# Engineroom Fire On Board U.S. Small Passenger Vessel *Queen of the West* Columbia River, near Rufus, Oregon April 8, 2008


**Accident Summary Report**

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PB2009-916404

National Transportation Safety Board

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Notation 8017A
Adopted November 17, 2009

# Marine Accident Summary

Engineroom Fire On Board U.S. Small Passenger Vessel
*Queen of the West*
Columbia River, near Rufus, Oregon
April 8, 2008

**National Transportation Safety Board**

490 L'Enfant Plaza, SW
Washington, DC 20594

**National Transportation Safety Board. 2009. *Engineroom Fire On Board U.S. Small Passenger Vessel* Queen of the West, *Columbia River, near Rufus, Oregon, April 8, 2008.* NTSB/MAR-09/04/SUM. Washington, DC.**

**Abstract:** This report discusses the April 8, 2008, engineroom fire on board the small passenger vessel *Queen of the West*. The vintage-styled paddlewheel vessel, carrying 124 overnight passengers and 53 crewmembers, was eastbound on the Columbia River near Rufus, Oregon, when the vessel's automatic fire detection system alerted the crew to the fire. The crew was able to suppress the fire using the vessel's fixed fire suppression system. The *Queen of the West* did not need to be emergency-evacuated. One crewmember was treated for mild hypothermia as a result of the accident. The *Queen of the West* sustained about $3.9 million in damage.

The following safety issues were identified as a result of the accident investigation: importance of having a functioning automatic fire detection system and a fixed fire suppression system on small passenger vessels; and the inadequate requirements for small passenger vessels regarding out-of-water survival craft for passengers and crew.

As a result of its investigation, the National Transportation Safety Board (NTSB) makes one new recommendation and reiterates a previous recommendation, both to the U.S. Coast Guard.

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# Acronyms and Abbreviations

| | |
|---|---|
| CFR | *Code of Federal Regulations* |
| COI | certificate of inspection |
| HPU | hydraulic power units |
| NOAA | National Oceanic and Atmospheric Administration |
| OCMI | Officer in Charge of Marine Inspection |
| psi | pounds per square inch |
| SCBA | self-contained breathing apparatus |

# Executive Summary

About 0012 Pacific daylight time on April 8, 2008, a fire broke out in the engineroom of the 221-foot-long U.S. small passenger vessel *Queen of the West*. The vintage-style, paddlewheel vessel was traveling east on the Columbia River near Rufus, Oregon, with 124 overnight passengers and 53 crewmembers on board, as part of a 7-day cruise. Though not required by Coast Guard regulations, the *Queen of the West* had an automatic fire detection system and a fixed fire suppression system on board. The systems functioned properly alerting the navigation team to the fire and helping to extinguish the flames. The crew was able to contain the fire to the engineroom, and the vessel did not need to be evacuated. The *Queen of the West* sustained about $3.9 million in damage. One crewmember was treated for mild hypothermia.

The National Transportation Safety Board (NTSB) determines that the probable cause of the fire on board the *Queen of the West* was the failure of a pressurized component on the port main propulsion hydraulic system, resulting in hydraulic oil spraying onto the port engine's exhaust piping and igniting. Contributing to the survivability of the vessel, and to the absence of injury or loss of life, was Majestic America Line's voluntary installation of an automatic fire detection system and a fixed fire suppression system.

The safety issues discussed in this report address the importance of having a functioning automatic fire detection system and a fixed fire suppression system on small passenger vessels and the inadequate requirements for small passenger vessels regarding out-of-water survival craft for passengers and crew.

As a result of the investigation, one new recommendation and one reiterated recommendation are addressed to the U.S. Coast Guard.

# The Accident

## Vessel Information

| | |
|---|---|
| Official Number | 1033572 |
| Name | *Queen of the West* |
| Type | Paddlewheel passenger vessel |
| Construction | Steel; 221 feet long, gross domestic registered tons 92 (GT ITC: 2115)<br>Keel laid in June 1994; vessel delivered in August 1995 |
| Engine | Cummins KTA50, 3,200 horse power |
| Owner | QW Boat Company, LLC, Newport Beach, California |
| Operator | Majestic America Line, Seattle, Washington |
| Property Damage | About $3.9 million |
| Injuries | 1 crewmember treated for hypothermia |
| Complement | 53 crew<br>124 passengers |

## Events Leading up to the Fire

On Sunday, April 6, 2008, the 221-foot-long, stern-wheel propelled riverboat *Queen of the West* (figure 1) embarked passengers in Portland, Oregon, for a 7-night "Northwest Rivers Cruise," the vessel's first tour of the 2008 season. The *Queen of the West* had completed its shipyard period the previous week with a successful sea trial on Friday, April 4.

Registered at less than 100 gross domestic tons and carrying more than 49 overnight passengers, the *Queen of the West* was inspected by the U.S. Coast Guard as a small passenger vessel. It had 71 staterooms arranged throughout four decks above the waterline and was certificated to carry 150 passengers. The vessel was operated by Majestic America Line.


**Figure 1.** The *Queen of the West* under way. Photo by Majestic America Line.

The Northwest Rivers Cruise was scheduled to take passengers north from Portland on the Willamette River and then east on the Columbia and Snake rivers to Lewiston, Idaho, just over the Oregon border. From Lewiston, the vessel was to backtrack down to the confluence of the Willamette and Columbia rivers north of Portland and then proceed further west down the lower Columbia River to Astoria, Oregon, near the Pacific coast. The final segment of the cruise was to backtrack on the Columbia and Willamette rivers, returning to Portland on Sunday, April 13, 2008 (figure 2).

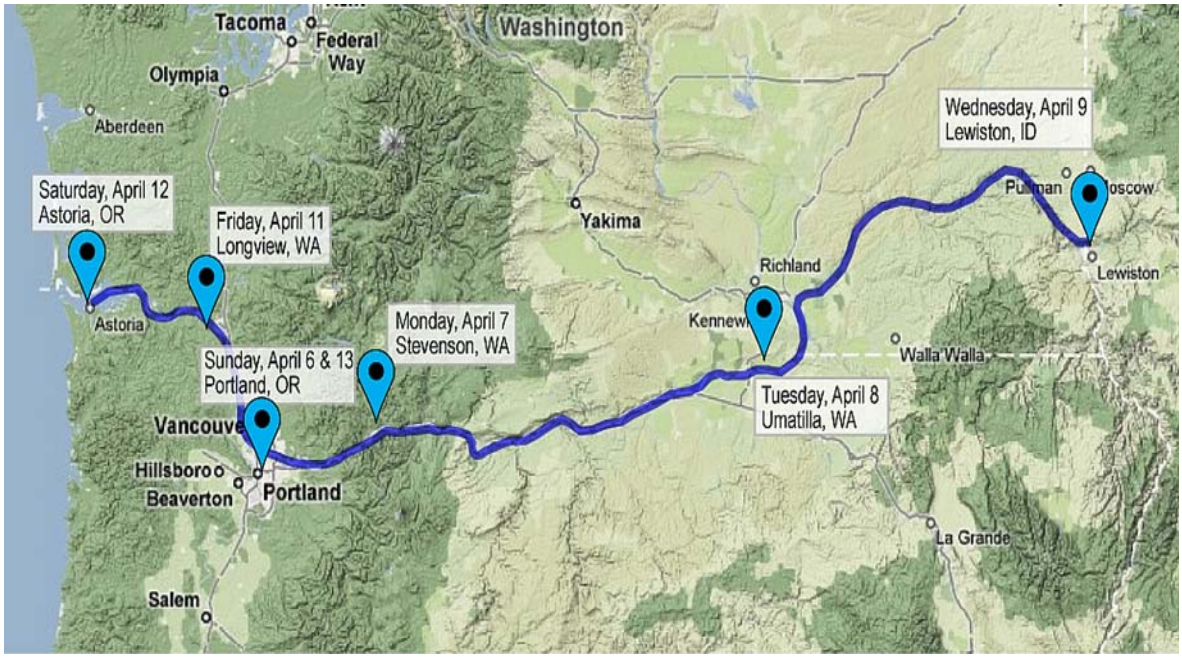


**Figure 2.** Route of the 7-night Northwest Rivers Cruise.

The Northwest Rivers Cruise was about 1,000 miles roundtrip and would take the vessel through a total of eight lock systems along the route (figure 3). The *Queen of the West* was to stop at towns along the way for day excursions and transit to its next destination at night.

