hoses on the starboard side of the main deck to fight the fire.

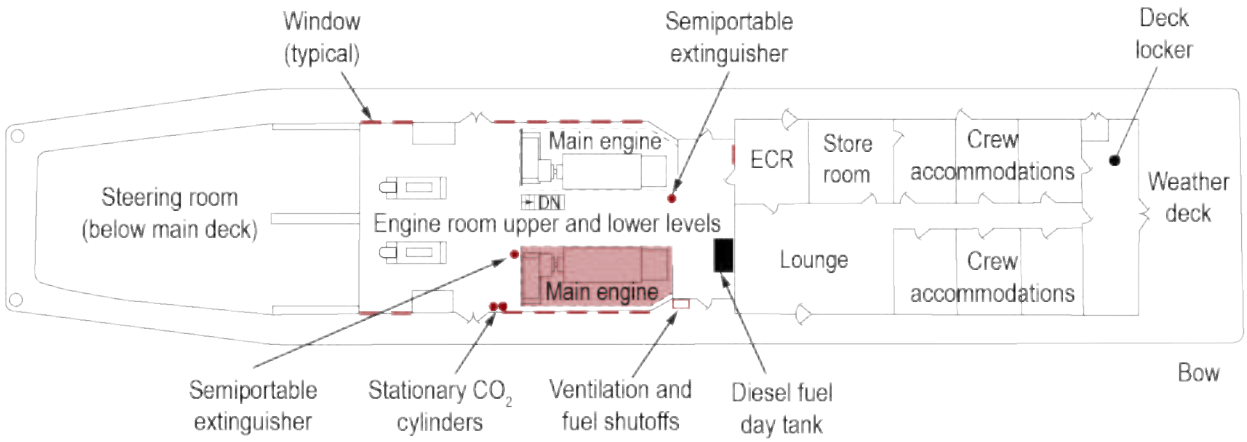

Figure 3. *Miss Dorothy* main deck layout. The area where the fire was discovered is highlighted in red.

Within 2 minutes of the fire alarm sounding, the captain, who had been sleeping, responded to the pilothouse and relieved the pilot, who went to assess the fire and assist the crew. Using the vessel's VHF radio, the captain attempted to notify the Coast Guard of the fire but did not receive a response. He was able to establish communications with the towing vessel *Christopher Wilson*, which was owned by the same company and happened to be about 3 miles south of the *Miss Dorothy*'s location. The *Christopher Wilson* notified the *Miss Dorothy* that Coast Guard Sector New Orleans had received the distress call and was attempting to respond. At this time, the pilothouse of the *Miss Dorothy* was filling with smoke from the fire, and the captain could see the glow of flames coming from the stern of the vessel.

On the main deck, the crew of the *Miss Dorothy* started the fire pump remotely from one of the hose stations and used a 1.5-inch fire hose to direct a water stream into the engine room through the starboard-side doors and opened windows. Some of the windows were open before the fire was discovered to cool the engine room. Several of the windows that were in the closed position at the onset of the fire were broken by the crew during firefighting efforts. Handheld extinguishers were also directed into the

engine room through open windows. The vessel was equipped with two 50-pound ABC semiportable extinguishers and two 50-pound stationary carbon dioxide (CO_2) cylinders that were connected to a hose reel. The crew attempted to operate the extinguishers and the CO_2 hose reel system but were unable to do so because all were located in the same space as the fire and were inaccessible due to the intensity of the smoke and flames. The engine room was not equipped with a fixed fire-extinguishing system, nor was it required by regulation to be.

Shortly after the crew began firefighting efforts, the chief engineer activated the ventilation shutdown, which stopped the engine room ventilation fans and allowed the gravity dampers in the ventilation ductwork to close. The two main engines and one generator remained in operation. Because the engines could not be secured remotely from the pilothouse, the captain gave the order to pull the fuel oil shutoffs to stop the engines.

