National Transportation Safety Board

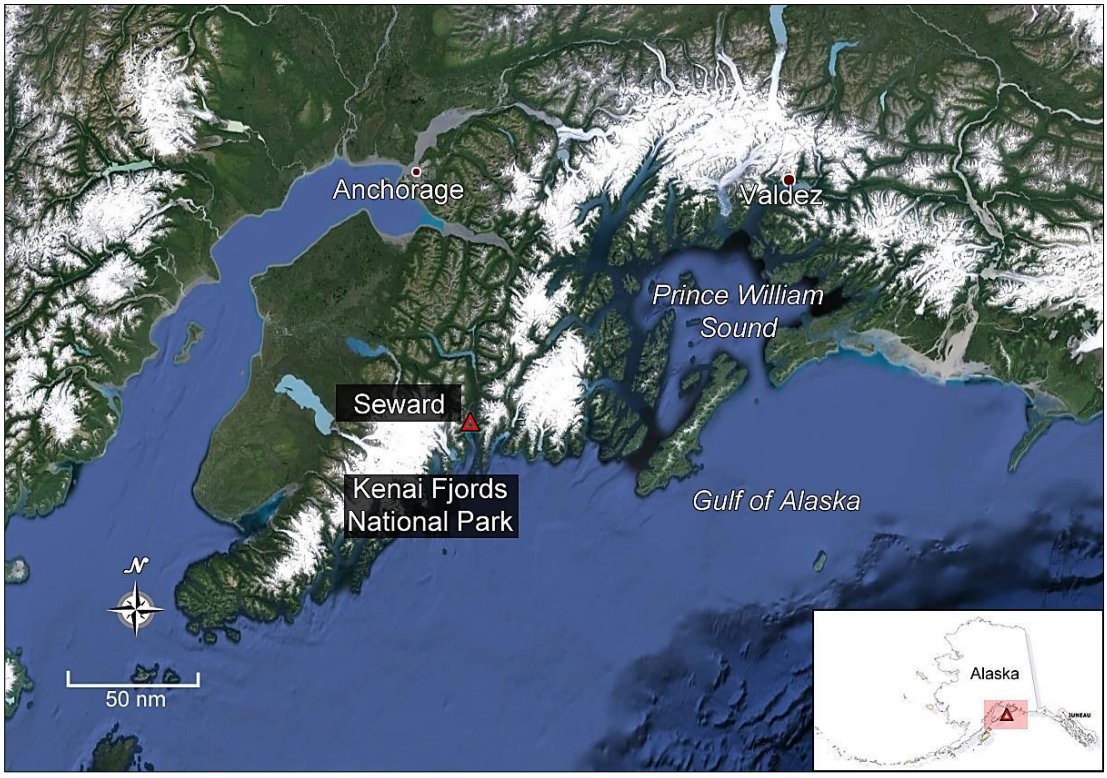
Marine Accident Brief

Partial Sinking of Small Passenger Vessel *Spirit of Adventure*

Accident no.	DCA15LM008
Vessel name	*Spirit of Adventure*
Accident type	Partial sinking
Location	Seward Boat Harbor, Seward, Alaska 60°7.069' N, 149°26.053' W
Date	December 6, 2014
Time	Before dawn, about 1000 Alaska standard time (coordinated universal time − 9 hours)
Injuries	None
Property damage	Damage was estimated at $2 million, resulting in a total loss of the vessel
Environmental damage	None
Weather	Calm winds, clear skies, visibility 10 nautical miles, water temperature 48°F, air temperature 32°F
Waterway information	Seward Boat Harbor is a protected harbor at the northern edge of Resurrection Bay, Gulf of Alaska

The *Spirit of Adventure*, a 99-gross ton catamaran small passenger vessel, flooded and partially sank while alongside its pier in Seward Boat Harbor, Alaska, before dawn on December 6, 2014. The vessel was out of service for the winter, and no one was on board. No injuries or pollution occurred as a result of the sinking. Damage to the vessel and its pier was estimated at $2 million, and the vessel was declared a constructive total loss by its insurer. The *Spirit of Adventure* was one of eight vessels operated by Major Marine Tours on sightseeing tours from Seward to Kenai Fjords National Park and Prince William Sound, Alaska.