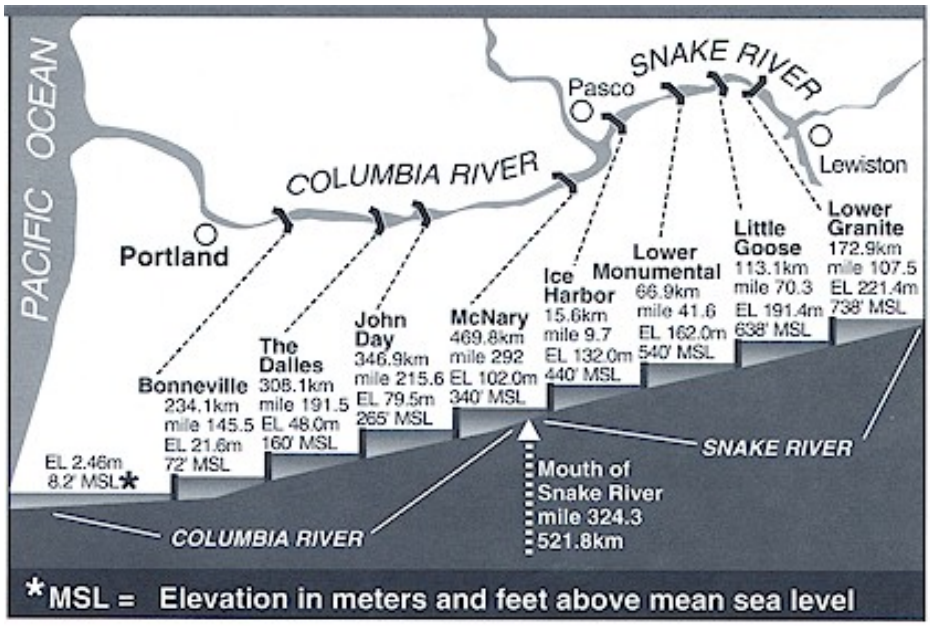


**Figure 3.** The eight locks along the vessel's route. Graphic by U.S. Army Core of Engineers.

On Monday, April 7, the *Queen of the West* spent the afternoon in Stevenson, Washington, before departing for an early Tuesday morning arrival at Umatilla, Oregon. On the evening of April 7, the ship transited The Dalles lock at mile marker 192[1] and proceeded upstream (east) through a section of the Columbia River called Lake Celilo, located between The Dalles and the John Day Dam locks (figure 4).

About 2330,[2] the chief mate arrived in the pilothouse[3] on board the *Queen of the West* to relieve the watch. At 2345 the vessel's riding captain[4] entered the pilothouse. Shortly thereafter, the watch officers overheard radio traffic between the John Day Dam lock personnel and the crew of a towboat named *Challenger*. The *Challenger* crew indicated that the towboat was 45 minutes upstream of the lock with a tow, and the lock operator was preparing to flood the lock to receive them. On board the *Queen of the West*, the riding captain immediately radioed the

[1] Mileage distances along the Columbia River are in statute miles. Distances along the Columbia River are eastward from the mouth (near Astoria).

[2] Times are Pacific daylight time, using a 24-hour clock.

[3] For vessels that travel on inland waters, "pilothouse" is the term customarily used for "navigation bridge."

[4] In addition to the regular vessel master and the regular chief engineer, the *Queen of the West* was carrying another captain and a chief engineer, each with previous experience on board the vessel. The additional captain and chief engineer were designated as "riding" staff, on board to assist in training engineers and officers who had just started in new positions. On the accident voyage, the "riding captain" was standing watch alongside the new chief mate.

lock stating that the *Queen of the West* was about 30 minutes away and requested that the lock stay down for them.[5] The lock operator and the *Challenger* crew agreed that since the *Queen of the West* was closer, she would enter the lock first.

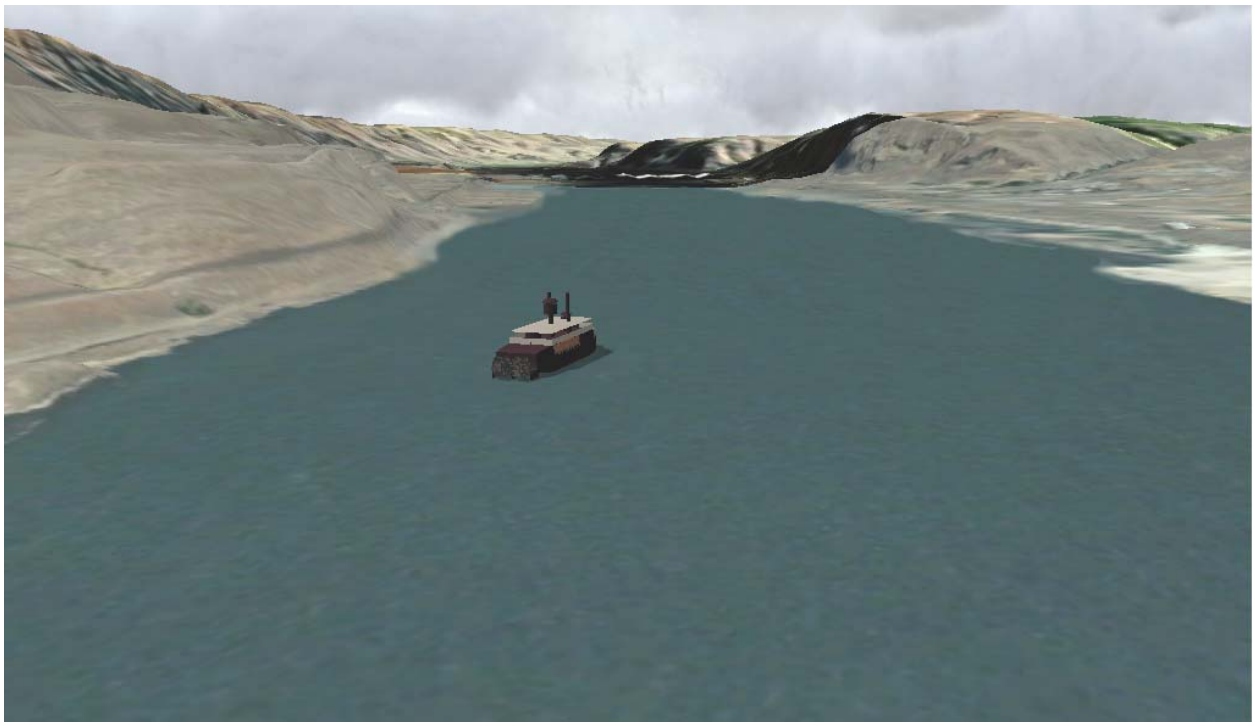

**Figure 4.** Computer-generated illustration of the *Queen of the West* anchored downstream of the John Day Dam in the easternmost section of Lake Celilo on the Columbia River. The dam is located in the top center of the image. The illustration shows the approximate scale of the vessel to the river and surrounding shores.

