

Sinking of Amphibious Passenger Vessel
Stretch Duck 7
Table Rock Lake, near Branson, Missouri
July 19, 2018



Marine Accident Report

NTSB/MAR-20/01
PB2020-101002



National
Transportation
Safety Board

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490 L'Enfant Plaza SW
Washington, DC 20594

National Transportation Safety Board. 2020. *Sinking of Amphibious Passenger Vessel Stretch Duck 7, Table Rock Lake, near Branson, Missouri, July 19, 2018. Marine Accident Report NTSB/MAR-20/01. Washington, DC.*

Abstract: About 1908 central daylight time on July 19, 2018, the *Stretch Duck 7*, a 33-foot-long, modified World War II-era DUKW amphibious passenger vessel that was operated by Ripley Entertainment Inc., dba Ride The Ducks Branson, sank during a storm with heavy winds that moved rapidly on Table Rock Lake near Branson, Missouri. Of the 31 persons aboard, 17 fatalities resulted. More than 7 hours prior to the accident, the National Weather Service had issued a severe thunderstorm watch for the area, followed by a severe thunderstorm warning a minute before the vessel departed the passenger boarding facility. As part of its accident investigation, the National Transportation Safety Board (NTSB) led a joint effort with the US Coast Guard, Ride The Ducks Branson, the Missouri State Highway Patrol, the National Weather Service (an office of the National Oceanic and Atmospheric Administration), and the Federal Aviation Administration. The NTSB's accident investigation identified the following safety issues: company oversight, engine compartment ventilation closures, reserve buoyancy, survivability, and Coast Guard oversight. The NTSB made safety recommendations to the US Coast Guard and Ripley Entertainment Inc., dba Ride The Ducks Branson.

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Acronyms and Abbreviations

APV	amphibious passenger vessel
CDL	commercial driver's license
<i>CFR</i>	<i>Code of Federal Regulations</i>
COI	certificate of inspection
CPR	cardiopulmonary resuscitation
DUKW	D=1942; U=utility; K=all-wheel drive; W=dual powered rear axles
DVR	digital video recorder
GPS	global positioning system
HDD	hard disk drive
hp	horsepower
mph	miles per hour
NTSB	National Transportation Safety Board
NVIC	Navigation and Vessel Inspection Circular
PA system	public address system
PFD	personal flotation device
SD	Secure Digital
VHF	very high frequency
WWII	World War II

Executive Summary

Accident Summary

About 1908 central daylight time on July 19, 2018, the *Stretch Duck 7*, a 33-foot-long, modified World War II-era DUKW amphibious passenger vessel that was operated by Ripley Entertainment Inc. dba Ride The Ducks Branson, sank during a storm with heavy winds that moved rapidly on Table Rock Lake near Branson, Missouri.¹ Of the 31 persons aboard, 17 fatalities resulted. Several hours prior to the accident, the National Weather Service had issued a severe thunderstorm watch for the area, followed by a severe thunderstorm warning a minute before the vessel departed the shoreside boarding facility—a roadside building about 6 miles away from the lake where the tours commenced and concluded. Due to the approaching weather, the manager-on-duty advised the captain and driver as passengers were boarding the vessel to complete the lake portion of the tour before the land tour (which normally occurred first). In addition, three other company vessels also began waterborne tours following the severe thunderstorm warning. About 5 minutes after the *Stretch Duck 7* entered the water, the leading edge of a storm front, later determined to be a “derecho,” passed through the area generating strong winds and waves reportedly 3–5 feet high, with the highest wind gust recorded at 73 miles per hour (mph).² The *Stretch Duck 54*, which entered the lake about 2 minutes before the *Stretch Duck 7* and was conducting a tour on the lake, was able to exit the water after experiencing the severe weather. During its effort to reach land, the *Stretch Duck 7* took on water and sank approximately 250 feet away from the exit ramp. Several first responders, along with the crewmembers and passengers aboard a paddlewheeler moored nearby, rescued and triaged 14 passengers, 7 of whom were transported to a local hospital. Loss of the vessel was estimated at \$184,000. Investigators retrieved and reviewed audio and video data from the vessel’s digital video recorder system, which provided first-hand observation of the circumstances leading up to the accident.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the sinking of the amphibious passenger vessel *Stretch Duck 7* was Ripley Entertainment Inc. dba Ride The Ducks Branson’s continued operation of waterborne tours after a severe thunderstorm warning was issued for Table Rock Lake, exposing the vessel to a derecho, which resulted in waves flooding through a non-weather-tight air intake hatch on the bow. Contributing to the sinking was the Coast Guard’s failure to require sufficient reserve buoyancy in amphibious vessels. Contributing to the loss of life was the Coast Guard’s ineffective action to address emergency egress on amphibious passenger vessels with fixed canopies, such as the *Stretch Duck 7*, which impeded passenger escape.

¹ A DUKW (pronounced “duck”) was an amphibious landing craft used to transport military personnel and cargo. The acronym signifies the characteristics of the vessel: D=1942 (the year of design), U=utility, K=all-wheel drive, and W=dual powered rear axles. The *Stretch Duck 7* was originally built in 1944.

² Pronounced “deh-REY-cho,” this widespread, long-lasting windstorm is associated with a continuous band of rapidly moving showers or intense thunderstorms and is characterized by a rapid increase of damaging, strong winds.

Safety Issues

The safety issues identified in this accident, some of which have been identified in previous accidents involving amphibious passenger vessels, include the following:

- **Company Oversight.** On the day of the accident, the National Weather Service issued a severe thunderstorm watch at 1120 effective until 2100. Later, at 1832, a warning advising of 60-mph wind gusts effective until 1930 was issued. Around this time, the manager-on-duty for Ride The Ducks Branson instructed the captain and the driver of the *Stretch Duck 7* to complete the lake portion of the tour first before the usual land tour. Three other company vessels also began their waterborne tours after the warning, entering the lake a few minutes apart from 1845 to 1854; the *Stretch Duck 7* was the last to enter the water at 1855. Company policy restricted water entry when “severe weather” was approaching but lacked a go/no-go policy providing specific guidance when to suspend operations in a timely manner before the arrival of a storm.
- **Engine Compartment Ventilation Closures.** The air intake hatch, which was designed to allow ventilation and combustion air into the engine space, was located on the most forward point of the bow on the *Stretch Duck 7*. The hatch was equipped with a spring-loaded damper that was closed as the vessel encountered severe weather but could not be secured against opening, because it was held closed in the upward position only by spring force. As the bow dipped beneath successive waves, a substantial amount of water likely entered the vessel through the nearly 3-square-foot opening.
- **Reserve Buoyancy.** The *Stretch Duck 7* did not have any compartmentalization or subdivision that would have contained the floodwater entering the engine compartment.³ The accident vessel and other DUKW amphibious passenger vessels were originally constructed with a low freeboard, an open hull, and no subdivision or flotation, resulting in a design without adequate reserve buoyancy.⁴ The NTSB has been concerned with the lack of sufficient reserve buoyancy of these vessels since the 1999 sinking of the *Miss Majestic*, another DUKW vessel that also had no subdivision or flotation. The NTSB issued a safety recommendation in 2002 to the Coast Guard to address this issue, but the recommendation was classified “Closed—Unacceptable Action” the following year. In November 2019, the NTSB issued a similar recommendation to the Coast Guard that required original and stretch DUKWs to have sufficient reserve buoyancy through passive means to improve survivability. (M-19-15)
- **Survivability.** The passenger compartment was enclosed by a fixed canopy with associated framing and side curtains, which can create an impediment to passenger egress during an abandonment of a vessel. Just before the vessel sank, the captain released the portside curtain on the *Stretch Duck 7*. With the starboard-side curtain closed and the vessel’s canopy, passengers were limited in their escape from the sinking vessel. These impediments, as well as procedures that call for donning lifejackets within an enclosed

³ *Subdivision* is the concept of dividing a vessel’s hull into watertight compartments using transverse watertight bulkheads so that, in the event of damage, flooding is restricted to the damaged compartments and the vessel will be less likely to sink.

⁴ (a) *Freeboard* is the distance between the deck edge and the waterline. (b) *Reserve buoyancy* is the internal volume of a vessel that is not flooded or capable of being flooded.

space (under a canopy), have been concerns in previous accidents and the subject of previous recommendations involving amphibious vessels.

- **Coast Guard Oversight.** The material covering basic weather and meteorology through Ride The Ducks' in-house training for new captains obtaining a 25-ton license was more than the Coast Guard-mandated training for 100-ton captains on rivers routes. Coast Guard-credentialed masters who operate small passenger vessels could benefit from a better understanding of weather service products that include severe thunderstorm watches and warnings. In addition, the Coast Guard's guidance that was developed in 2000 after the *Miss Majestic* sinking does not effectively address the issues and circumstances found in the *Stretch Duck 7* sinking, including operations during approaching severe weather and emergency egress during rapid sinking.

Findings

1. The *Stretch Duck 7*'s propulsion, steering, and bilge systems operated normally and thus were not factors in this accident.
2. Neither alcohol nor other impairing drugs were factors in this accident.
3. On the day of the accident, the National Weather Service accurately forecasted and issued timely notifications of a severe thunderstorm that would impact the accident location.
4. Ride The Ducks did not effectively use all available weather information to monitor the approaching severe weather and assess the risk it posed to its waterborne operations.
5. Ride The Ducks should have suspended waterborne operations for the *Stretch Duck 7* and the other last tours of the day in anticipation of imminent severe weather.
6. Ride The Ducks should have had specific guidance for the operations team to determine when to suspend waterborne operations due to approaching severe weather (go/no-go policy).
7. It is likely that the captain believed he could safely complete the waterborne portion of the tour before the thunderstorm arrived.
8. The captain's decision to head toward the exit ramp when encountering the severe weather was appropriate.
9. Initial water ingress to the *Stretch Duck 7* was likely from waves rolling over the air intake hatch's spring-loaded damper and intermittently opening it, thereby allowing water into the engine compartment.
10. The rapid sinking of the *Stretch Duck 7* resulted from uncontrolled progressive flooding due to a lack of subdivision.
11. Had the Coast Guard implemented Safety Recommendation M-02-1 to require sufficient reserve buoyancy through passive means, the *Stretch Duck 7* likely would not have sunk.
12. The *Stretch Duck 54* was able to exit the lake while exposed to the same conditions as the *Stretch Duck 7* due to the increased freeboard, greater reserve buoyancy, and a securable bow hatch that prevented the ingress of water.
13. When the vessel sank, the closed starboard-side curtain aboard the *Stretch Duck 7* impeded egress and likely resulted in additional fatalities.