Small passenger vessel *Spirit of Adventure* under way on a sightseeing tour before the accident. (Photo by Major Marine Tours)



Satellite image showing the location of Seward, Alaska, where the *Spirit of Adventure* partially sank, and the surrounding area. (Background by Google Earth)

When the operating season for the *Spirit of Adventure* ended on September 11, 2014, the vessel entered its winter layup period, during which company personnel conducted end-of-season maintenance, including cleaning of the bilges in the machinery spaces. The company's maintenance staff, which consisted of a fleet maintenance manager, two port engineers, and three mechanics, also performed various repairs and upgrades to all of the vessels in Major Marine Tours' fleet to prepare them for operations beginning in spring 2015.

The *Spirit of Adventure* was a catamaran vessel. Each hull had an engine room and a generator room. Each engine room had a single propulsion engine. The propulsion engines were fitted with wet exhaust systems; the exhaust from the engines was mixed with cooling water and discharged overboard through hull penetrations below the waterline. The cooling water for the exhaust systems was supplied by the main engine sea water system pumps, which also supplied lubricating water to the stern tube seal and bearing.

During mid-October 2014, company maintenance personnel removed a section of 10-inch-diameter, 90-degree elbow piping from the exhaust systems of both propulsion engines. The piping had developed leaks over a period of years that could no longer be repaired by welding or patching. The elbow sections were taken ashore to serve as patterns for the fabrication of new piping sections. When the exhaust piping elbows were removed, the flanged end of the vertical section of exhaust piping was open to the sea. The mechanics covered the opening with a plywood blank bolted to the flange but did not install a gasket to prevent leakage. Also, 3/4-inch-diameter cooling sea water lines to the exhaust piping were disconnected when the exhaust elbows were removed. The disconnected cooling sea water lines were not capped or plugged and were left loosely supported at an elevation above the waterline.