Following this radio conversation, the riding captain instructed the chief mate to increase the hydraulic pressure to the vessel's propulsion system from 2,400 pounds per square inch (psi) to 2,600 psi to increase speed[6] and thus expedite the ship's arrival at the lock entrance. The chief mate increased the pressure cautiously as it was his first time manipulating the throttle, and both the riding captain and the vessel master had warned him of the possibility of pressure spikes on the hydraulic propulsion system when transiting through shallow waters.[7] The chief mate later

[5] The upper lock gate was damaged on February 29, 2008, and the gate, awaiting final repairs, was not yet working properly. The riding captain told investigators that, because of the damaged gate, lock transit time had increased to over 2 hours from the normal 45 minutes.

[6] On the *Queen of the West*, vessel speed was a function of propulsion hydraulic system drive pressure; adjusting the pressure changed the vessel speed. When the paddlewheel turned at a rate of 8 or more revolutions per minute, hydraulic pressure was carefully monitored by the pilothouse watch. The "full speed" hydraulic system pressure, and therefore maximum vessel speed, was obtained at the 2,800 psi system limit pressure.

[7] The deck officers stated that the hydraulic system pressure typically varied with water depth. When encountering shallow water at a fixed throttle position, the vessel speed reduced and the hydraulic drive system pressure increased; when transiting back over deeper water the vessel speed increased and the hydraulic pressure correspondingly decreased.

told investigators that when he initially increased the pressure to gain speed, he briefly saw the digital pressure gauge spike through 3,000 psi. He heard a "beep" from the control panel before the pressure settled back to about 2,600 psi. The *Queen of the West* continued toward the dam. The navigation team increased the pressure to 2,740 psi, which equated to about 14.5 rotations per minute of the paddlewheel and a speed of about 10.6 mph. About 0010, the first engineer radioed the pilothouse to report that he had paralleled[8] an additional generator and was about to power the bow thruster to prepare for transiting the lock.[9]

About 0012, the navigation team heard beeping sounds from the port side of the pilothouse near the fire alarm panel. The pilothouse deckhand reviewed the alarm panel but no zones showed alarm status. About 1 minute later, a light designated for the engineroom activated on the alarm panel and a beeping alarm sounded continuously.

About this time, a crewmember in the vessel's hotel staff noticed a glow of fire on the aft port side of the main deck and alerted the second engineer who was just coming off his watch.[10] The second engineer approached the area and saw smoke and flames emerging from the garbage room, which was located adjacent to and outboard of the port side of the engineroom. He then shut off the fuel supply and activated the damper[11] closure pull cables to the machinery spaces, then called the pilothouse and reported the fire to the riding captain.

In the pilothouse, the chief mate noticed that the vessel's propulsion hydraulic system pressure had dropped to 660 psi, and he alerted the riding captain who told him about the fire. The riding captain eased the throttle from full ahead to zero to stop the vessel. The chief mate then told the pilothouse crew that he would assume control at the scene of the fire and left the pilothouse. As the chief mate exited, the vessel lost electrical power and, according to a pilothouse crewmember, "every alarm . . . started going off." Shortly after electrical power was lost, which resulted from the engineers' shutting off the fuel oil to the engines and generators, the vessel's emergency battery-powered system engaged, enabling basic pilothouse navigation equipment and the vessel's emergency lighting to function. However, primary electrical power, propulsion, and steering capability were lost.

The riding captain decided to anchor the vessel and so informed the navigation team. The riding captain also called the vessel master, who was off duty and asleep in his stateroom. The master arrived in the pilothouse about 30 seconds after receiving the call and assumed command from the riding captain. The master ordered the crew to drop the port anchor, and the anchor was dropped just past mile marker 213, about 3 miles west of the John Day Dam lock, in about 24 feet of water. The nearest land was about 250 yards away, on the river's north shore (figure 5). Hearing reports on his handheld radio that the fire was raging in the engineroom, the master

[8] "Paralleling" is to electrically connect an idle or off-line generator to an energized electrical distribution bus in an alternating current (AC) system. On board the *Queen of the West*, the additional generator connected to the distribution bus effectively doubled available power to motors and pumps, such as the bow thruster.

[9] The bow thruster was used primarily for maneuvering purposes, such as transiting through locks, and during docking and undocking.

[10] The second engineer had been relieved by the first engineer who had the 0000-to-0400 watch.

[11] Dampers are devices designed to provide an airtight boundary in ventilated spaces when closed.

sounded the vessel's general alarm, called Mayday over the pilothouse radio and radioed the lock operator requesting tug assistance. The master also asked the lock operator to alert all local authorities, including the Coast Guard.

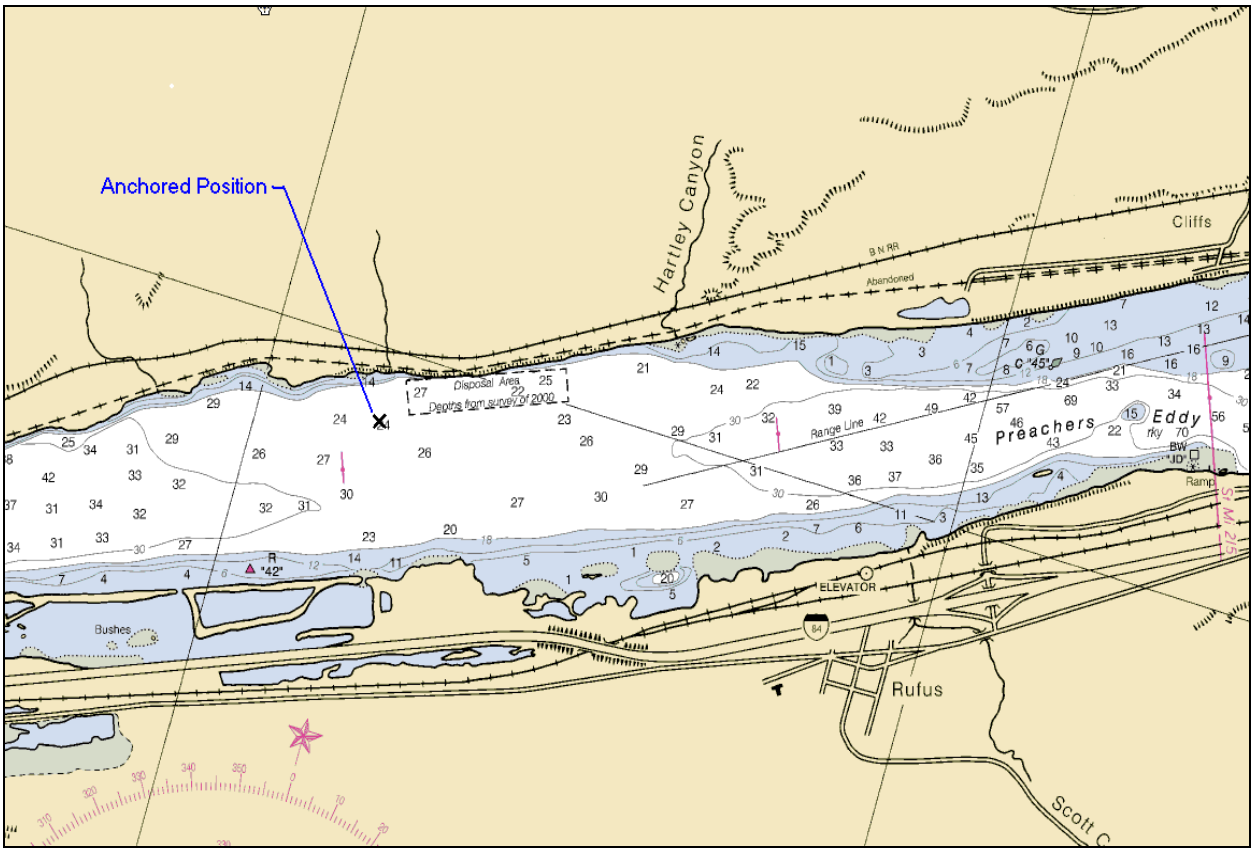


**Figure 5.** Location where the *Queen of the West* anchored after losing electrical power. National Oceanic and Atmospheric Administration (NOAA) Chart 18533, 12th Edition.