14. Donning lifejackets on the *Stretch Duck 7* while fitted with an overhead canopy would have created an impediment to escape, would have increased the risk of persons being entrapped, and could have resulted in additional fatalities.
15. The actions of the crew and passengers aboard the *Showboat Branson Belle* prevented more fatalities.
16. The response by emergency services was timely and effective.
17. Improved training is needed for small passenger vessel operators on rivers routes to recognize and better understand weather conditions.
18. Coast Guard Navigation and Vessel Inspection Circular 1-01 (*Inspection of Amphibious Passenger Carrying Vehicles*) did not effectively address the National Transportation Safety Board's 2002 recommendation (M-02-2) to require the removal of, or Coast Guard's approval of, fixed canopies and likely increased the number of fatalities consequently.
19. Coast Guard Navigation and Vessel Inspection Circular 1-01 (*Inspection of Amphibious Passenger Carrying Vehicles*) does not account for circumstances found in the *Stretch Duck 7* accident, including operations during approaching severe weather and emergency egress during rapid sinking, and should be updated to provide guidance accordingly.

Recommendations

New Recommendations

As a result of its investigation of this accident, the National Transportation Safety Board makes the following six new safety recommendations:

To the US Coast Guard

Require that amphibious passenger vessels equipped with forward hatches enable operators to securely close them during waterborne operations to prevent water ingress. (M-20-1)

Review the circumstances of the *Stretch Duck 7* sinking and other amphibious passenger vessel accidents, and revise Navigation and Vessel Inspection Circular (NVIC) 1-01 to address the issues found in these accidents, including operations during imminent severe weather and emergency egress during rapid sinking. (M-20-2)

Examine existing training and knowledge requirements for understanding and applying fundamental weather principles to waterborne operations for Coast Guard-credentialed masters who operate small passenger vessels; and, if warranted, require additional training requirements for these ratings on recognition of critical weather situations in pre-departure planning and while under way. (M-20-3)

To Ripley Entertainment Inc., dba Ride The Ducks Branson

Using the operating restrictions found in vessel certificates of inspection, review and revise your current operating policy to provide specific guidance on vessel operations when adverse conditions could be encountered during any part of the waterborne tour by implementing a go/no-go policy. (M-20-4)

Modify spring-loaded forward hatches of modified DUKW amphibious passenger vessels to enable their closure during waterborne operations as a prevention for water ingress. (M-20-5)

Re-evaluate emergency procedures regarding the donning of lifejackets aboard modified DUKW amphibious passenger vessels when equipped with fixed canopies. (M-20-6)

Previously Issued Recommendations

As a result of its investigation of this accident, the National Transportation Safety Board issued the following two safety recommendations, which currently are classified as “Open—Initial Response Received”:

To the US Coast Guard

Require DUKW amphibious passenger vessels (commonly referred to as original and/or “stretch” DUKWs) to have sufficient reserve buoyancy through passive means, so that they remain upright and afloat with a full complement of passengers and crewmembers in the event of damage or flooding. (M-19-15)

For DUKW amphibious passenger vessels without sufficient reserve buoyancy (commonly referred to as original and/or “stretch” DUKWs), require the removal of canopies, side curtains, and their associated framing during waterborne operations to improve emergency egress in the event of sinking. (M-19-16)

1 Factual Information



Figure 1. *Stretch Duck 7* after being recovered from Table Rock Lake following the sinking.

1.1 Events Preceding Accident

On the morning of July 19, 2018, the *Stretch Duck 7*, an original DUKW used during World War II (WWII) that was later modified into a commercial amphibious passenger vessel ([figure 1](#)), was being prepared for the day's series of excursion tours.⁵ Owned and operated by Ripley Entertainment Inc. dba Ride The Ducks Branson (hereafter referred to as Ride The Ducks), the vessel was parked at the company's boarding facility in Branson, Missouri, known as the "duck dock." The captain and driver, who were commonly assigned to this vessel, had completed the pre-trip inspection together in preparation of the tours; no deficiencies were noted.

Between 1000 and 1600, the captain and driver made four trips with the *Stretch Duck 7*, each with passenger loads ranging from 22 to 32 persons.⁶ The vessel was operated by the captain while

⁵ A DUKW (pronounced "duck") was an amphibious landing craft used to transport military personnel and cargo. The acronym signifies the characteristics of the vessel: D=1942 (the year of design), U=utility, K=all-wheel drive, and W=dual powered rear axles. The *Stretch Duck 7* was originally built in 1944.

⁶ In this report, all times are central daylight times (CDT), based on a 24-hour clock, and all miles are statute miles.

on the water and by the driver while on the roadway.⁷ The trips followed the typical route of touring the land nearby first and subsequently Table Rock Lake for the waterborne portion.

Several other Ride The Ducks vessels operated throughout the day. At 1730, the *Stretch Duck 26* left the duck dock facility with 30 passengers. The *Stretch Duck 27* and the *Stretch Duck 17* followed later, at 1800, with 34 and 26 passengers, respectively. The captain/driver of the *Stretch Duck 27*, who was accompanying a captain-trainee, was Ride The Ducks' general manager.

Around 1844, the captain of the *Stretch Duck 26* stopped its tour at the ramp just before entering the lake, because he was unable to engage the propeller shaft. The crew and passengers waited there for a replacement, which was the *Stretch Duck 54*. Meanwhile, the *Stretch Duck 27* and *Stretch Duck 17* started their water tours ahead of them.

The storm system that impacted Table Rock Lake that evening began to develop before noon in north central and northeast Kansas, approximately 400 miles northwest. The National Weather Service Storm Prediction Center had issued a severe thunderstorm watch at 1120 for western and central Missouri, including Table Rock Lake. The watch was valid until 2100 that evening and identified the potential for damaging high winds up to 75 miles per hour (mph). The forecast also warned, "Scattered large hail likely with isolated very large hail events to 2.5 inches in diameter possible. A tornado or two possible."

Anticipating the weather, the crewmembers of the *Showboat Branson Belle*, a three-deck paddlewheeler moored on Table Rock Lake near where Ride The Ducks' vessels operated, doubled the vessel's mooring lines after their last voyage at 1600. At 1850, passengers began boarding for the showboat's final cruise. However, the cruise scheduled for 2000 was cancelled later due to high winds.

1.2 Accident Narrative

Boarding the *Stretch Duck 7*. Shortly after 1800 on July 19, the *Stretch Duck 7* had returned to the duck dock—a roadside building about 6 miles away from the lake where the tours commenced and concluded—awaiting to embark on its fifth and final trip of the day. Video from the vessel's digital video recorder (DVR) revealed that at 1827, the operations supervisor, who was the manager-on-duty that afternoon, stepped onto the vessel and instructed the captain and driver to "go to the water first."⁸ Normally, the approximately 90-minute tour began with the land-based transit from the duck dock, via Highway 76 across Table Rock Dam, to Baird Mountain ([figure 2](#)); followed by the waterborne portion on Table Rock Lake, which averaged 15–20 minutes; and ended back at the facility.

At 1828, as passengers began boarding, the captain mentioned a storm approaching, which he said he observed while watching the weather radar earlier.⁹ "We noticed there was some weather

⁷ As required by law, the driver held a state commercial driver's license (CDL), and the captain held a Coast Guard-issued merchant mariner's credential.

⁸ The DVR system on the *Stretch Duck 7* was equipped with inward- and outward-facing video cameras that provided multiple views: interior, forward, aft, portside, and starboard side.

⁹ The captain did not specify the weather observation system he was using to follow weather developments.

coming in,” the captain later stated in a postaccident interview.¹⁰ “Didn’t look like it was severe.” A total of 29 passengers boarded. Four minutes later, the manager-on-duty closed the hatch near the rear of the *Stretch Duck 7* and then confirmed the passenger count.

At 1832, the National Weather Service issued a severe thunderstorm warning for an area that included Table Rock Lake. The warning, which lasted until 1930, forecasted 60-mph wind gusts.



Figure 2. Red line indicates the route the *Stretch Duck 7* followed directly to Table Rock Lake, where the vessel sank (red triangle). Brown line identifies the portion of the land tour that was skipped on the day of the accident. (Source: Google Maps)

¹⁰ NTSB investigators were unable to interview the captain but were provided information from an interview by the Missouri State Highway Patrol following the accident. With the agency’s investigation of this accident having been conducted in parallel with the US Attorney’s criminal investigation, access was limited to key personnel of Ride The Ducks working at the time of the accident, including the captain of the *Stretch Duck 7*, manager-on-duty, general manager (who was also captain of the *Stretch Duck 54*), operations supervisor, and operations manager.

While on scene, investigators interviewed crewmembers from other Ride The Ducks’ vessels and the *Showboat Branson Belle*, and first responders from the Branson area. NTSB and state police investigators together interviewed almost a dozen passengers from the *Stretch Duck 7*.

Before departing the duck dock, the captain began providing a safety briefing for the land-based transit that covered seatbelt usage, smoking restrictions, egress, and other safety topics. At 1833, the driver departed the facility and proceeded along the route, while the captain narrated the tour during the 16-minute drive to Table Rock Lake.

At 1850, the *Stretch Duck 7* pulled off the main road and onto the road leading to the entry ramp for the lake used by Ride The Ducks' vessels. While approaching the ramp, the captain gave a safety briefing for the waterborne portion of the tour, covering fire extinguishers, locations of the life rings and lifejackets, and emergency exits through the port- and starboard-side openings outboard of the passenger area. The captain then donned a personal flotation device (PFD) to demonstrate how to properly put on and adjust a lifejacket.¹¹

At 1852, the driver stopped the *Stretch Duck 7* at the top of the ramp, and the captain changed the radio's frequency to very high frequency (VHF) marine channel 13. The two operators changed seats, with the captain taking the driver's seat and the driver sitting directly behind him in the first row of passenger seats on the port side. [Figure 7](#) provides a seating diagram of the captain, driver, and passengers on board.