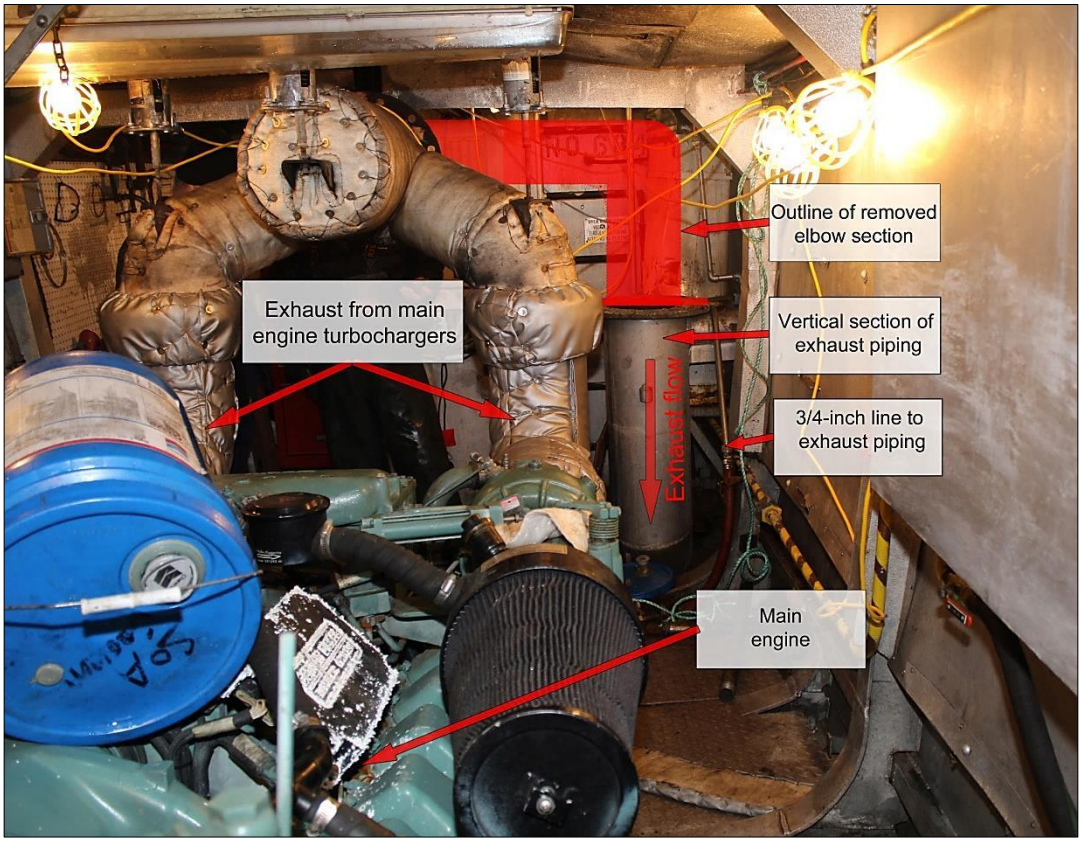


Photo of the port main engine room, looking aft. The red-shaded area indicates the approximate location of the elbow section removed from the main engine exhaust system piping. The opening at the top vertical section of the piping was covered by a bolted plywood blank.

During a 2-day period at the end of October 2014, two company mechanics winterized the vessel. During this process, the lubricating oil was changed in certain equipment, and water was drained from equipment that held fluids susceptible to freezing, such as the fresh water and sea water piping systems, diesel engine cooling systems, pump housings, and strainer bodies. To remove the water, the mechanics opened drain plugs at low points, removed strainer covers, or disconnected piping connections from the equipment. Openings made in piping systems with connections to the sea were isolated by closed sea valves, but the valves were not locked or tagged to prevent their inadvertent opening; the company did not have a written lock-out/tag-out policy. For equipment from which collected water could not be drained, antifreeze solution was added to prevent freezing.

During the winter layup period, a company employee who was not a member of the maintenance staff was assigned to visit Major Marine Tours' vessels regularly to ensure that the vessels were in a safe condition. The inspection, referred to as a "boat check," included removing any snow accumulated on the exterior deck areas and checking the water levels in the bilges of machinery spaces and accessible void spaces. If excess water was found in the bilges, the employee was required to use a portable pump at the aft end of the space to remove the accumulated water. The check was required weekly, and the findings were to be noted on a log sheet.

The employee assigned to perform the boat check stated that he last visited the *Spirit of Adventure* on December 1, 2014, 5 days before the accident, and found no abnormally high water

levels in any bilges. The *Spirit of Adventure* log sheet showed no notation for the December 1 boat check, but a notation for the November 24 check indicated that no water was found in the bilges.

The harbor master of the Seward Boat Harbor marina assigned an employee to inspect the piers and moored vessels Tuesday to Saturday of each week. The marina employee stated that she last checked the *Spirit of Adventure* during the morning of December 5, 2014, the day before the accident, and did not see any abnormal conditions, such as listing or excessive hull submergence at the stern.

Shortly after dawn on December 6, 2014, about 1000, the captain of another vessel in the harbor observed the *Spirit of Adventure* partially sunk at its pier with its bow projecting from the water at a high angle of trim. The captain reported his observation to an employee at the marina harbor master's office, who then notified Major Marine Tours. By about 1030, staff from the operator and a local salvage company responded to the reported sinking to stabilize the situation, check for indications of water pollution, and begin salvaging the vessel.