The emergency fuel oil shutoff pull station was located on the starboard-side main deck, on the external bulkhead of the engine room. The shutoff pulls were connected to wires that were directly connected to the valve handles on the fuel supply valves for their respective engine or generator. These valves were located beneath a 500-gallon day tank filled with ultra-low sulfur diesel fuel. The tank was positioned just forward of the starboard engine room door and several feet from the pull station. The tank was kept nearly full by an electric automatic transfer pump, which functioned off tank level sensors. (The location of the day tank above the main engines created a positive head for the engines' fuel oil supply system.)

The chief engineer stated that he was able to pull the shutoff for the starboard main engine, but, due to the fire, the cable handles for the port main engine and the online generator were too hot for him to pull. He believed that the starboard main engine stopped several moments after he pulled the wire. (During a postcasualty examination, investigators discovered that all four fuel oil shutoff valves were open, and the metal cables connected to the valves had been severed during the fire.)

Figure 4. Engine room fire-extinguishing equipment (*left*). Emergency fuel oil shutoff pull station (*right*). (Source: WRBM)

The crew could not quell the engine room fire with the hose, so it continued to grow. About 0052, the captain ordered the crew to abandon ship. The pilot and crew mustered on the forward end of the vessel before being joined by the captain from the pilothouse. About 0100, the crew of the *Miss Dorothy* evacuated the vessel to the tow's barges.

Figure 5. *Miss Dorothy*'s wheelhouse and superstructure consumed in flames following the crew's evacuation to the tow's barges. (Source: WRBM)

While on the barges, the crew communicated via cell phone with the captain on the *Christopher Wilson*, whose crew was in the process of tying off their tow to shore several miles downriver in order to better assist the distressed *Miss Dorothy*. As the fire continued to spread, engulfing the *Miss Dorothy*'s superstructure, the river current turned the tow around and pushed it downriver. About 45 minutes after the crew evacuated the *Miss Dorothy,* the *Christopher Wilson* arrived, positioned itself alongside the barges to pick up the crew, and pushed the *Miss Dorothy* and its tow into the left descending bank at mile 244. The crew of the *Christopher Wilson*, assisted by the crew from the *Miss Dorothy*, fought the fire using fire hoses aboard the *Christopher Wilson*.

At 0145, the West Baton Rouge area 911 dispatch received notification of a vessel on fire and in turn notified emergency personnel. The East Baton Rouge Sheriff's Office Marine Division, the Baton Rouge Fire Department, and the St. George Fire Department assembled and boarded the sheriff's department's 45-foot fire boat, which was located along the river at mile 240. The fire boat was launched and navigated upriver, arriving on scene at 0330.

Figure 6. Starboard side of the *Miss Dorothy* during firefighting efforts from the Good Samaritan towing vessel *Christopher Wilson*. (Source: WRBM)

The first responders fought the fire in concert with the crew of the *Christopher Wilson* and were aided by the arrival of an ExxonMobil Refinery fire boat, which had suppression foam to help extinguish the fire. By 0505, the superstructure fire was extinguished, and by 0940, the engine room fire was declared extinguished.

Later the same day, the Coast Guard, a certified marine surveyor, and WRBM personnel boarded the vessel to assess the damage. A tow plan was approved for the disabled vessel and tow, and the *Christopher Wilson* began towing the *Miss Dorothy* to the company's facility in Calvert City, Kentucky, where the vessel was determined to be a total loss.

Figure 7. East Baton Rouge Sheriff's Office and ExxonMobil fire boats alongside the burned-out *Miss Dorothy* after the fire had been extinguished. (Source: WRBM)

1.3 Additional Information

1.3.1 Damage

The fire destroyed much of the vessel, including the engine room, storerooms, accommodation spaces, and the wheelhouse. A postcasualty examination of the *Miss Dorothy* showed that the level of severity of fire damage was highest on the forward end of the starboard main engine. Heat damage in this area was also more severe, and the aluminum valve covers and the aluminum engine governor control housing were all

melted away. A forensic fire investigator contracted by the underwriters of the vessel concluded that the rapid fire growth and spread was indicative of a fuel oil fire.