The *Stretch Duck 54*, which had arrived at the entry ramp to replace the *Stretch Duck 26*, entered the lake at 18:53:50, about 2 minutes before the *Stretch Duck 7* entered the water.

At 1853, while moving down the boat ramp, the captain of the *Stretch Duck 7* broadcast via VHF radio a message to any concerned traffic on the water; no response was heard.¹² He then warned passengers to brace themselves for the forward surge upon contact with the water, before continuing down the ramp while increasing the *Stretch Duck 7*'s speed.

Entering the Water. At 1855, the *Stretch Duck 7* entered Table Rock Lake in calm water ([figure 3](#)). The captain described the lake as "calm" with "light winds" in a postaccident interview. During his interview after the accident, the captain of the *Stretch Duck 54* described the condition of the lake at that time as "a little pond. I mean, glass. It was just crystal clear. The water was perfect." The driver of the *Stretch Duck 54*, likewise, recalled the water appearing as "calm" and "glassy," adding, "I remember looking back after we put in [entered the water] and you could actually see the reflection of the trees in the water. I had never seen this lake that calm before." Video from the *Stretch Duck 7*'s starboard-facing camera showed darkened clouds northwest of the vessel. After the *Stretch Duck 7* entered the water, the captain set the hand throttle speed, turned off the windshield wipers, and lowered the front windshield.

A minute after entering the lake, at 1856, while the vessel headed straight out from the entry ramp, the captain allowed young passengers to take turns steering the vessel, which was a regular feature of the tour, as he stood by closely monitoring. Over the next 4 minutes, a series of four children sat in the driver's seat while the captain, who had moved into the jump seat on the starboard side of the captain's station, engaged them as well as continued his tour narration to the other passengers over the public address (PA) system. Relatives accompanied the young passengers to the front and took

¹¹ PFD and the more common term *lifejacket* are used interchangeably in this report.

¹² The captain of the *Stretch Duck 7* made a *sécurité* call, although he did not use the term. A *sécurité* call is a VHF radio transmission of important safety-related information for vessels in the broadcast area. The vessel or station transmitting the message begins by saying "Sécurité, Sécurité, Sécurité" and follows with the specific safety information.

videos and photographs. As the wind increased after the third young passenger began driving, the captain closed the front windshield. The driver remained seated behind the captain's seat.

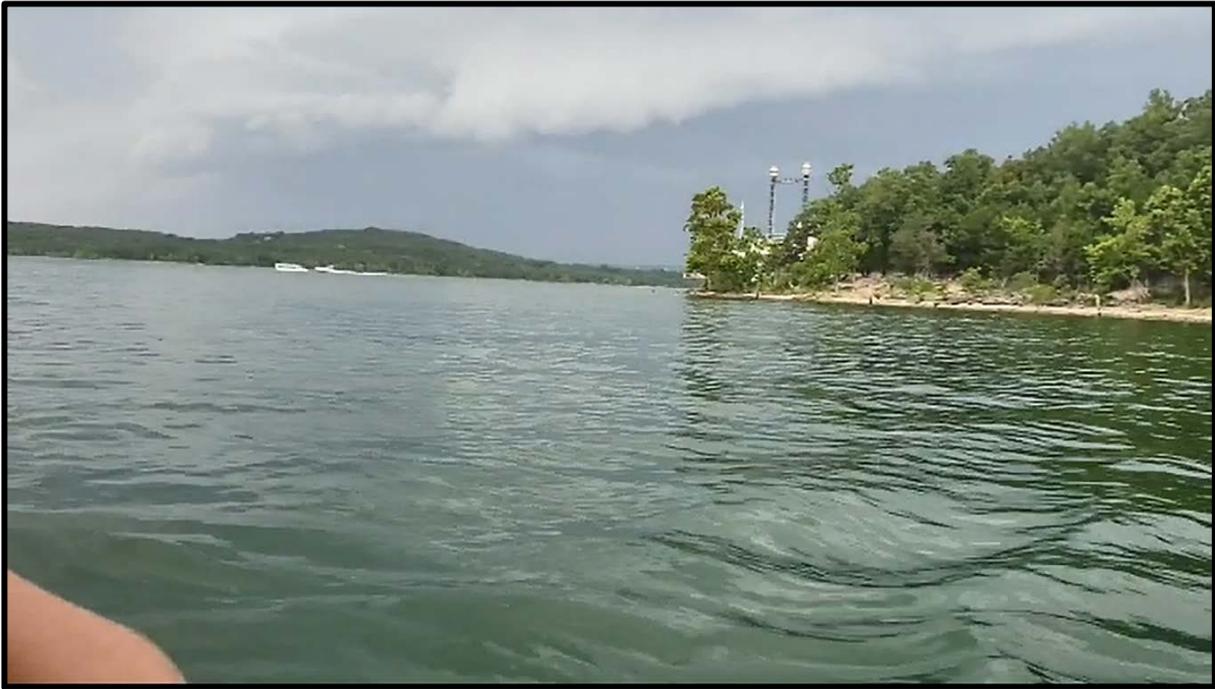


Figure 3. About 1856, screenshot from video taken by a passenger aboard the *Stretch Duck 7* shows calm water shortly after the vessel entered the lake.

At 1859, when the *Stretch Duck 7* was about 600 feet away from a small island known locally as “Duck Island” (about 1,000 feet due west of the entry ramp), the captain turned north, altering from the usual course around the island. As [figure 4](#) shows, he took a more direct route toward the exit ramp, leaving on its port side the *Stretch Duck 54*, which was farther from shore. The captain of the *Stretch Duck 7* later stated that he felt he was “far enough around” to be closer to the exit than the entry ramp. Video from the camera mounted on the *Stretch Duck 7*'s bow showed that low-level darkened clouds were visible ahead. “Yeah, we’re gonna try and beat this weather off the water as fast as we can here,” the captain told the passengers. He then spoke about lightning as he assured them that it would not adversely affect the vessel’s steel frame. No other observations of lightning were made from persons aboard the *Stretch Duck 7*.

About 10 minutes earlier (at 18:50:06), a passenger on board the *Stretch Duck 27*, one of the other two vessels on the lake that were nearing the end of their tour (after taking the normal route around the island), had mentioned seeing lightning. The captain, who was also Ride The Ducks’ general manager, responded, “Oh, gosh, there are three things that will take us off the water. One is lightning, so we’re heading out. Two is also the waves, if they get two feet high or higher. And three is the wind, if it gets thirty-five miles an hour or more.”

The *Stretch Duck 27* and the *Stretch Duck 17* exited the water at 19:00:10 and 19:00:36, respectively. While exiting the lake, the captain of the *Stretch Duck 27* observed a “dark cloud over to the west-northwest.” Neither the captain on the *Stretch Duck 27* or the *Stretch Duck 17* called the duck dock facility nor the other duck boats on the lake regarding the storm.



Figure 4. Vessel voyages on Table Rock Lake the evening of the accident. Red line represents the calculated trackline of the *Stretch Duck 7*, and yellow line represents the actual trackline of the *Stretch Duck 54* based on GPS data.¹³

¹³ Tracklines were created by the NTSB in a video study report (see [section 1.12.6](#)). This report and other additional information about the *Stretch Duck 7* accident investigation are available in the public docket by accessing the [Docket Management System](#) at www.nts.gov with the identification number DCA18MM028.

Once they arrived on land, the crews on both vessels closed (lowered) their side curtains. As the captain of the *Stretch Duck 17* began driving back to the duck dock, he pulled off the road instead of crossing Table Rock Dam due to the high winds.

Encountering Severe Weather.

Increased winds began impacting the area at 1900. At 19:00:15, within a span of 15 seconds, the water surface changed rapidly, from a calm state to waves with whitecaps ([figure 5](#)).

In video from the *Stretch Duck 7* recorded at 19:00:27, a sound similar to a gust of wind can be heard. Soon afterward, the captain told the fourth young passenger participating in the driving activity that he would take over the steering due to the wind. The young passenger and his relative returned to their seats.

At 19:00:41, the plastic window at the captain's station began blowing in the wind. After the driver stood up to close the captain's portside window, the captain resumed operating the vessel. Six seconds later, using an electric switch on the dashboard, the captain closed both port- and starboard-side curtains outboard of the passenger area.

The captain on the *Stretch Duck 54* closed the curtains on his vessel about the same time as the captain of the *Stretch Duck 7*. At 19:00:56, while south of the *Stretch Duck 7*, the captain of the *Stretch Duck 54* informed the passengers of his plan to cut short the tour. He changed course and proceeded toward the exit ramp without going around Duck Island.

At 19:01:26, the driver of the *Stretch Duck 7*, who is seen on video standing up from the seat behind the captain, zipped closed the portside plastic window by the captain's station, right before spray began forming off the whitecaps on the water's surface. Darkened clouds that were previously visible in the distance now envelope all camera views. The driver then returned to the seat behind the captain and began talking with passengers nearby.

At 19:01:56, video on board the *Stretch Duck 54* shows the driver coming from the back of the vessel. As he assisted the captain in closing the plastic window on the port side of the captain's station, the wind blew the hat from his head. Oncoming waves began splashing onto some passengers and submerging the vessel's forward-facing camera mounted on the bow. The driver of the *Stretch*



Figure 5. About 1900, screenshot from passenger video shows whitecaps building on the lake seconds before the starboard-side curtain (top left) was closed on the *Stretch Duck 7*. In the background is the moored passenger vessel *Showboat Branson Belle*.

Duck 54 remained at the captain's station wiping the console with a rag and bracing the top of the windshield closed.

At 19:02:09, the captain of the *Stretch Duck 7* closed the hood on the bow engine compartment using a lever by the steering wheel. Around this time, the sound of the engine revving under load can be heard.

Flooding and Sinking. At 19:02:28, the *Stretch Duck 7* was approaching the stern of the paddlewheeler *Showboat Branson Belle*, which was moored on the lake near the exit ramp. A minute later, as the *Stretch Duck 7*'s pitching motion increased, the captain attempted to call the duck dock facility; no response was heard on the vessel's DVR recordings.