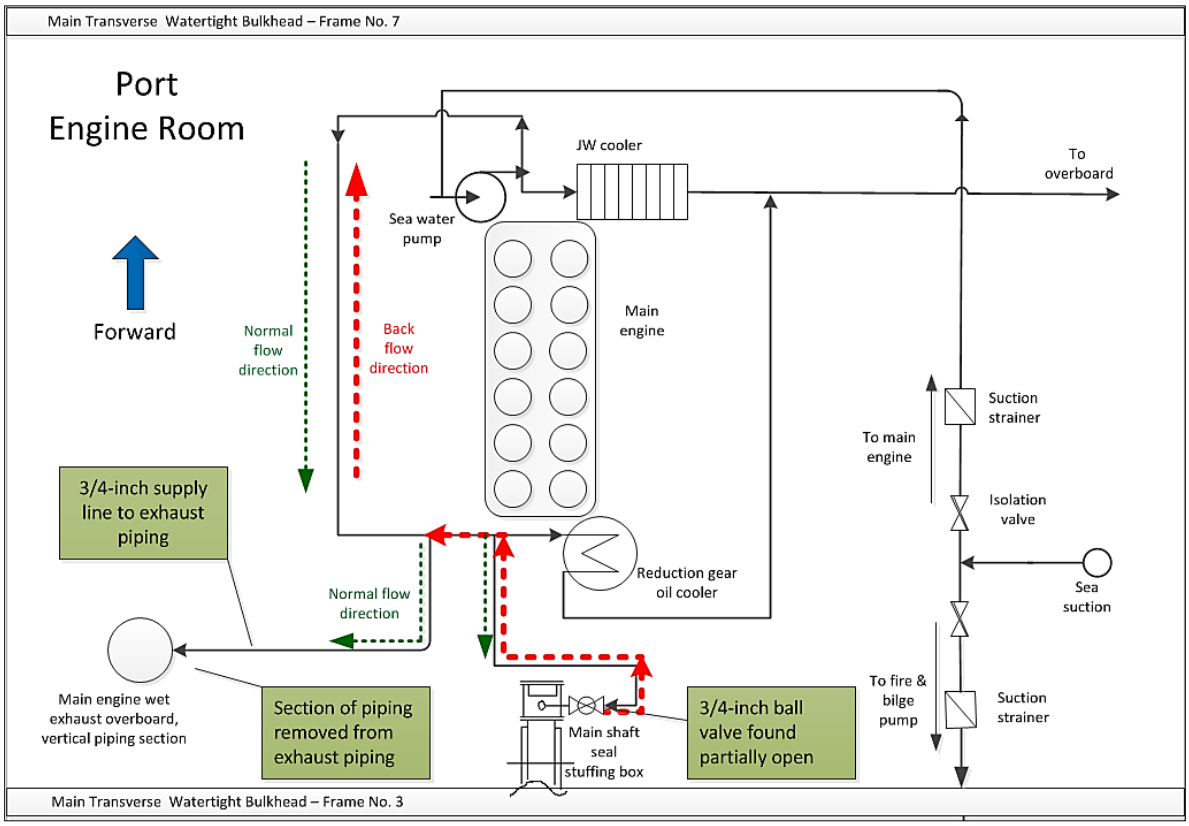
Small passenger vessel *Spirit of Adventure* partially sunk at its winter layup pier, Seward Boat Harbor, Alaska. (Photo by Seward City News)

According to the responding staff from the operator, a bilge high-level alarm was sounding in the wheelhouse when they arrived at the scene; the vessel was not equipped with a bilge alarm system that could be monitored from shore. About 1600, refloating of the vessel began using two inflatable salvage air bags inserted between the hulls. By about 2030, the vessel was at an even keel supported by the air bags. Water was found in the machinery spaces, which were then dewatered using portable pumps.