1.3.2 Fuel Piping

Both of the *Miss Dorothy*'s main engines were 12-cylinder EMD 12-645E5. Engine-driven fuel oil and lube oil pumps and their associated networks of hoses and piping were mounted to the forward end of the engines. Crewmembers had not documented any issues with the engine and fuel oil systems. The starboard main engine lube oil filters were changed about 100 hours (about 4 days) before the fire, and the port and starboard main engine fuel filters were changed about 400 hours (about 16 days) before the fire. No other maintenance had been documented on either system.

During the postcasualty examination of the vessel, investigators discovered that the 0.5-inch fuel oil return line from the left bank of the starboard main engine, located on the forward end of the engine, had become displaced from its connection flange. The starboard engine exhaust manifold was lagged with insulation, but the section of exhaust header between the engine block and the horizontal portions of the exhaust manifold were not shrouded, insulated, or lagged. This section of exhaust header for the forward inboard cylinder of the starboard engine was about 36 inches from the fuel oil pump end of the starboard main engine and the fuel oil return line that was discovered to be disconnected. WRBM management stated that the engine exhaust surfaces could reach "north of 600°F" when the engine was operating loaded (similar to the night of the fire) and that the fuel pressure in the return line varied between 15 and 30 pounds per square inch gauge.

Section 143.220 (b) of Title 46 *Code of Federal Regulations* Subchapter M for existing towing vessels such as the *Miss Dorothy* states that "piping and machinery components that exceed 220 °C (428°F), including fittings, flanges, valves, exhaust manifolds, and turbochargers, must be insulated. Measures must be in place to prevent flammable or combustible liquid piping leaks from coming into contact with these components."

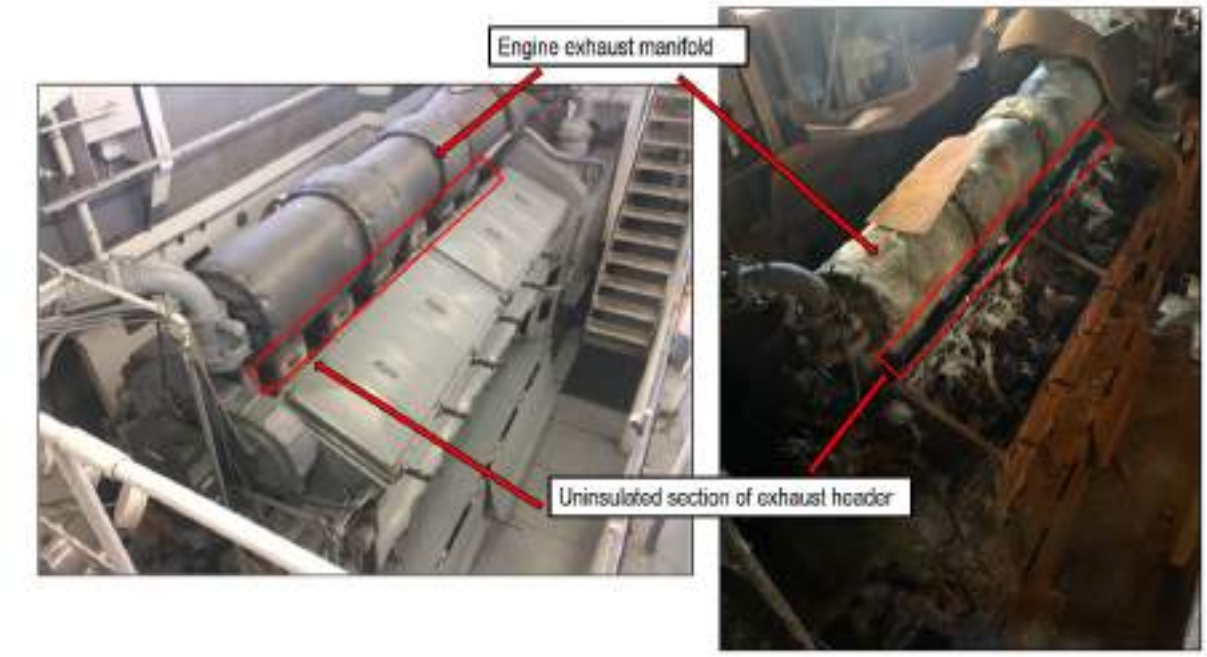

Figure 8. Starboard main engine before (*left*) and after (*right*) the fire, with the uninsulated section of exhaust header indicated. (Source: WRBM)