## Mustering of Passengers

The master attempted to use the public address (PA) system to inform the passengers and the crew about the nature of the alarm, but the PA system had stopped working due to the loss of electrical power. The master then used his handheld radio and instructed radio-carrying crewmembers to notify the passengers and the rest of the crew of the emergency. The crewmembers went door-to-door through the entire vessel to ensure that all passengers were informed of the situation and that they exited their staterooms to muster in the vessel's Columbia Showroom, located on the forward main deck. The crewmembers were to muster at their respective emergency stations. By 0049, all passengers had donned lifejackets, mustered in the Columbia Showroom, and been accounted for, with the hotel manager confirming the passenger count against the vessel's manifest. The passengers consisted mainly of senior citizens, some with walkers. No children were on board.

The riding captain was standing by to evacuate the passengers from the vessel. An evacuation to shore,[12] if necessary, would have had to use the vessel's sole rescue boat (figure 6), which, according to the vessel master, could accommodate six persons at a time, two of whom had to be crewmembers. Therefore, the rescue boat would have had to make numerous trips—conveying four passengers at a time—unless other help became available. Because the fire was later suppressed and because the towboat *Challenger* was en route to assist, the *Queen of the West* did not need to be evacuated in the rescue boat, and the passengers were so informed.


**Figure 6.** The rescue boat positioned at the *Queen of the West*'s port forward side.

The only compulsory craft on board the vessel was this rescue boat, required by Sector Portland's Officer in Charge of Marine Inspection (OCMI) and identified on the vessel's certificate of inspection (COI) in accordance with Title 46 *Code of Federal Regulations* (CFR) 117.208. In carrying the rescue boat, the *Queen of the West* was in compliance with Coast Guard regulations (also see "Certificate of Inspection and Regulatory Status" section).

[12] It is not known to which shore the officers intended to evacuate the passengers. The south shore was farther away but appeared more populated.

## Fire Extinguishing

When the fire began about 0012, the first engineer was near the bow starting the bow thruster and was therefore not in the engineroom. He was notified of the fire by the riding captain, who called him by radio. On receiving the call, the first engineer proceeded aft to the engine control room. There, he was met by the second engineer, who had just cut off the fuel supply and closed the ventilation dampers. The first engineer began to check the engineroom dampers and noticed that the ambient pressure in the engineroom prevented the portside intake ventilation damper from closing completely. The first engineer retrieved and emptied two portable $CO_2$ extinguishers through the damper opening into the engineroom before heavy smoke forced him to retreat. Another engineer then manually closed the damper with a long hook. The three engineers also closed the fuel oil supply root[13] valves located in the hotel laundry room. By this time the vessel's chief engineer, who had been off duty and asleep when the fire started, had also arrived on scene and was aiding in the effort.

The first and second engineers realized that because the ship had lost power its main fire pumps would not work. The engineers prepared to use a gasoline-powered portable pump[14] to fight the fire instead. Meanwhile, members of the vessel's fire team (several crewmembers assigned to assist with firefighting in the event of a fire) mustered on the portside aft main deck, began connecting hoses, and donned firefighter suits. The chief mate began cooling the exterior aft bulkhead of the engineroom with water from the portable pump.

The fire team, working with the chief engineer, prepared to release additional $CO_2$ into the engineroom, this time from the vessel's fixed supply system.[15] In preparation for the fixed supply $CO_2$ release, the engineers checked the ventilation dampers and other openings into the space to ensure that they were closed. The engineers found that the port exhaust damper and the starboard intake damper had failed to close from the initial remote pulls. In addition, the access door on the engineroom's aft starboard side, as well as the ventilation doors to the generator space,[16] had not yet been closed.

The second engineer, being the most familiar with the damper closure mechanism and with the areas where the vents were located, donned a self-contained breathing apparatus (SCBA) and proceeded to the smoke-filled spaces adjoining the engineroom to secure the remaining vent dampers. However, the portside exhaust damper could not be secured because of its proximity to the fire and because of the damage it sustained from the fire. The damper remained partially open throughout the fire. Shortly after the second engineer had exited and

[13] Root valves are valves located upstream of additional system valves. In this case, the root valves were located upstream of the remote fuel oil cut-off valves previously closed.

[14] The gasoline-powered pump could only supply a 1.5-inch hose. The pump was not required by regulation to be carried on board the vessel.

[15] The fixed $CO_2$ system was dedicated to the engineroom. The system was designed to suppress a fire in a set volume, thereby requiring that all ventilation supply and boundaries be secured before release. The fixed $CO_2$ system was not required by regulation to be installed on the vessel.

[16] The ventilation doors to the generator space were manually operated only and did not connect to the remote pulls.

after ensuring that no one remained in the affected spaces, the chief engineer released the $CO_2$ into the engineroom.

In the pilothouse, the riding chief engineer—who had received fire training in the Navy and was the most experienced firefighter on board—briefed the master on the situation in the engineroom. The master decided that about 30 minutes after the $CO_2$ had been released, the second engineer and the riding chief engineer would enter the engineroom and extinguish any residual fire using a water fog nozzle charged from the portable pump.

During the half hour following the release of the $CO_2$, the second engineer and the riding chief engineer connected another hose from the portable pump through the galley located just forward of the engineroom. The two engineers then entered the engineroom through the centerline door, with the riding chief engineer manning the nozzle. They discovered two small residual fires, one on the outboard hydraulic pump near the port main engine, and the other near a large-diameter, high-pressure hydraulic hose on the forward port side of the engineroom. The hydraulic hose was leaking in its middle section, with oil shooting out and igniting. The second engineer and the riding chief engineer applied a water fog to the fires and extinguished them, which took about 5 minutes. The two men spent another 20 minutes cooling and securing the area until their SCBA air ran low, and then left the engineroom. Reflash watches[17] were set, and the chief mate and crewmembers who were working the portable pump hose resumed cooling the aft exterior bulkhead of the engineroom. The portable pump had to be stopped periodically and refueled. When one gallon of gasoline remained, the crew decided to only intermittently hose the bulkhead to conserve fuel. When the towboat *Challenger* arrived (over 2.5 hours after the fire started), its crew began cooling the aft engineroom bulkhead. Shortly thereafter, the hose team on the *Queen of the West* suspended firefighting operations.

## External Response

About 0031, two boats from the sheriff's office in Klickitat County, Washington, were dispatched, and the Klickitat County sheriff boarded the *Queen of the West* about 0230. About 0300, the *Challenger* arrived, and by 0315 the towboat was secured along the port side of the *Queen of the West*. The Coast Guard dispatched an HH-60 Jayhawk helicopter from Air Station Astoria after the Army Corps of Engineers operator at the John Day Dam received the report of fire. The helicopter arrived on scene about 0310. In addition, a Coast Guard vessel was dispatched from Portland.