After the machinery spaces were dewatered, the responders checked the areas to determine the water's point of ingress. They found water flowing from the 3/4-inch-diameter sea water supply line to the port main engine exhaust system piping that had been disconnected along with the removal of the exhaust piping elbows. Additionally, the responders found the 3/4-inch-diameter ball valve at the shaft sealing water connection partially opened and assumed

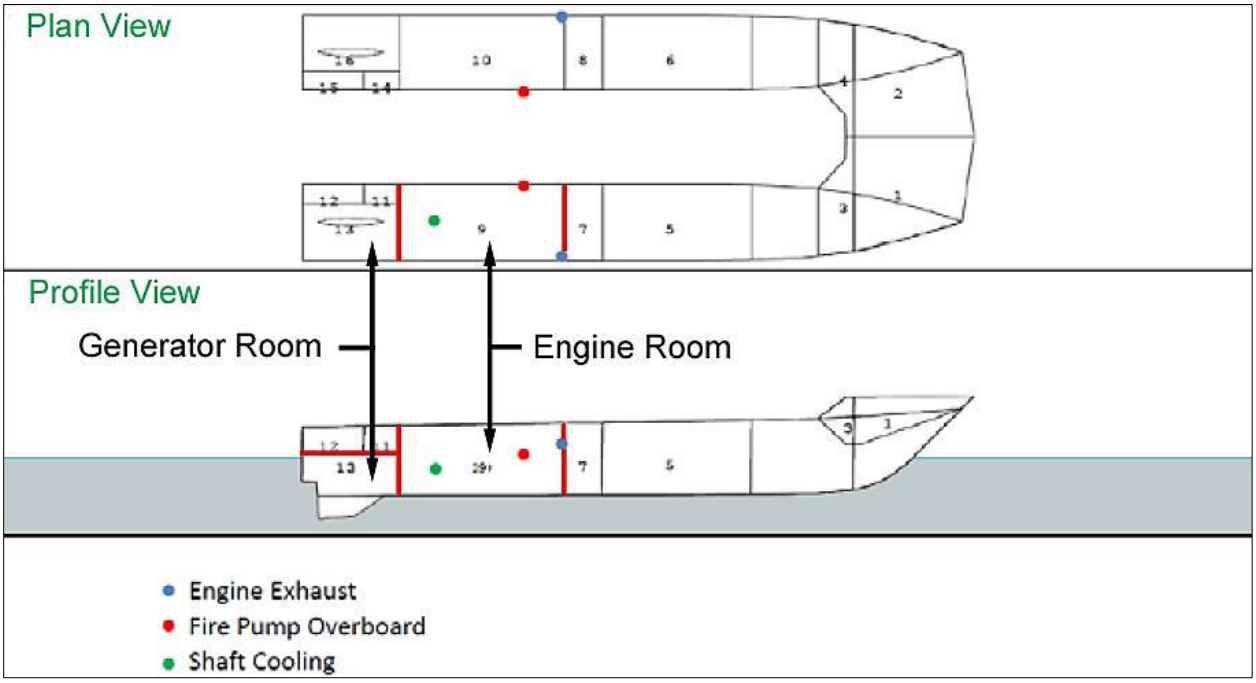
that this partial opening was the point of ingress of the water flowing from the sea water supply line.

The fire/bilge pump overboard discharge valves in the port and starboard generator spaces were also found open, which would have allowed sea water to enter through the discharge openings in the vessel's hulls. The discharge openings were above the waterline at normal draft but would have become submerged as the draft increased from flooding in the port engine room. The increased draft would have allowed sea water to backflow into the generator spaces through drain plugs in the fire/bilge pumps, which were opened during the winter layup process.



Simplified schematic diagram of the sea water system in the port engine room showing the location of the shaft seal ball valve found partially open and removed piping connection to the main diesel engine exhaust system elbow. The normal water flow direction is shown by green arrows, and the backflow direction is shown by red arrows.

According to the 1999 Coast Guard vessel stability letter for the *Spirit of Adventure*, calculations indicated that the vessel would remain afloat with any one major watertight compartment flooded (one compartment subdivision). After the accident, the Coast Guard performed a stability analysis to evaluate the flooding scenario indicated by the sea water system conditions found in the vessel after it was salvaged. The Coast Guard analysis indicated that, when 20 percent of the port engine room was flooded by the disconnected 3/4-inch-diameter cooling line to the main engine exhaust, the port fire/bilge pump discharge opening became submerged, and flooding of the port generator space occurred. Further flooding in these port-side spaces resulted in subsequent flooding of the starboard machinery spaces, beginning in the generator room and continuing through the side fire/ballast pump discharge opening. The analysis also indicated that the vessel would sink with the flooding scenario indicated by the conditions found after the vessel was salvaged.