Materials engineers from the National Transportation Safety Board examined the fuel oil supply and return lines from the left banks of both the starboard and port main engines. The lines for the starboard main engine were pressure-tested for leaks; none were found. The fuel pipes and flanges were examined for other notable features (such as cracks, crevices, or dents), but none were found. In addition, the chemical composition of the starboard main engine flange, fuel pipes, and brazing metal was examined using a scanning electron microscope equipped with an energy-dispersive X-ray spectrometer. The flange material was consistent with a low-carbon steel. The fuel lines were made of a double-wall construction, and the material was consistent with mild or low-carbon steel. The brazing compound used to secure the supply and return fuel lines to the flange was determined to have a composition very similar to a commercially available silver alloy brazing material, which had a brazing range between 1,205°F and 1,400°F. The brazing material on the displaced starboard main engine return line was "denuded of braze metal on its top side, and the braze material had accumulated on underside." The supply line on the starboard main engine showed signs of extrusion but did not become displaced similarly to the return line.

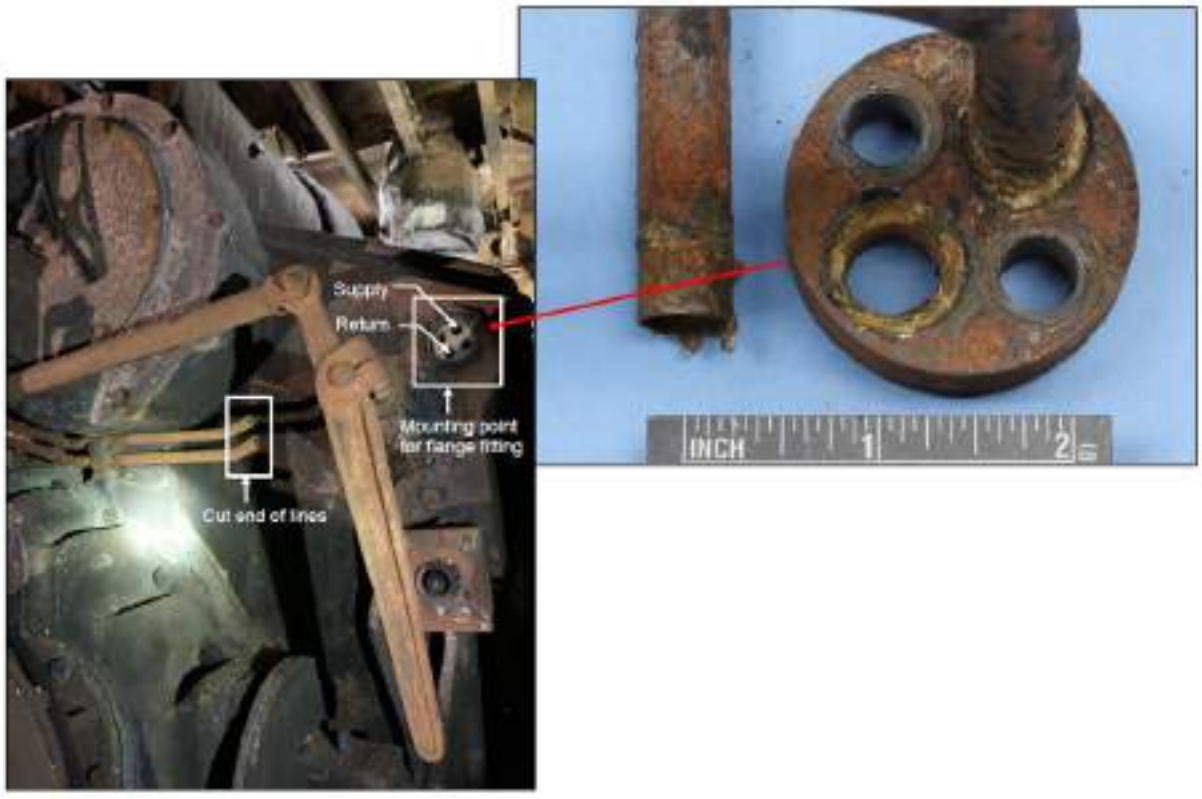

Figure 9. Starboard main engine after the fire with section of fuel oil supply and return lines removed (*left*). Laboratory image of flange and de-brazed and separated fuel oil return line (*right*).

1.3.3 Related Casualties

In December 2017, the towing vessel *J.W. Herron* experienced an engine room fire while shifting barges near Mobile, Alabama. Both of the *J.W. Herron*'s main engines were EMD 12-645.[2] The NTSB found that the probable cause of the fire was "leaking lube oil from a propulsion diesel engine hose or tubing fitting that was ignited off an exposed hot engine surface or slipping clutch." The NTSB attributed the spread of the fire to the "inability to secure ventilation to the engine room."

In February 2020, the towing vessel *City of Cleveland* experienced an engine room fire while pushing barges near Natchez, Mississippi.[3] The NTSB found that "the lack of a fixed fire-extinguishing system for the engine room" contributed to the severity of the fire. In its report, the NTSB highlighted the importance of evaluating engine room fire

[2] *Engine Room Fire aboard Towing Vessel* J.W. Herron, Marine Accident Brief NTSB/MAB-18/28. Washington, DC: NTSB.