At 0320, the *Queen of the West* raised anchor and was taken under tow by the *Challenger* to Maryhill Landing, Maryhill State Park, Washington, about 3.5 miles downstream to the west in Lake Celilo. As a matter of routine during the vessel's inland excursions, Majestic America Line arranged for buses to "shadow" the vessel along the river. On the night of the fire, the company arranged for buses to meet the *Queen of the West* at Maryhill Landing at 0340, and the navigation team was made aware of this. The *Challenger* and the *Queen of the West* arrived at 0433. About 15 minutes later, the bow ramp was down and at 0500 the vessel disembarked

[17] A reflash watch is the surveillance of a fire area to ensure that the fire does not reignite. Crews will often stage in a fire area with a charged hose and wait 2 to 3 hours, depending on the severity of the fire.

passengers, with local fire department assets on scene to assist. At 1000, with the disembarkation completed at Maryhill Landing, the *Queen of the West* was again under tow by the *Challenger*. After switching towboats, the vessel arrived in Washougal, Washington,[18] at 1205 on April 9.

## Injuries

The chief mate was treated for mild hypothermia due to his prolonged exposure to the elements while hosing the aft bulkhead on the vessel's stern during the fire. He returned to work that same afternoon. No other injuries were reported.

## Toxicological Tests

About 0615 on April 8, the Klickitat County Sheriff's deputy performed alcohol tests on six of the vessel's officers involved in the accident. Those six officers and twelve additional crewmembers were also tested for illegal drug use. All drug and alcohol tests were negative.

## Weather and Waterway Conditions

The air temperature at the time of the fire was about 45° F and dropped to the upper 30s by early morning on April 8. The wind was out of the west at 7 mph, with gusts up to 11 mph. Data from the U.S. Geological Survey's station on the Columbia River at The Dalles lock, just downriver of the accident location, indicated that the water temperature on the day of the incident was about 44° F. The current in Lake Celilo was not recorded, but the deck crew on the *Queen of the West* estimated it as 2 to 4 knots near the John Day Dam.

## Postaccident Action

### Repairs

The *Queen of the West* was taken out of service for 2 months to undergo engineroom repairs and other renovation as a result of the fire damage. The vessel sustained moderate smoke damage in the areas near the fire, necessitating replacement of carpet and upholstery. The vessel returned to its normal cruise schedule on June 8, 2008.

### Majestic America Line

Following the accident, Majestic America Line installed heat shields between the hydraulic pumps and the propulsion engines on the *Queen of the West*. This was done to prevent flammable liquids from spraying onto the engine in the event of a hose or pump failure. Majestic America Line also took steps to insulate all exposed exhaust piping surfaces in the engine spaces.

[18] NTSB investigators arrived on scene in the afternoon of April 9 in Washougal.

Not long after the *Queen of the West* returned to service in June 2008, Majestic America Line experienced a significant decrease in customer demand, and in late 2008 the company suspended operations. The *Queen of the West*'s last cruise took place in November 2008. As of the date of this report, the *Queen of the West*, as well as other vessels formerly in Majestic America Line's fleet, are not operating and are for sale.

## Coast Guard

In December 2008, the Coast Guard issued Marine Safety Alert 13-08, regarding ventilation closures on small passenger vessels. The alert did not reference the *Queen of the West* or any other accident specifically, but stated that ". . . recent vessel casualty investigations . . . into fires aboard small passenger vessels have raised awareness for the need to properly inspect and test ventilation closures . . ." so that they function reliably in vessel spaces protected by fixed fire suppression systems.

# Investigation and Analysis

## Certificate of Inspection and Regulatory Status

The *Queen of the West* was inspected by the Coast Guard according to subchapter K of the small passenger vessel regulations because it was registered at less than 100 gross tons and was certificated to carry more than 49 overnight passengers. However, when the vessel was first put in service in 1995, it fell under the version of subchapter T then in effect because subchapter K had not yet taken effect. Being built and classified as a T-vessel before subchapter K's effective date of March 10, 1996, meant, in part, that the *Queen of the West* was not required to have an emergency generator. The *Queen of the West* was also not required to carry an automatic fire detection system or a fixed fire suppression system, which, like the emergency generator, would have been required had the vessel been built after March 10, 1996. However, Majestic America Line voluntarily equipped the *Queen of the West* with an automatic fire detection system and a fixed fire suppression system.

The *Queen of the West*'s COI certificated the vessel for passage on the Columbia, Willamette, and Snake rivers only. According to Coast Guard Marine Information for Safety and Law Enforcement records, the *Queen of the West* was the only subchapter K vessel in service in the United States certificated to operate only on river routes and accommodating more than 49 overnight passengers.

## Vessel's Hydraulic Propulsion System

The stern paddlewheel on the *Queen of the West* provided main propulsion using two hydraulic drive motors mounted outboard on each side of the paddlewheel. Two diesel-engine-driven hydraulic power units (HPUs) in the engineroom provided hydraulic pressure. The vessel needed only one main propulsion engine and HPU to achieve full speed; the other components were redundant to provide backup. The system had a main relief valve set at 3,500 psi, with an audio/visual overpressure alarm installed in the engineroom and in the pilothouse operator station. The vessel's recommended maximum hydraulic system operating pressure was 2,800 psi, with the pressure limited only by the operator controlling the pilothouse throttle and by the system's main relief valves.

The vessel engineers stated that they typically kept the system pressure below 2,800 psi to extend the pump service intervals to every 1.5 years and system hose replacements to every 3 years. The *Queen of the West* had a full hose replacement during its shipyard period in February and March 2008, and all hoses were visually inspected during the April 4 sea trial. The riding chief engineer stated that the vessel's hydraulic pressure system had experienced "occasional blowouts" in the past, but no fire had ever resulted. From his experience, the riding chief engineer considered the system's weak points to be the o-ring seals on the flexible discharge hoses.

The engineroom on board the *Queen of the West* was not constantly manned. The space was narrow and comprised an upper and lower level. The lower level of the engineroom

contained the vessel's two diesel-driven electrical generators, which supplied AC power throughout the vessel and powered the bow thruster. The upper level of the engineroom contained most of the vessel's propulsion machinery (figure 7). The machinery consisted of two main propulsion engines of 1,600 horsepower each, one on the starboard side and one on the port side. Each engine supplied power to the vessel's propulsion system, which comprised eight hydraulic pumps sequentially attached to each engine.