Plan and profile views of the *Spirit of Adventure* showing the arrangement of machinery spaces and locations of downflooding points. (Drawing from Coast Guard stability analysis)

As a result of submergence in sea water for several hours, all mechanical and electrical equipment in both machinery spaces was damaged, including diesel generators, main engines, wiring, and electrical control equipment. About 3,200 gallons of diesel fuel was on board the vessel. Because the fuel tank fill connections and vents were above the waterline of the vessel, no pollution resulted from the accident. Because the estimated cost of repairs exceeded the insured value, the insurer declared the vessel a constructive total loss.

The operator of the accident vessel did not have a formal safety system that specified, among other things, the procedure to winterize each of the company's vessels at the end of the operating season. As a result of the absence of such a procedure or checklist, the mechanics performed the multistep winterization procedure based on verbal guidance from their supervisor, which made it more likely that errors could occur. Furthermore, the lack of a formal procedure approved by company management could lead to process errors that are not consistent with best marine practices. For example, this accident demonstrated that intentionally leaving sea water strainer covers open, drain plugs removed, and overboard discharge valves open could be hazardous to overall vessel safety.

In addition, the operator did not have a lock-out/tag-out policy, which is generally a component of a formal safety system for vessels. A lock-out/tag-out policy could be used to protect machinery spaces from flooding by preventing the inadvertent opening of sea valves. Such a policy might have prevented the inadvertent opening of the shaft seal cooling water ball valve, the likely initiating event that caused the vessel to partially sink.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the partial sinking of the *Spirit of Adventure* was the failure to ensure watertight integrity during the vessel's winter maintenance period, which resulted from the operator's lack of a formal safety system, including a lock-out/tag-out policy and a vessel winterization procedure.

Vessel Particulars

Vessel	*Spirit of Adventure*
Owner/operator	Owner: Four Seasons Marine Services Corp. Operator: Seward Wildlife Cruises LLC, doing business as Major Marine Tours
Port of registry	Glacier Bay, Alaska
Flag	United States
Type	Catamaran small passenger vessel
Year built	1985
Official number (US)	684714
IMO number	N/A
Construction	Aluminum
Length	85.80 ft (26.15 m)
Draft	7.25 ft (2.21 m)
Beam/width	31.50 ft (9.60 m)
Gross and/or ITC tonnage	99 gross tons; 264 ITC tons[1]
Engine power; manufacturer	Two 1,285-hp (958 kW) Detroit Diesel-MTU 16V2000 diesel engines
Passenger capacity	240
Persons on board	None

[1] Tonnage according to International Tonnage Convention

NTSB investigators worked closely with our counterparts from US Coast Guard Sector Anchorage throughout this investigation.

For more details about this accident, visit www.ntsb.gov and search for NTSB accident ID DCA15LM008.

Adopted: September 30, 2015

The NTSB has authority to investigate and establish the probable cause of any major marine casualty or any marine casualty involving both public and nonpublic vessels under Title 49 *United States Code*, 1131. This report is based on factual information either gathered by NTSB investigators or provided by the Coast Guard from its informal investigation of the accident.

The NTSB does not assign fault or blame for a marine casualty; rather, as specified by NTSB regulation, "[NTSB] investigations are fact-finding proceedings with no formal issues and no adverse parties . . . and are not conducted for the purpose of determining the rights or liabilities of any person." Title 49 *Code of Federal Regulations*, 831.4.

Assignment of fault or legal liability is not relevant to the NTSB's statutory mission to improve transportation safety by conducting investigations and issuing safety recommendations. In addition, statutory language prohibits the admission into evidence or use of any part of an NTSB report related to an accident in a civil action for damages resulting from a matter mentioned in the report. Title 49 *United States Code*, 1154(b).