At 19:04:22, a bilge alarm sounded on the *Stretch Duck 7*. Eleven seconds later (at 19:04:33), a bilge alarm sounded on the *Stretch Duck 54* as the two vessels proceeded toward the exit ramp, according to video recordings.¹⁴

At 19:04:40, the *Stretch Duck 7* appeared to be pitching and rolling more than previously seen on the video recording. Seventeen seconds later, onboard video captured the midship bilge pump on the port side discharging water that was accumulating in the bilges.

By 19:05:00, the *Stretch Duck 54*, traveling about 4 mph, had overtaken the *Stretch Duck 7*, which was farther into the lake and traveling at a speed of 1.7 mph (figure 6). Seventeen seconds later, the captain of the *Stretch Duck 7* attempted a second time to contact the duck dock. Again, no response was heard.

Just after 1905, the distance between the two vessels continued to widen, with the *Stretch Duck 54* having traveled the full length of the 196-foot-long *Showboat Branson Belle* in about a minute, compared to the *Stretch Duck 7* traveling about half that speed.



Figure 6. At 19:05:03, screenshot from video taken by a passenger inside the *Showboat Branson Belle* captures the *Stretch Duck 54* passing the *Stretch Duck 7* as they attempt to reach the exit ramp. Furnishing from the showboat's dining area is reflected in the glass. (Source: Jenny Carr)

¹⁴ The alarm lights on the dashboards indicating which alarms were active are not visible in the videos.

About this time, the moored *Showboat Branson Belle* had stopped boarding passengers (which began at 1850) for its scheduled 2000 cruise, which was ultimately cancelled. The captain of the showboat stated that the winds had increased from 5–6 mph to over 50 mph in about 90 seconds. The strong wind and swell directly on the stern caused the showboat to surge and pin the gangway in place. To free the gangway, ease the tension on the mooring lines, and safely disconnect the utility shore cables and hoses, the crewmembers started the twin paddle wheels, which were used for propulsion, in the astern direction. They also operated the fore and aft tunnel thrusters at 50- to 75-percent power to keep the vessel in position alongside the dock by thrusting toward the shore.

As the *Stretch Duck 54* reached the stern of the *Showboat Branson Belle*, the captain of the *Stretch Duck 54* made radio contact with the crewmembers on the bridge of the showboat. He was told they were not getting under way but were running propulsion to maintain their position in the storm-force winds. At 19:07:05, the *Stretch Duck 54* passed astern of the showboat and exited the water.

At 19:07:24, the *Stretch Duck 7* had yet to pass the *Showboat Branson Belle*. The captain turned the *Stretch Duck 7* to starboard toward the exit ramp, around the stern of the showboat, which positioned the wind on the port bow of the vessel. A few seconds earlier, passengers on the video recording could be heard commenting about getting wet by the incoming water.

The *Stretch Duck 7* was listing to starboard while taking on water, most survivors indicated. One passenger described the water level rising from her feet to knees in seconds. She stated that after the vessel “took a sharp right turn and the right side of the boat went down...water came exactly with me as I stood up to get a last breath of air.” Several passenger accounts believed the source of the water ingress was the bottom of the side curtain, while others thought it was the stern.

At 19:08:18, just before the video ended, the captain of the *Stretch Duck 7* is heard ordering passengers to move to the port side of the vessel. The starboard side of the stern was the first part of the vessel that dipped below the water’s surface on a witness video. Seconds later, the *Stretch Duck 7* sank rapidly by the stern approximately 250 feet away from the exit ramp, just north of the *Showboat Branson Belle*’s stern. At some point before the vessel sank, the captain released the portside curtain and was immediately pushed out of the vessel by the water through the opened windshield.¹⁵ He did not release the starboard-side curtain.

Realizing the occupants of the *Stretch Duck 7* were in peril, the showboat’s crew immediately stopped the paddle wheels. One showboat crewmember described the sinking to investigators: “It took maybe ten seconds until it was under...As soon as it flooded on that starboard side just a little bit, it [the water] all went to the stern and then...it [the *Stretch Duck 7*] went down with the bow out of the water. It wasn’t at...a big angle.”

About 1910, a wind gust near the accident site was logged at 73 mph, according to the anemometer aboard the *Showboat Branson Belle*. Light rain likely began around this time, with heavier rain occurring 3–5 minutes later.

¹⁵ When opened, the glass windshield folded forward and laid on top of the bow.

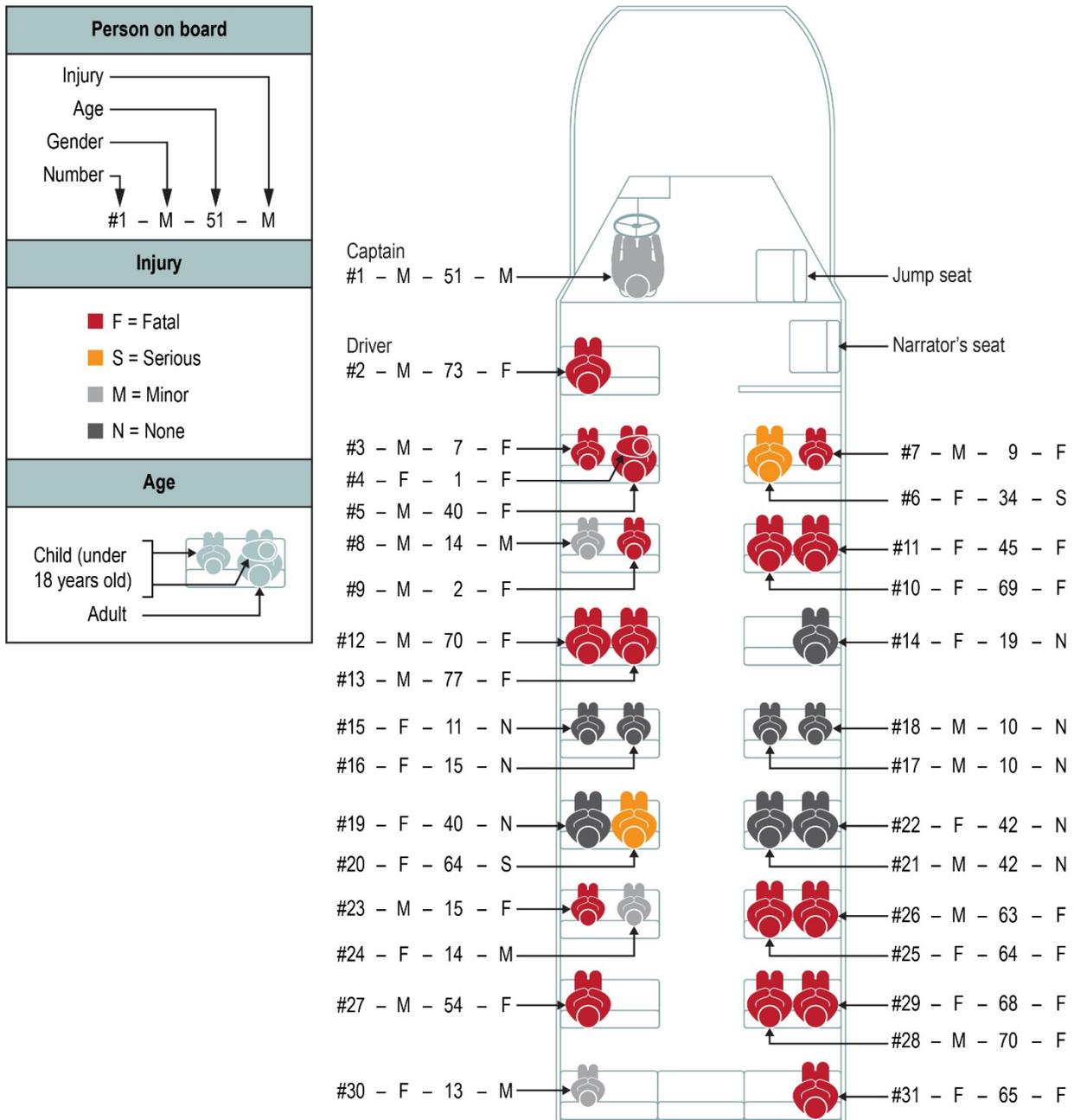


Figure 7. Stretch Duck 7 seating diagram on the evening of the accident.

1.3 Search and Rescue

The *Stretch Duck 7* sank just north and astern of the *Showboat Branson Belle* on the east shore of Table Rock Lake in Stone County, Missouri. The *Showboat Branson Belle* was moored to a floating wharf that connected to the shore by a floating walkway. On each side of the walkway, two horizontal supports held the floating wharf in place.¹⁶ At the time of the accident, a small tugboat

¹⁶ The showboat’s personnel referred to the steel, horizontal supports as “stiff arms.”

was moored alongside the horizontal support north of the walkway. (The floating wharf and steel supports are visible in the satellite image of [figure 4](#).)

After the vessel sank, several occupants of the *Stretch Duck 7* surfaced astern of the *Showboat Branson Belle* and either drifted into the northernmost horizontal support, or downwind along the outboard side of the showboat, or south into the paddle wheels (which had already been stopped) on the stern. In storm-force winds and heavy rain, the crew and passengers of the *Showboat Branson Belle* lifted victims from the water while standing on the horizontal support and in the nearby moored tugboat, which had a low freeboard.¹⁷ Some survivors climbed onto the paddle wheels themselves or received assistance to climb onto it. The crew attempted to launch the showboat's rescue boat, but when lowered into the water, it was immediately swamped by large waves over the transom.¹⁸

At least two *Showboat Branson Belle* crewmembers, one passenger, and a deputy sheriff (who was aboard the showboat) entered the water with PFDs to assist survivors and recover victims. During the rescue, the two crewmembers were swept out into the lake with the passenger. All three, along with another passenger, were recovered by a Good Samaritan boat, which was among the first waterborne resources to arrive on scene. At least four passengers of the *Stretch Duck 7* received cardiopulmonary resuscitation (CPR) after being recovered from the water. On board the showboat, crewmembers assisted survivors with first aid and dry clothing.