[3] *Engine Room Fire aboard Towing Vessel* City of Cleveland, Marine Accident Brief NTSB/MAB-21/04. Washington, DC: NTSB.

hazards and providing effective means to mitigate them, stating, "Operators should have equipment and procedures in place to quickly contain and suppress engine room fires before they can spread to other spaces and/or cause a loss of propulsion and electrical power."

2. Analysis

The postcasualty inspection of the *Miss Dorothy*'s engine room showed that the level of severity of fire damage was highest on the forward end of the starboard main engine. Crewmembers' testimony of the fire origin area was consistent with the fire damage observed by investigators, indicating that the fire likely started in that area.

A forensic fire investigator concluded that the rapid growth and spread of the fire was indicative of a fuel oil fire. In the area of the starboard main engine, investigators found a 0.5-inch fuel return line that had a de-brazed joint that had separated; however, a laboratory examination of the line showed no signs of loss of integrity, fatigue, or material failure, other than the de-brazed joint. Due to the chemical composition of the brazed joint, temperatures exceeding 1,200°F would have been required to de-braze it and only would have been present in a well-established fire. Therefore, the return line likely separated as a result of the fire, and it is probable that the source of fuel oil did not originate from the examined section of the return fuel line nor the brazed joint. Instead, the fuel likely came from another undetermined pressurized source (near the forward end of the starboard main engine) capable of spraying or atomizing the fuel, such as a faulty flange connection, gauge line, pressure gauge, or pump seal.

The fuel used in the engine at the time of the fire was ultra-low sulfur diesel, a highly combustible liquid with a standard flashpoint of 140°F and an average autoignition temperature of 428°F.[4] To prevent combustible liquids, such as diesel fuel, from contacting piping and machinery components that exceed temperatures of 428°F, regulations require that such components be insulated. However, after the fire, investigators found that the exhaust header leading from the individual cylinder heads to the exhaust manifold—which were subject to temperatures greater than 428°F (often higher than 600°F)—near the suspected origin of the fire were uninsulated. Therefore, it is likely that the uninsulated exhaust header acted as an ignition point for the atomized or spraying diesel fuel.