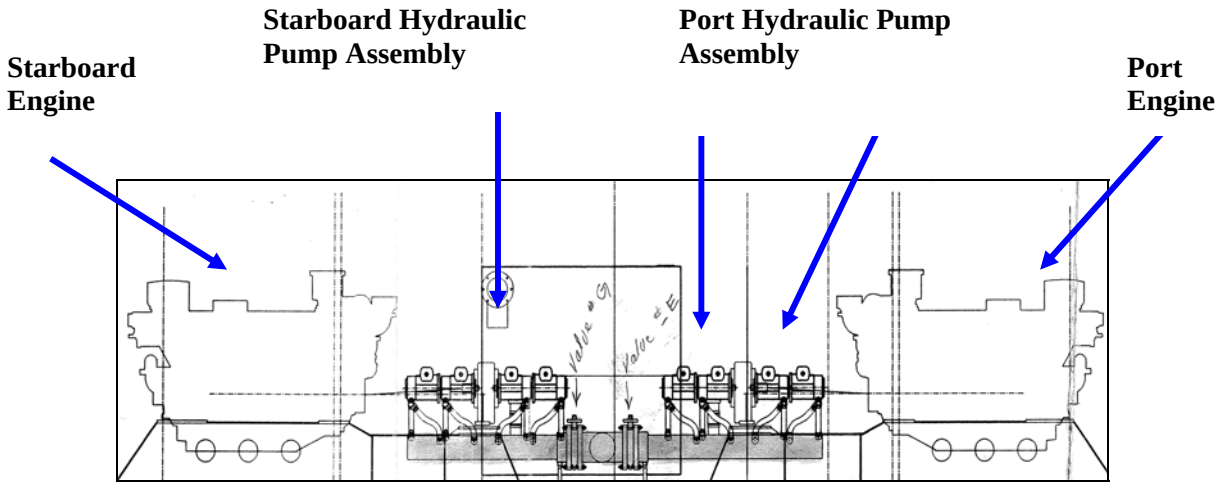


**Figure 7.** Upper engine level configuration, facing aft.

## Fire Damage

The damage to the vessel was limited to the upper engine level and the adjoining ventilation dampers and vents. The starboard side of the engineroom, including the engine and eight hydraulic pumps, sustained significantly less damage than the port side of the engineroom, which exhibited heavy fire damage. The space's aluminum bulkhead lining melted away from the overhead and from the upper portion of the bulkhead in the area of the hydraulic pump assembly. Hydraulic pumps 1, 2, and 5–8 on the port side were heavily sooted and had moderate thermal damage (their vibration protection covers had melted). The pumps were covered with hydraulic oil (figure 8).

The area near pumps 3 and 4 for the portside engine exhibited heavy thermal damage. Almost no hydraulic oil residue was found on exposed surfaces, and a "clean" area (free of soot) was located directly above pumps 3 and 4, indicating that this area had been exposed to high localized temperatures that burned away the hydraulic oil (figure 9).[19]

[19] If the temperature of a surface (such as metal) exceeds about 750° F, soot cannot attach itself to that surface.

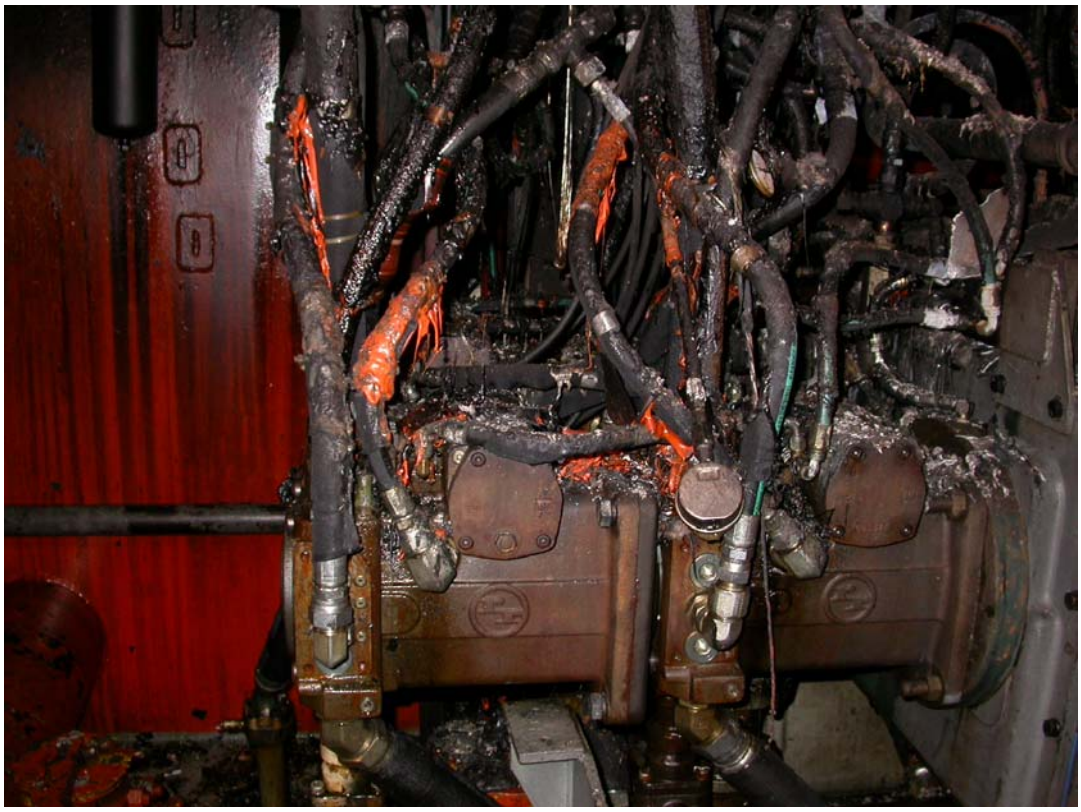

**Figure 8.** Pumps 1 and 2 and associated hoses for the portside engine.

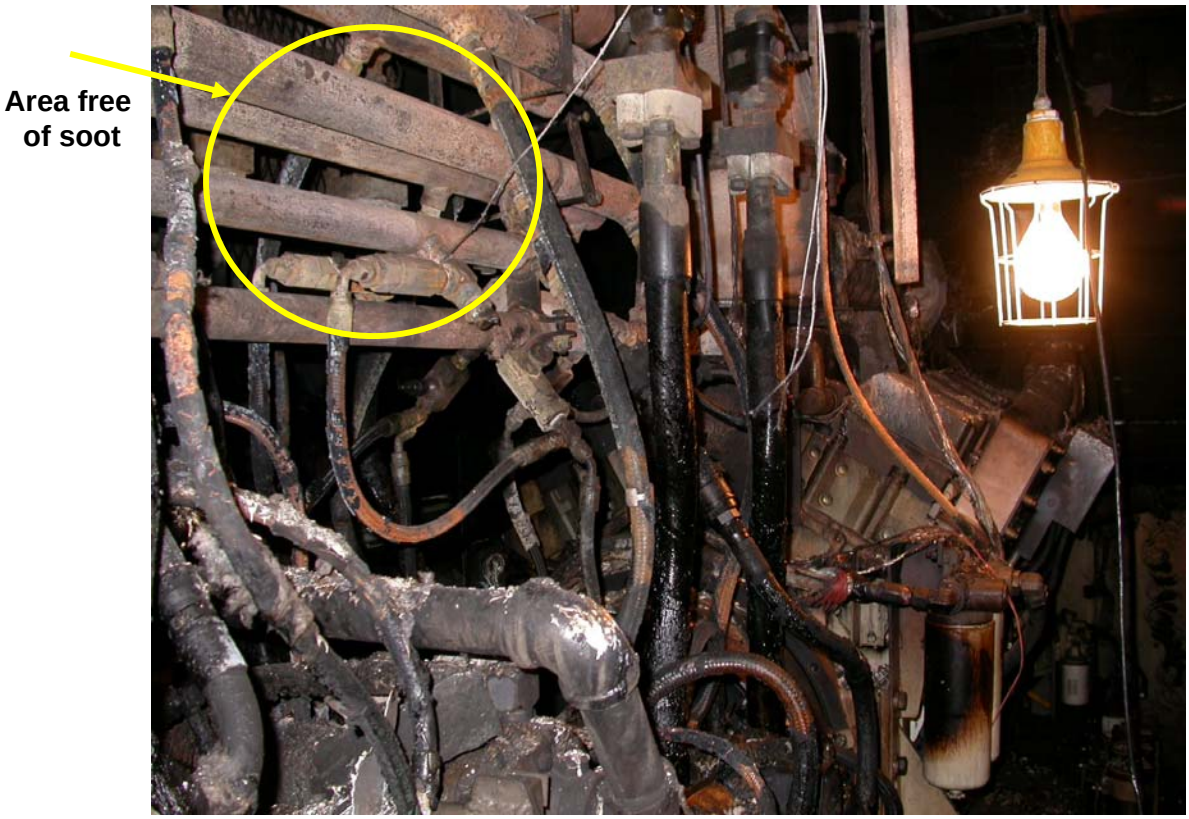


**Figure 9.** Area directly above portside pumps 3 and 4.

Investigators concluded that one of the hydraulic oil hoses that serviced portside pumps 3 and 4 must have failed. Exactly which hose failed and where could not be determined because of the fire damage. Two of the hoses had melted through adjacent to the steel fittings. Portside pumps 3 and 4 and their associated hosing were removed from the vessel for further examination and testing by a third-party forensics-testing laboratory. The pump examination found no leakage around the seals and connections. Because of the fire damage, the hoses could not be pressure-tested for preexisting holes or leaks.