The first call to 911, made by a *Showboat Branson Belle* crewmember, was received by the Stone County emergency call center at 19:08:32. At 19:25, the fire marshal of the Southern Stone County Fire Protection District was the first responder on scene, with its fire boat following shortly afterward, and established an incident command post.¹⁹ Other emergency service agencies to follow included neighboring Western Taney County Fire District, Taney County Ambulance District, Mercy Emergency Medical Services, Missouri State Highway Patrol, and Branson Fire Department. First responders from a Taney County ambulance started triage.

Only 14 of the 31 persons on board the *Stretch Duck 7* survived the sinking. Seven of the 14 survivors were transported by ambulance to Cox Medical Center. The remaining seven survivors were transported by bus to a family assistance center in Branson.

Of the 17 deceased, eight were recovered from the surface of the water: four had drifted south and outboard of the *Showboat Branson Belle*, while the other four were recovered at the showboat's stern. The remaining nine victims were recovered underwater. Several hours after the accident, about 2200, a dive team recovered three from the lakebed. The following morning, another dive team recovered the remaining six victims: three from a depth of 44 feet; two from 85 feet of water near

¹⁷ *Freeboard* is the distance between the deck edge and the waterline.

¹⁸ The *Showboat Branson Belle* was equipped with a 12-foot-long, 15-horsepower (hp) rescue boat that accommodated four persons. Rescue boats are typically rigged to be launched with the vessel under way and with their bows into the sea. (The wind and seas at the time of the accident were on the paddlewheeler's stern.) When the weather later subsided, the crew was able to launch the rescue boat; search for survivors; and retrieve personal belongings, lifejackets, and other floating items.

¹⁹ The incident command system is a standardized approach to the command, control, and coordination of emergency response by providing a common hierarchy within which responders from multiple agencies can be effective.

the *Stretch Duck 7*, where it came to rest after rolling downhill; and one victim inside the vessel. All the *Stretch Duck 7* occupants were accounted for by 1033 the next day.

1.4 Injuries

Twenty-three of the 31 persons on board the *Stretch Duck 7* sustained some level of injury in the sinking. (The types of injury are enumerated in the table below and identified according to each passenger in [figure 7](#).) The eight passengers who reported no physical injuries were all under the age of 42. Individuals who either had no injury or had minor injuries swam to the area behind the *Showboat Branson Belle* from where they exited the water. Of the seven persons who were transported to a nearby hospital, two were deemed serious; four were minor, which included the captain; and one had no injury.²⁰ As a result of the accident, there were 17 fatal injuries: 16 passengers and the driver. The coroner determined that drowning was the cause of death for all the deceased.

Table 1. Injuries sustained in the *Stretch Duck 7* accident.

Type of Injury	Crew	Passengers	Total
<i>Fatal</i>	1	16	17
<i>Serious</i>	0	2	2
<i>Minor</i>	1	3	4
<i>None</i>	0	8	8

1.5 Damage

On July 23, 4 days after the accident, the *Stretch Duck 7* was recovered from Table Rock Lake by a crane barge. It was found in an upright position on the bottom of the lake at a depth of 85 feet. The condition of the vessel was documented immediately after it was removed from the water and transported to a secure facility.

Investigators found the canopy was torn along the center support beam for most of the length of the vessel and peeled back to the outboard sides. The starboard-side curtain was found closed, and the portside curtain, which had been released, was recovered separately. The “sea chest” was inspected and found to be in good condition.²¹ Postaccident testing and inspection of the vessel is covered in [section 1.12](#). The engine was presumed to be full of water and was not tested postaccident.

Ride The Ducks estimated that damage to the *Stretch Duck 7* was \$184,000.

²⁰ Title 49 *Code of Federal Regulations (CFR)* 830.2 defines a serious injury as “any injury which: (1) Requires hospitalization for more than 48 hours, commencing within 7 days from the date of the injury was received; (2) results in a fracture of any bone (except simple fractures of fingers, toes, or nose); (3) causes severe hemorrhages, nerve, muscle, or tendon damage; (4) involves any internal organ; or (5) involves second- or third-degree burns, or any burns affecting more than 5 percent of the body surface.”

²¹ The sea chest, as referred to on these types of amphibious vessels, was a rectangular, watertight enclosure in the hull of amphibious vessels that contained water in the event that one of the vessel’s through-hull penetrations within the chest leaked.

1.6 Vessel Information

1.6.1 General

The *Stretch Duck 7* was built in 1944 as a DUKW amphibious vehicle for military use during World War II and was converted later for commercial service.²² General Motors Corporation manufactured more than 21,000 of these vehicles based on the chassis (frame), drive train, and engine of a 2.5-ton, six-wheel-drive (6 x 6) truck. Expected to last for only a few months, these vessels were designed as landing crafts to transport troops and cargo onshore during wartime. Although they were mechanically rugged, hull construction was simplified to meet the accelerated production schedule and their anticipated brief lifespan. The vessels had no internal watertight subdivision bulkheads; except for minor structural interferences such as tunnels and hull stiffeners, their internal hull was open forward to aft.²³

Vessel particulars of the *Stretch Duck 7* were as follows:

Length:	33 feet
Beam:	8 feet
Draft:	5 feet 2.375 inches
Gross tonnage:	4
Crew:	2 (captain and driver)
Passenger capacity:	38
Engine:	Chevrolet 427, gasoline, 235 hp

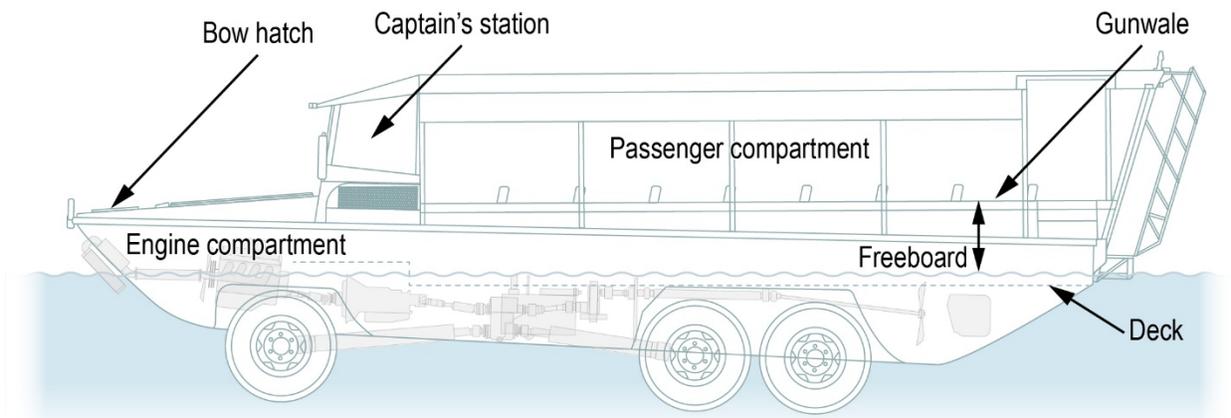


Figure 8. Profile drawing of *Stretch Duck 7* also showing engine, drive train, and propeller.

The conversion and operation of these former military amphibious vessels for use in the tourism industry began in 1971 in Branson, Missouri. The *Stretch Duck 7* was acquired by Ozark Scenic Tours Inc. in 1982 and modified in 1996. With components both new and rebuilt, the majority of the vessel's hull and its mechanical systems were replaced (including the drive train, suspension, tires, wheels, axles, and wiring) and installed on the chassis of a 1944 vintage DUKW. The hull was

²² DUKW vessels are also referred to as *vehicles* due to their dual function of being operated on land and in water.

²³ *Subdivision* is the concept of dividing a vessel's hull into watertight compartments using transverse watertight bulkheads so that, in the event of damage, flooding is restricted to the damaged compartments and the vessel will be less likely to sink.

made of 14-gauge side shell, 12-gauge bottom plating, and 10-gauge bow steel, reinforced by interior framing and exterior reinforcement ribs.²⁴ Other modifications included:

- On-road drive system modified to a four-wheel drive (6 x 4)
- Overall length increased by 15 inches
- Captain's station moved 18 inches forward
- Hull deepened in the stern area

According to Ride The Ducks' director of fleet operations, these modifications reduced the vessel's trim, improved maneuverability and visibility for the driver, and increased reserve buoyancy as an added benefit.²⁵

Vessels modified in this manner are known as "stretch ducks." The *Stretch Duck 7*, *Stretch Duck 17*, and *Stretch Duck 27* were, as their names intimated, stretch ducks. Those DUKWs not "stretched," or elongated, are referred to as either "fleet ducks" or "original ducks." Later models of stretch ducks known as "master jig ducks" were updated with completely new hulls, increased beams (by 6 inches), and higher gunwales (by about 6 inches).²⁶ The *Stretch Duck 54* was a master jig duck with a gasoline engine rated the same as the *Stretch Duck 7*'s (235 hp).²⁷ [Figure 9](#) provides a juxtaposed view of the two vessels.

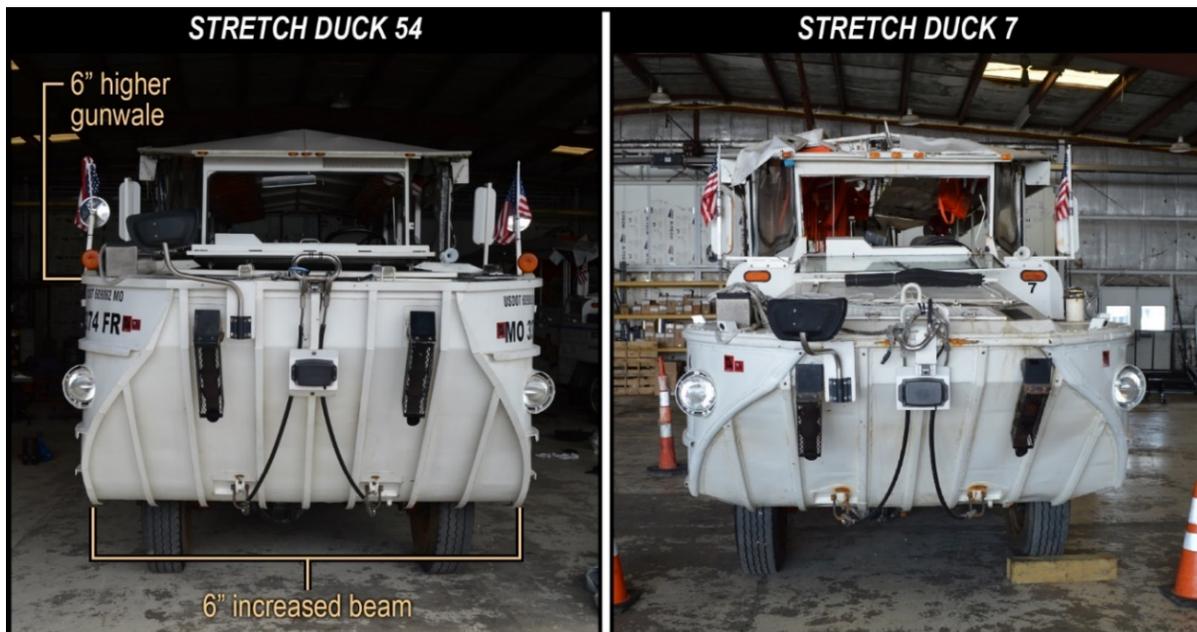


Figure 9. As shown in these photos taken postaccident, the *Stretch Duck 54*, a later model of the stretch duck known as a master jig, had a larger beam and higher gunwale than the *Stretch Duck 7*.