The chief engineer attempted to pull the fuel oil shutoffs for both main engines, and while he said the shutoff for the port main engine was too hot to pull, he was able to

[4] The standard flashpoint of a combustible liquid is determined experimentally under laboratory conditions. The actual flashpoint can be reduced as much as 100°F when the combustible liquid is splashed or aerosolized.

pull the shutoff for the starboard main engine. However, after the fire, investigators discovered that the emergency fuel shutoff valves located on the fuel oil day tank remained open and that the wires leading to the remote activation pull station were severed and partly consumed by fire. Because these valves remined open, fuel oil would have remained available to the engines so long as the integrity of the fuel supply system was maintained and the engine-driven fuel pumps remained operational. If the engine continued to operate after the fire was well-established, the brazed joint on the starboard main engine 0.5-inch fuel return line would have de-brazed, causing fuel to leak from the joint while the engine was running, which likely contributed considerably to the severity of the fire. Additionally, throughout the fire, up until the point when the electrical system ceased to operate due to failure of the onboard electric generator or electrical circuitry, the automatic electric fuel oil transfer pump would have continued to fill the 500-gallon diesel fuel day tank when the low-level switch was activated. This perpetual supply of fuel would have contributed to the size and duration of the fire.

To fight the fire, the crew used handheld fire extinguishers and 1.5-inch pressurized water hoses, but these did little to suppress the well-established fire, given that the fire was largely fueled by diesel fuel. The vessel was equipped with two semiportable extinguishers and two stationary CO_2 cylinders fitted with a hose reel, but they were located in the engine room and were inaccessible due to the flames. In an attempt to suppress the fire by limiting the amount of oxygen available to feed it, the crew secured the engine room's mechanical ventilation. However, this action was ultimately futile due to the uncontrolled amounts of oxygen being drawn in through open engine room doors and open or broken windows. Additionally, the engine room was not equipped with a fixed fire-extinguishing system, nor was it required to be by existing regulations. If the *Miss Dorothy* had a fixed fire-extinguishing system in the engine room or another effective means to starve the fire of oxygen, the fire may have been able to be extinguished or contained in the engine room. Without an effective means to isolate the diesel fuel feeding the fire, secure the ventilation supplying oxygen to the fire, or fight the fire using onboard equipment, the crew were forced to evacuate the vessel onto the tow's barges as the fire grew.

3. Conclusions

3.1 Probable Cause

The National Transportation Safety Board determines that the probable cause of the engine room fire aboard the towing vessel *Miss Dorothy* was the ignition of spraying diesel fuel from a main engine's fuel system onto an uninsulated section of the engine's

exhaust system. Contributing to the severity of the fire and damage to the vessel was the inability to effectively secure ventilation to the space and fuel to the affected engine.

3.2 Lessons Learned: Towing Vessel Engine Exhaust Component Insulation

Engine rooms contain multiple fuel sources, making the spaces especially vulnerable to rapidly spreading fires. Regulations for towing vessels state that "piping and machinery components that exceed 220 °C (428°F), including fittings, flanges, valves, exhaust manifolds, and turbochargers, must be insulated." Uninsulated engine exhaust surfaces can provide an ignition source for flammable liquids that can easily develop into fires that are difficult to contain. Towing vessel owners and operators, Coast Guard marine inspectors, and third-party organization (TPO) towing vessel examiners should be aware of these dangers and fire risks and should regularly and thoroughly inspect equipment to ensure that measures are in place to prevent flammable liquids from coming into contact with hot surfaces.

Vessel	*Miss Dorothy*
Type	Towing/barge (Towing vessel)
Flag	United States
Port of registry	Paducah, Kentucky
Year built	1956
Official number (US)	271680
IMO number	N/A
Classification society	N/A
Length (overall)	155.8 ft (47.5 m)
Beam	36.1 ft (11.0 m)
Draft (casualty)	10.8 ft (3.3 m)
Tonnage	743 GRT
Engine power; manufacturer	2 x 2,100 hp (1,566 kW); EMD 12-645E5 diesel engines

NTSB investigators worked closely with our counterparts from **Coast Guard Marine Safety Unit Baton Rouge** throughout this investigation.