Also located in the area of portside pumps 3 and 4, above and immediately aft, was the steel exhaust piping for the port propulsion engine (figure 10).

**Figure 10.** The exhaust piping onto which hydraulic oil sprayed and ignited. The piping can be seen in the upper center of the photo, with an arrow pointing to it.

Because of the proximity between the hydraulic oil hoses and the hot exhaust piping, and because of the lack of alternative ignition and fuel sources in the immediate area, investigators determined that the fire was caused by hot surface ignition of hydraulic oil. The hot exhaust piping was the fire's ignition source and the paddlewheel hydraulic oil—Synterra oil by ConocoPhillips—from the failed hydraulic hose was the fire's fuel source. Synterra oil's auto ignition temperature is about 657° F. Because the hydraulic oil leak was in the form of atomized[20] spray, it created a fuel-air mixture that ignited when it came in contact with the near-800° F exhaust piping.

[20] Fluids under pressure tend to atomize, that is, become fine mist, when pushed through a small opening or leak in a pressurized system.

# Safety Issues

## Fire Detection and Suppression Systems on Small Passenger Vessels

Because the *Queen of the West* was of steel construction (as opposed to wood or fiberglass) and built before March 10, 1996, the vessel was not required to have either an automatic fire detection system or a fixed fire suppression system, as outlined at 46 CFR, Part 118, Section 400-420, which applies to small passenger vessels. Nevertheless, the *Queen of the West* was equipped with heat and smoke detectors throughout, as well as a fixed $CO_2$ fire suppression system on the main deck directly outboard of the engineroom. The fire detection system, with detectors identified by zone, featured a Cerberus Systems 3 fire alarm panel located in the pilothouse. A single heat detector was located in the engineroom, and its remains were found in the debris after the fire. The suppression system consisted of eight 100-pound cylinders of $CO_2$ and eight discharge nozzles (four in the upper level of the engineroom and four in the lower level), a discharge alarm, and a 30-second delay device to allow for evacuation of the engineroom if necessary. Records indicate that the fire detection and suppression systems were last inspected in March and April 2008, with both systems found in working order. During the postaccident investigation, the suppression system's cylinders, piping, and nozzles were examined. All parts of the system were intact and it appeared that the cylinders had properly emptied.

Majestic America Line exceeded Coast Guard requirements by equipping the *Queen of the West* with fire detection and suppression systems. The NTSB therefore concludes that Majestic America Line acted proactively by installing an automatic fire detection system and a fixed fire suppression system on board the *Queen of the West*, and this action, which was not required by Coast Guard regulations, limited the fire damage to the vessel and enhanced the survivability of passengers and crew.

Had the non-mandatory fire systems and equipment not been installed on board the *Queen of the West*, and had the fire continued to burn unchecked, hundreds of gallons of diesel oil and hydraulic oil in the engineroom tanks could have ignited, necessitating an urgent evacuation. The NTSB therefore concludes that the automatic fire detection system and the fixed fire suppression system on the *Queen of the West*, and other onboard equipment not currently required by Coast Guard regulations for a vessel of this age and classification, functioned properly and prevented the spread of the fire.

The engineers, working in conjunction with the navigation team and master, acted appropriately and effectively in discharging the $CO_2$ when it became clear that the fire was raging beyond their means to fight it manually. Without releasing the $CO_2$ when they did, the fire could have escalated and the situation deteriorated, forcing the master to evacuate everyone on board into the cold water. The NTSB therefore concludes that early use of the fixed fire suppression system avoided a forced evacuation and likely prevented significant injuries and loss of life.

The riding captain, the vessel master, and the navigation team took appropriate steps to ensure that proper authorities were notified of the fire and that crewmembers quickly mustered

and accounted for all of the passengers. In addition, the members of the firefighting team performed commendably in extinguishing the fire using the available onboard fire equipment. The NTSB therefore concludes that the efforts by the *Queen of the West* crew were timely and appropriate.

## Previously Issued Recommendation Reiterated in This Report

In March 2007, the NTSB issued Safety Recommendation M-07-1 to the Coast Guard following the June 12, 2006, engineroom fire on board U.S. commuter ferry M/V *Massachusetts* in Boston Harbor.[21] The *Massachusetts*, carrying 65 passengers and 4 crewmembers, was about 15 minutes into a scheduled transit between Rowe's Wharf in Boston and Hingham, Massachusetts, when black smoke and an engine high-water-temperature alarm alerted the crew to the fire. Like the *Queen of the West*, the *Massachusetts* was not required to have an automatic fire detection system and a fixed fire suppression system. However, unlike the *Queen of the West*, the *Massachusetts* did not carry this non-mandatory equipment on board. As a result of its engineroom fire, the *Massachusetts* sustained about $800,000 in damage,[22] and two passengers were treated for smoke inhalation.

Safety Recommendation M-07-1 asks the Coast Guard to take the following action:

> 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 enginerooms.[23]

The NTSB directed the recommendation toward vessels carrying more than 49 passengers because of vessel design considerations. Vessels certificated to carry fewer than 49 passengers are typically smaller, do not always have segregated engine spaces to accommodate an automatic fire detection system and a fixed fire suppression system, and are often propelled by stern-mounted outboard engines.

In correspondence and at a meeting with NTSB staff to discuss Safety Recommendation M-07-1, the Coast Guard indicated that it did not concur with the recommendation, citing system costs, a lack of injuries from similar accidents, and the small number of fires that would be

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[21] *Fire on Board U.S. Small Passenger Vessel M/V* Massachusetts, *Boston Harbor, Massachusetts, June 12, 2006*, Marine Accident Brief NTSB/MAB-07/01 (Washington, DC: National Transportation Safety Board, 2007).

[22] The fire damage on board the *Massachusetts* was more extensive than that on the *Queen of the West*; however, because the *Queen of the West*'s propulsion system was more complex and one of a kind, repair and replacement costs were considerably higher for the *Queen of the West* than for the *Massachusetts*.

[23] Safety Recommendation M-07-1 supersedes Safety Recommendations M-02-6 and -8, which were issued to the Coast Guard following the November 17, 2000, engineroom fire on board small passenger vessel *Port Imperial Manhattan*. Eight passengers and three crewmembers were on board. As a result of the accident, one passenger was treated for smoke inhalation and the cost to repair the vessel was estimated at $1.2 million. Safety Recommendations M-02-6 and -8 asked the Coast Guard to require that all small passenger vessels in commuter and ferry service, regardless of their date of build, be fitted with a fire detection system and a fixed fire suppression system in the engineroom. The recommendations are classified "Closed—Unacceptable Action/Superseded."

affected by the recommendation. As of the date of this report, the Coast Guard has not implemented M-07-1, and the recommendation is currently classified "Open—Unacceptable Response."