²⁴ Sheet metal is measured in gauge. The thickness of the measurements listed equate to .0747 inches for 14 gauge, .1046 inches for 12 gauge, and .1345 inches for 10 gauge.

²⁵ *Reserve buoyancy* is the internal volume of a vessel that is not flooded or capable of being flooded.

²⁶ (1) From 1996 to 2005, multiple amphibious vessel manufacturers updated and converted a total of 56 fleet ducks to stretch ducks or master jig ducks. (2) *Gunwales* are the upper edge of the vessel's sides.

²⁷ The master jig model had dimensions similar to a "truck duck," which was a newer version of the amphibious vessel built from about 2005 to 2014. Truck ducks were powered by a diesel engine, contained no original DUKW parts, and were built on the chassis of an M35 series 2.5-ton, 6 x 6 military truck. Ride The Ducks' subsidiary, Amphibious Vehicle Manufacturing, received Coast Guard approval for the patented truck duck in 2005. After taking over this business in 2008, Chance Rides of Wichita, Kansas, continued building truck ducks until 2014.

1.6.2 Inspection and Certification

The *Stretch Duck 7* was inspected and certificated by the US Coast Guard as a small passenger vessel under Subchapter T of 46 *CFR*.²⁸ In addition, as a requirement for amphibious vehicles operating shoreside, it was regulated by the National Highway Traffic Safety Administration (NHTSA) and the Federal Motor Carrier Safety Administration.²⁹

The *Stretch Duck 7*'s certificate of inspection (COI) was renewed in February 2017 and was valid for 5 years. The COI required only one crewmember (a master or captain) to operate the vessel and permitted the carriage of 37 passengers.³⁰ The vessel's route was limited to Table Rock Lake and Lake Taneycomo with a distance not more than 1,000 feet from shore.³¹ The COI also stipulated the weather conditions in which the vessel was not allowed to operate on water: "when winds exceed thirty-five (35) miles per hour, and/or the wave height exceeds two (2) feet."

Coast Guard personnel typically inspected Ride The Ducks vessels in Branson during the winter overhaul. Prior to their arrival, Ride The Ducks would strip the vessel of seats and deck plates to provide inspectors access to the hull, machinery, and through-hull penetrations. On each boat in this condition, inspectors conducted sea trials with maintenance personnel to verify watertight integrity and machinery operations. The vessels were then outfitted for the season and checked by inspectors on a return visit, during which time they also witnessed the crew participating in emergency drills.

At the time the most recent COI was renewed, an examination of the hull had been conducted. Coast Guard inspectors attended the vessel later that year in November 2017, completing an annual inspection. The last visit to the vessel that was documented prior to the accident occurred in February 2018, to inspect the relocation of the headlights.

Investigators reviewed the last 6 years of Coast Guard documentation for the *Stretch Duck 7*. Only two deficiencies had been documented since 2012 and were cleared before the operating season. Both were discovered during the December 2014 annual exam: one issue involved a small hole in the hull in the starboard forward wheel well, which was later attributed to a maintenance error; the other was related to less-than-adequate discharge volumes of the bilge pumps, which were replaced along with their discharge piping. That same year, the hull penetrations for the keel cooler were moved inside the sea chest, as required when the original Higgins bilge pumps were removed.³²

In June 2015, during an incident that was reported to the Coast Guard, the vessel lost propulsion on entry into the water with 34 passengers on board. The captain had entered the water

²⁸ A vessel of less than 100 gross tons carrying more than six passengers for hire.

²⁹ Individual states, rather than NHTSA, are responsible for registering motor vehicles and for regulating their operation on public roads. However, in the state of Missouri, where the *Stretch Duck 7* operated, duck boats were registered as boats and were not inspected or required to have license plates.

³⁰ When an additional crewmember was on board, the passenger count had to be reduced to 36.

³¹ The vessel was permitted to travel farther if a VHF marine band radio was installed.

³² A *keel cooler* is a heat exchanger mounted externally on a vessel's hull below the waterline. Similar to a car radiator, a keel cooler removes heat from the engine coolant circulated through it before the coolant returns to the engine, by transferring the heat to seawater (or lake water, in the case of the *Stretch Duck 7*).

too quickly, which created a larger-than-normal splash, causing water ingress in the engine intakes. No injuries resulted.

Guidance for Amphibious Vessels: NVIC 1-01. The Coast Guard provided supplemental guidance for the inspection and certification of amphibious vessels carrying passengers in its Navigation and Vessel Inspection Circular (NVIC) 1-01, *Inspection of Amphibious Passenger Carrying Vehicles* (USCG 2000).³³ Released on December 11, 2000, this comprehensive guidance was developed in collaboration with owners/operators of DUKW vehicles and industry experts following the 1999 sinking of the amphibious passenger vessel *Miss Majestic*, which resulted in 13 fatalities. The circular offered to marine inspectors and the amphibious industry best practices that addressed the operational hazards and unique design and repair of these vessels in an effort “to require a level of safety equivalent to that required for a vessel of similar size and service.” Among these standards, the NVIC recommended four bilge pumps, extra bilge alarms, an operations manual, route restrictions, and detailed inspection of through-hull penetrations.

In a part-by-part discussion of 46 *CFR* Subchapter T, the guidance covered regulations concerning stability, manning, and egress, to name a few. Recognizing that amphibious vessels “have a tendency to sink stern first,” the Coast Guard determined that the primary escape was over the side. To improve emergency egress, the guidance recommended spacing canopy supports at unobstructed positions; providing a minimum of 32 inches of vertical distance from the gunwale to the canopy; ensuring the overhead storage of lifejackets did not obstruct escape; and, if a curtain was installed, ensuring it could “be opened with minimal force, generally by a simple action by one person.”

1.6.3 Stability

The Coast Guard issues stability letters to small passenger vessels (100 tons or less) based on either an inclining experiment or simplified stability test.³⁴ The letter specifies, among conditions of operation, the approved route, maximum persons allowed, and minimum freeboard.

In February 2007, Ride The Ducks requested that an inclining experiment and subsequent stability analysis be conducted of the *Stretch Duck 1* to ascertain compliance with Coast Guard intact stability requirements for the *Stretch Duck 1* and its sister vessels, including the *Stretch Duck 7*.³⁵ The Coast Guard requested that owners and operators re-evaluate the stability of their vessels using an increased passenger weight of 185 pounds per passenger (*Federal Register*, 24732) (NARA). Originally, in October 1998, the *Stretch Duck 1* had passed a simplified stability test conducted with an assumed passenger weight of 160 pounds per passenger.

³³ Although [NVIC 1-01](#) was written specifically for DUKW vessels, Coast Guard inspectors and various stakeholders apply its guidelines to other amphibious vessels.

³⁴ (a) A stability letter provides operating guidelines and loading restrictions on vessel stability in accordance with the Coast Guard’s stability regulations at 46 *CFR* 178.210(a). A vessel captain must comply with the provisions of the stability letter and any conditions of operation listed on the COI, which also may include specific stability restrictions, as did the *Stretch Duck 7*’s [see 46 *CFR* 178.210(c)]. For a commercial small passenger vessel, obtaining a stability letter is a requisite for obtaining a COI. (b) An *inclining experiment* is part of a stability test in which the vessel is intentionally heeled using inclining weights moved transversely on board the vessel. The inclining moment and resulting heel angle data are used to experimentally determine the vessel’s vertical center of gravity.

³⁵ *Sister vessels* are similar vessels that do not differ in any way from the analyzed vessel, which would result in a lessening of its stability characteristics.

An inclining experiment was conducted on the *Stretch Duck 1* on February 20, 2007, at Table Rock Lake. The test procedure and test were approved and witnessed by the Coast Guard. Calculations were made for the following four load conditions for “protected waters,” such as a lake: full load (38 passengers, 2 crewmembers), half load (19 passengers, 2 crewmembers) loaded forward, half load (19 passengers, 2 crewmembers) loaded aft, and only 2 crewmembers with no passengers.³⁶ A stability study report was then conducted to demonstrate compliance with 46 *CFR* Parts 170 and 171 with an assumed passenger weight of 185 pounds per person. The report calculations indicated that the subject vessel would meet all Coast Guard intact stability criteria for all load conditions on protected waters.

The report also stated that the *Stretch Duck 1* met the intact stability requirements for operation on protected waters, with a maximum of 40 persons carried, of which 38 could be passengers. Also, the vessel was limited to a maximum speed of 6.9 knots, and an operating environment with a maximum significant wave height of 2.5 feet.

Other recommendations in the report included maintaining a specific freeboard, minimal trim and minimal bilge levels, and keeping closed any openings that could allow water to enter the hull when rough weather or sea conditions exist or are anticipated. The stability analysis report referenced NVIC 1-01, which required operators to provide a permanent loading mark at the stern to indicate the minimum freeboard at the maximum load. During water operations with a full passenger load, the *Stretch Duck 7* had a freeboard of about 2 feet.

The stability study report was submitted to the Coast Guard to request stability letters for the *Stretch Duck 1* and sister vessels. The Coast Guard issued a stability letter on March 19, 2009, for the *Stretch Duck 7* permitting operation on protected waters with a maximum of 40 people on board (including 38 passengers), a maximum sea height of 2.5 feet, and a maximum vessel speed of 6.9 knots. Maximum draft at the stern was 5 feet 2.375 inches. DUKWs were considered “open boats” for the purpose of Coast Guard regulations.³⁷

Following the sinking of the *Stretch Duck 7*, the Coast Guard’s Marine Safety Center was asked to perform a stability analysis on the recovered vessel. In order to replicate the hull form for the study, an engineering firm was contracted to create a three-dimensional model of the vessel. As of the date of this report, the stability analysis has not yet been received.

1.6.4 Propulsion System

The *Stretch Duck 7* was propelled on both land and water by a Chevrolet 8-cylinder, 235-hp gasoline engine that was fitted in an engine compartment located forward of the captain’s station (see [figure 8](#)). The engine output shaft was connected to an automatic transmission that, through a single-speed transfer case, drove the forward and middle wheel sets for land operation; a separate output from the transfer case was connected to a three-bladed propeller for waterborne operations.

³⁶ *Protected waters* are “sheltered waters presenting no special hazards such as most rivers, harbors, lakes, etc.” as defined at 46 *CFR* 170.050(j).

³⁷ An *open boat* is “a vessel not protected from entry of water by means of a complete weathertight deck, or by a combination of a partial weathertight deck and superstructure that is structurally suitable for the waters upon which the vessel operates,” as defined in the stability terms found in 46 *CFR* 28.510.

The operator had to engage and disengage the propeller manually before and after each waterborne operation.

A conventional (automotive-style) power-assisted, hydraulic steering system was used to steer the *Stretch Duck 7* on the road. On water, steering was accomplished by a mechanical linkage from the steering column to the rudder tiller at the stern.³⁸ In the event of a waterborne steering failure, the vehicle was equipped with a redundant steering cable that could be connected manually to the tiller and be operated with a hand crank.

The engine was cooled by a conventional closed, pressurized cooling system that used a mixture of water and ethylene glycol (antifreeze). The mixture ran through both a traditional air-cooled radiator mounted at the front of the engine and the keel cooler, which was mounted on the exterior of the vessel below the waterline. Air flow across the radiator was generated by an engine-driven, axial-flow fan and could be supplemented by air entering through the partially open engine compartment cover, or hood ([figure 10](#)). The hood, which was hinged on the aft side, could be closed remotely by pulling a handle below the steering wheel in the captain's station.

The original *Stretch Duck 7* was designed with another ventilation opening located forward of the radiator, which allowed air to enter the engine compartment. This bow hatch measuring 27.5 inches wide by 15.5 inches long (about 3 square feet) was covered by grating made of expanded metal ([figure 10](#)). Between 1998 and 1999, the Coast Guard identified an issue with the opening: the hatch lacked a means for isolating incoming air to the engine compartment in the event of a fire. As a remedy, Ride The Ducks installed a spring-loaded damper that could be held open with a latch. The damper could be closed by pulling the same handle as the one designated for the hood closure. When closed, the air intake damper was held upward by a spring to prevent air from entering the engine compartment. This design was approved and inspected by the Coast Guard. During the 2018 season, Ride The Ducks had been operating the *Stretch Duck 7* with the damper in the closed position, after the installation of the keel cooler, and was evaluating the feasibility of replacing the grating with a solid cover over the hatch. After the accident, both the hood and the damper were found closed, and investigators determined that about 3 pounds of static weight could open the hatch.

After passing across the radiator, the air was directed to port and starboard plenums on either side of the engine bay before exiting to the atmosphere through 28-inch-wide-by-7.5-inch-high ducts on both port and starboard sides outboard of the captain's station ([figure 10](#)).³⁹ Each of the openings for the cooling air discharge ducts were covered by gratings and had separate dampers that could be closed individually from the captain's station. The lever for the starboard damper was located on the starboard side of the captain's station against the starboard bulkhead.

Witness video (captured as a screenshot in [figure 6](#)) reveals that as the *Stretch Duck 7* was attempting to reach the exit ramp, the vessel's bow was intermittently submerged in the water. A few minutes earlier, at 1902, a sound consistent with the engine compartment cover closing was heard on the DVR.

³⁸ A *rudder tiller* is a handle attached to a rudder post that provides leverage in the form of torque to turn a rudder on small vessels.

³⁹ *Plenums* are ducts that provide spaces for air circulation.

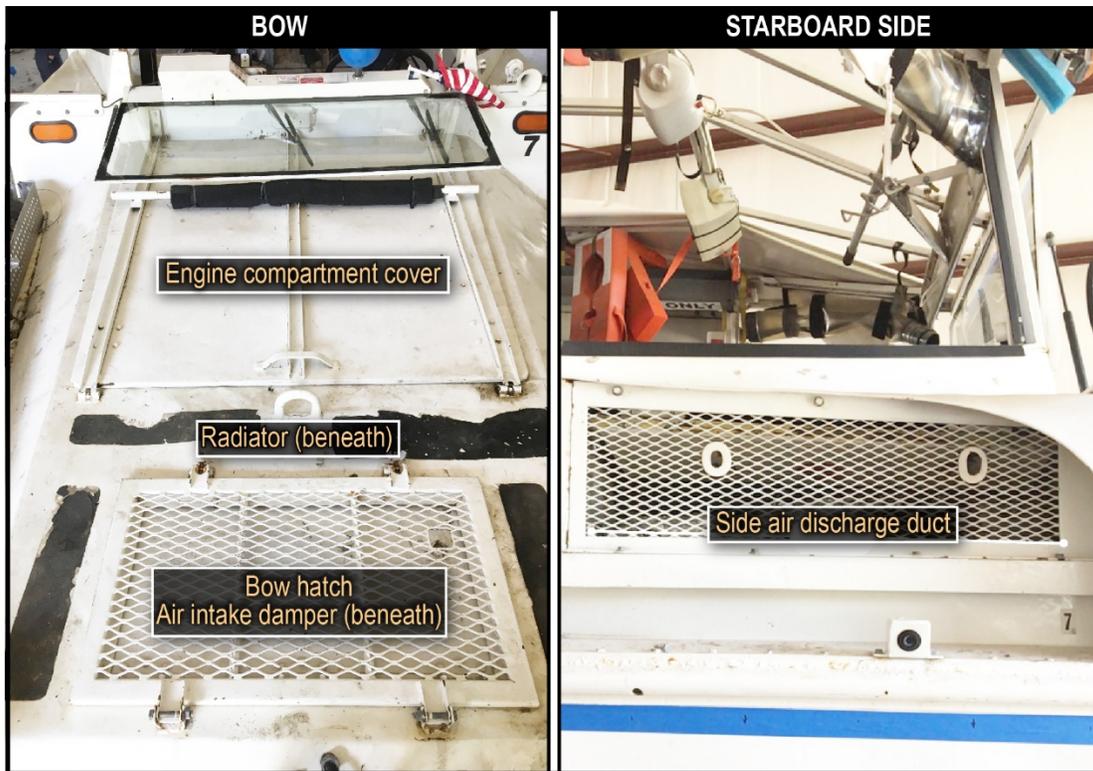


Figure 10. *Left:* Below the open windshield on the bow of the recovered *Stretch Duck 7* are the engine compartment cover and the air intake damper covered by grating, which are both closed. *Right:* Air discharge duct, opened and covered by grating, on the starboard side of the captain's station.

1.6.5 Bilge System

The *Stretch Duck 7* was outfitted with three bilge pumps, each rated for 33.3 gallons per minute.⁴⁰ Two pumps were located on the hull bottom in each of the aft wheel wells outside of the propeller and shaft tunnel, and one pump was located on the port side between the forward and aft wheel wells.

Although the *Stretch Duck 7* was classified as an open boat with no subdivision, the wheel wells around the axles and shaft tunnel created four separate spaces where bilge water could accumulate: the engine compartment forward of the front axle, the midship section, and each side of the shaft tunnel aft of the rear axle. Each of these spaces, as well as the sea chest, were equipped with high-level bilge alarms that provided audible and visual signals on the starboard side of the captain's station under the dashboard. The bilge alarms had float switches that were activated when the water level exceeded a predetermined height.

1.6.6 Canopy

The *Stretch Duck 7* was equipped with a canopy to protect passengers from rain or other inclement weather. The canopy consisted of a vinyl cover fitted on a fixed metal frame that extended over the entire passenger compartment and the captain's station. It was 1/32 of an inch thick and

⁴⁰ The equivalent of 2,000 gallons per hour.

pressed into a seam along the horizontal support at the center of the vessel. On recovery of the *Stretch Duck 7*, the canopy was found torn from forward to aft: the starboard side was peeled back, but most of the port side remained intact ([figure 11](#)). Underneath, the vessel's PFDs were stored above the passenger area. Of the 56 lifejackets investigators counted postaccident, a total of 41 were still connected to the vessel's canopy framing by their straps. The remaining lifejackets were recovered from the lake's surface or within the vessel outside of their storage locations.



Figure 11. Torn canopy on the *Stretch Duck 7* during recovery at Table Rock Lake.

1.6.7 Side Curtains

Clear vinyl curtains were also installed on the *Stretch Duck 7* as a protective measure against the weather. Two large curtains, each constructed of a continuous sheet of 1/32-inch-thick vinyl, hung from the canopy's horizontal frame along the periphery of the vessel on both sides of the passenger area. These side curtains could be opened (raised) and closed (lowered) by using an electric switch at the captain's station. When closed, the curtains were held in place at the bottom with tabs connected to the outboard side of the vessel ([figure 12](#)). For an emergency release, they could be jettisoned manually by pulling their release handle. One release lever was located above the driver's seat near the top of the portside curtain, and the other was at a corresponding location on the starboard side. On recovery of the vessel, investigators found the starboard-side curtain was closed and the portside curtain had been released.

Additionally, in the captain's station, there were two smaller curtains on the port and starboard sides mounted to the vessel with Velcro that could be zippered opened and closed. Another two small curtains located at the passenger entrance on the stern and at a second entrance on the port quarter could also be manually opened (rolled, using Velcro straps to secure them in the open position) and closed (unrolled). Based on video evidence, the two smaller curtains at the captain's station were closed before the sinking.