Because the fire on board the *Queen of the West* illustrates how effective an automatic fire detection system and a fixed fire suppression system can be in minimizing damage and preventing injury, the NTSB reiterates Safety Recommendation M-07-1 to the Coast Guard and urges the installation of these systems to protect vessel passengers and crew.

## Out-Of-Water Flotation Equipment on Small Passenger Vessels

Though no injuries resulted from the fire on board the *Queen of the West*, the accident highlights the potential for significant casualties when small passenger vessels do not carry out-of-water flotation for 100 percent of the persons on board. Had the *Queen of the West* not been equipped with fire detection and suppression systems, or had those systems and the crew not performed as well as they did in detecting and combating the fire, or had the fire intensified beyond the crew's ability to fight it, the master would have had no choice but to order an evacuation from the vessel. The 177 persons on board would have faced an uncontrollable fire while waiting to transfer into the only rescue craft available on the vessel—a small boat that could only carry six people at a time. One of the two crewmembers on board would have needed to return the boat to the ship to pick up the next five persons in line (four passengers and one crewmember). The situation would have quickly deteriorated, and the master would have had little choice but to order all on board into the 44º F water with only their lifejackets. The effects of the cold water would have quickly set in. The NTSB therefore concludes that had an emergency evacuation been required, the absence of out-of-water flotation—not currently required by Coast Guard regulations for a vessel of this classification operating in the waters in which the accident occurred—would have subjected both passengers and crew to high risk of injury and death from exposure to cold water temperatures.

In addition, the evacuation would have taken place in an area of the Columbia River where no other marine traffic was transiting at that hour of the night. From the time the fire broke out, it took the two Klickitat sheriff's boats about two hours to reach to *Queen of the West*, and the towboat *Challenger* needed over 2.5 hours (from its location on the other side of the John Day Dam) to reach the vessel. The NTSB therefore concludes that had an emergency evacuation been required, by the time external response vessels arrived, people could have been in the water for about two hours, and the current could have scattered them a mile or more down the river.

The NTSB has long recommended that passenger vessels, regardless of what body of water they travel on, carry enough primary lifesaving equipment to safely offload all passengers and crew and support 100 percent of them in craft designed to prevent immersion in water. For example, in September 1994, following the December 1993 sinking of the 58-foot-long U.S. small passenger vessel *El Toro II*[24] on the Chesapeake Bay near Point Lookout, Maryland, the

[24] *Sinking of U.S. Small Passenger Vessel* El Toro II, *Near Point Lookout, Maryland, Chesapeake Bay, December 5, 1993*, Marine Accident Report NTSB/MAR-94/03 (Washington, DC: National Transportation Safety Board, 1994).

NTSB issued Safety Recommendation M-94-26 to the Coast Guard and also placed that recommendation on the NTSB Most Wanted List of Transportation Safety Improvements in 1995:

> Require that out-of-the-water survival craft for all passengers and crew be provided onboard small passenger vessels on all routes. (Class II, Priority Action)

*El Toro II* was certificated to carry up to 49 passengers. On the day of the accident, 20 passengers and 3 crewmembers were on board. Three lives were lost in the sinking. In response to the recommendation, the Coast Guard stated in January 1995:

> Casualty statistics do not suggest the need for out-of-the-water survival craft on vessels operating on all routes. The Coast Guard is considering increasing primary lifesaving [equipment] as part of the current regulatory project for small passenger vessel inspection and certification. We believe that focusing on the survivability of the wooden vessel through better inspection guidance, the addition of high level bilge alarms in the machinery space, fixed firefighting systems, and optional subdivision requirements, properly complements the required survival craft equipment.

The NTSB responded in April 1995:

> While the Board is encouraged that the Coast Guard is considering increasing primary lifesaving [equipment] as part of its current regulatory project for small passenger vessel inspection and certification, we are disappointed that the Coast Guard still does not see the need for 100 percent out-of-the-water protection for all vessels on all routes. The Board rejects the argument that casualty statistics do not justify the added expense of providing 100 percent out-of-the-water survival craft for all vessels, no matter the route. People have died in the Gulf of Mexico, Southern California, and the Caribbean, as well as northern waters, without out-of-the-water flotation, and such deaths will continue to occur. The Board urges the Coast Guard to reevaluate its position and require the provision of out-of-the-water flotation equipment sufficient to accommodate all passengers and crewmembers on all passenger vessels regardless of the water temperature along the route.

The Coast Guard did not implement M-94-26, and in March 1997, the NTSB classified the recommendation "Closed—Unacceptable Action" and removed it from the Most Wanted List in 1998. In correspondence to the Coast Guard in connection with closing M-94-26, the NTSB stated in part: "The Board holds firm in its belief, as it has stated in many accident investigation reports involving loss of life, that there must be 100 percent out-of-water survival craft for all passengers on all routes regardless of the [water] temperature. . . . We will continue to highlight this issue in future investigations where appropriate."

In light of the *El Toro II* accident and the fact that serious injuries or fatalities could have resulted from the *Queen of the West* accident had the fire escalated, the NTSB concludes that equipping small passenger vessels with out-of-water survival craft capable of supporting 100 percent of vessel occupants is crucial in reducing casualties in the event of an emergency evacuation into the water. Therefore, the NTSB recommends that the Coast Guard require that out-of-water survival craft for all passengers and crew be provided on board small passenger vessels on all routes.

# Conclusions

## Findings

1. Majestic America Line acted proactively by installing an automatic fire detection system and a fixed fire suppression system on board the *Queen of the West*, and this action, which was not required by Coast Guard regulations, limited the fire damage to the vessel and enhanced the survivability of passengers and crew.

2. The automatic fire detection system and the fixed fire suppression system on the *Queen of the West*, and other onboard equipment not currently required by Coast Guard regulations for a vessel of this age and classification, functioned properly and prevented the spread of the fire.

3. Early use of the fixed fire suppression system avoided a forced evacuation and likely prevented significant injuries and loss of life.

4. The efforts by the *Queen of the West* crew were timely and appropriate.

5. Had an emergency evacuation been required, the absence of out-of-water flotation—not currently required by Coast Guard regulations for a vessel of this classification operating in the waters in which the accident occurred—would have subjected both passengers and crew to high risk of injury and death from exposure to cold water temperatures.

6. Had an emergency evacuation been required, by the time external response vessels arrived, people could have been in the water for about two hours, and the current could have scattered them a mile or more down the river.

7. Equipping small passenger vessels with out-of-water survival craft capable of supporting 100 percent of vessel occupants is crucial in reducing casualties in the event of an emergency evacuation into the water.

## Probable Cause

The National Transportation Safety Board determines that the probable cause of the fire on board the *Queen of the West* was the failure of a pressurized component on the port main propulsion hydraulic system, resulting in hydraulic oil spraying onto the port engine's exhaust piping and igniting. Contributing to the survivability of the vessel, and to the absence of injury or loss of life, was Majestic America Line's voluntary installation of an automatic fire detection system and a fixed fire suppression system.

# Recommendations

## New Recommendation

As a result of its investigation, the National Transportation Safety Board makes the following safety recommendation:

**To the U.S. Coast Guard:**

Require that out-of-water survival craft for all passengers and crew be provided on board small passenger vessels on all routes. (M-09-17)

## Previously Issued Recommendation Reiterated in This Report

As a result of its investigation, the National Transportation Safety Board reiterates the following safety recommendation:

**To the U.S. Coast Guard:**

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 enginerooms. (M-07-1) (Supersedes Safety Recommendations M-02-6 and M-02-8.)

## BY THE NATIONAL TRANSPORTATION SAFETY BOARD

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Chairman

**ROBERT L. SUMWALT**
Member

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Vice Chairman

**Adopted: November 17, 2009**