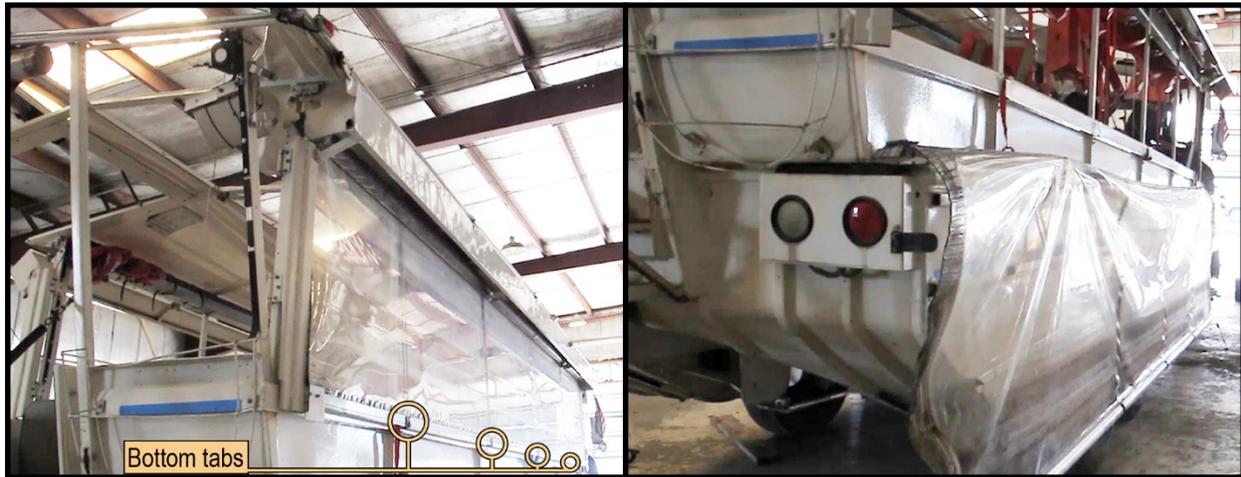


Figure 12. Closed starboard-side curtain as found during recovery (*left*) and then released (*right*) during the postaccident investigation.

1.6.8 Maintenance

Maintenance procedures included checklists for pre- and post-trip inspections to be conducted by the drivers and captains, as well as post-trip inspection checklists for maintenance crews. Annual inspections and maintenance following 250 hours of road use were also prescribed.⁴¹ Preventative and corrective maintenance was documented in a computerized maintenance system. Investigators reviewed checklists and computer records for the *Stretch Duck 7* in 2018 and found that issues identified in the checklists every day of operation were addressed.

During an examination of the *Stretch Duck 7* after it was recovered, investigators noted a missing life ring light. Deficiencies previously logged by crewmembers that had been addressed earlier in the season by maintenance staff included adjusting turn signal levers, mirrors, and engine timing, and repairing a switch for the PA system.

1.7 Survival Factors

The 29 passengers on board the *Stretch Duck 7* at the time of the accident were all United States citizens from various states across the country. Passenger ages ranged from 1 year to 77 years old. Of the total passengers on board, 12 were children. There were no survivors under age 10 or over age 65.

1.7.1 Safety Briefing

Before getting under way, the captain on a small passenger vessel such as the *Stretch Duck 7* is required by federal law to provide a safety briefing to passengers.⁴² The briefing, at a minimum, must include the location of emergency exits, the location of lifesaving equipment, and a demonstration of donning lifejackets properly. In addition, passengers must be informed that they

⁴¹ The inspections were required by the US Department of Transportation under 46 *CFR* Part 396.

⁴² See 46 *CFR* 185.506.

will be required to don a lifejacket “when possible hazardous conditions exist, as directed by the master.”

Operators of Ride The Ducks International amphibious vessels were also subject to the company’s operation manual, which provided specific instructions for delivering the safety briefing. In addition to requiring that the briefing be provided prior to water entry, Ride The Ducks specified that its delivery should be done “in a serious manner with no jokes.” A script exemplifying how crews could recite the information for the safety briefing was included in the manual.

On the accident voyage for the *Stretch Duck 7*, the safety briefing provided by the captain covered the topics listed in the operations manual. Video from the vessel’s interior camera shows that he started the briefing with identifying the location of the fire extinguishers and ended with identifying the location of the life rings. In discussing the lifejackets, he explained how to release the straps and pointed to the adult, child, and infant lifejackets stowed overhead. Crews and managers told investigators that rarely do passengers request to wear a lifejacket on the water.

1.7.2 Lifesaving Appliances

The *Stretch Duck 7*’s COI required the vessel to carry lifesaving equipment for 38 persons, the maximum number allowed on board. This safety equipment included:

Adult lifejackets: 38

Child lifejackets: 4

Ring buoys: 2 (one with a line attached and the other with a light)

The COI also stipulated that when four or more children, or adults weighing less than 90 pounds, were on board, a child lifejacket must be provided for each additional person. The vessel was not required to carry a liferaft, life float, or buoyant apparatus.

The number of lifejackets stowed on the *Stretch Duck 7* exceeded the required amount. The 56 lifejackets that were recovered from the vessel and the lake’s surface included 38 adult, 14 child, and 4 infant sizes. The adult and child lifejackets met the Coast Guard’s requirements for reversible, “bib type” lifejackets constructed of unicellular plastic foam.⁴³ The infant lifejackets were also approved for use.

All the PFDs were stored under the canopy on the port and starboard sides above the passenger area. They were stacked in pairs and wedged in a metal channel that had been labeled to identify the locations of the three various sizes. On the starboard side were all adult sizes; on the port side, from forward to aft, were the child and infant sizes.

The lifejackets were secured in their stowage locations by canvas straps attached to the canopy’s frame. Fitted with a snap fastener, each strap ran through the neck opening of the lifejackets. To release the lifejackets, the fastener had to be unsnapped first, which freed the top portion of the lifejacket while the bottom remained wedged in the channel. The lifejackets then would have to be pulled out of the channel to be released.

⁴³ See 46 *CFR* 160.055.

According to the Coast Guard’s NVIC 1-01, vessel operators should store lifejackets “in convenient places distributed throughout the accommodation space and be readily available. If practicable, the stowage should allow the life jackets to float free.” Following the accident, only three adult lifejackets belonging to the *Stretch Duck 7* were found floating on the lake’s surface. The majority of the lifejackets were found within the vessel still connected to the canopy’s frame by their straps. [Figure 13](#) shows the 30 adult and eight child lifejackets found on the starboard and port sides, respectively, strapped to the *Stretch Duck 7* after it was recovered (the three infant lifejackets are not visible).



Figure 13. Lifejackets recovered on the *Stretch Duck 7* (left) compared to how they would have been stowed, as shown on the similar vessel *Stretch Duck 9* (right). Infant lifejackets would have been stowed aft of the child lifejackets. (Source: Missouri State Highway Patrol)

1.7.3 Evacuation

Investigators interviewed 11 passengers who had been aboard the *Stretch Duck 7* during the accident. NTSB investigators were unable to interview the captain but were provided information from a postaccident interview by the Missouri State Highway Patrol. The survivors were asked to recall how water entered the vessel, how they escaped during the sinking, and what followed immediately afterward. The majority of the recollections indicated that the vessel listed to starboard and quickly sank by the stern. No announcement was made to abandon the vessel. The only instruction the captain provided just before the sinking was for passengers to move to the port side of the vessel.

Several passengers recalled water entering from under the vessel’s floorboards as well as through the bottom of the starboard-side curtain after the captain turned the vessel to starboard near the *Showboat Branson Belle*’s stern. Describing the force of the water on the curtain, one passenger drew a comparison: “If you threw a big bucket of water on a shower curtain, it would cave it in, and that’s kind of how I felt it did.” As water rose quickly inside, the passengers’ response quickly shifted, according to one young passenger: “We all thought it was just fun and games, like... probably just part of the ride...and then [the water] started getting a little under my knee. And then we all started panicking. And after that [the vessel] just went down really fast.” Several passengers stated that the water, which rose from their feet to their shoulders as they stood up, filled the *Stretch Duck 7* within seconds; one passenger said the rate of water ingress seemed “almost instantaneous.” Several passengers recalled reaching for a lifejacket around this time but were unsuccessful because of the rapid flooding. Video from the *Stretch Duck 7*’s camera, which ended seconds before the vessel sank, showed no one wearing a lifejacket.

One passenger remembered her head, feet, and ankles hitting the inside of the vessel while being disoriented under water: “Basically, it was like I was dropped in the Twilight Zone. I didn’t know where I was. I was hitting, trying to get out.” She escaped from a depth where she described the water as “icy cold.” The captain and a young passenger recalled escaping through the front windshield. However, several passengers stated that the vessel’s canopy, which they referred to as a “roof,” obstructed their egress. One remembered when the vessel went under water, “we all kind of floated up, couldn’t get out because the roof was on.” Another recalled just seeing the “the white of the roof” while below the water’s surface and “banging on the roof...to see if the roof would come off.” Another said her head hit the canopy several times before it eventually tore open, which allowed her and other passengers to escape. According to one passenger, being trapped by the canopy was “feeling like a caged animal.” Only a few of the surviving passengers stated that they were able to float free without encountering any obstructions.

The captain remembered that after being pushed out of the *Stretch Duck 7*, he “swam and swam and swam to get back up for air.” Once he was above the water’s surface, the waves fell on top of him, regularly submerging him under water. With no lifejacket, he eventually made his way to the pier behind the *Showboat Branson Belle*, where he hung onto the dock until he was pulled from the water. Several passengers recalled similar experiences of struggling to reach the surface of the water and, once they surfaced, having to battle large waves before they could reach the pier or the *Showboat Branson Belle*’s paddle wheels (which had been stopped). Most survivors grasped life rings and lifejackets that were thrown from the pier and the showboat. Almost all the survivors were lifted out of the water by rescuers on the dock.

1.8 Operations

1.8.1 Company Information

Ride The Ducks was incorporated in 1971, providing duck boat tours in the Branson, Missouri, area. By 1999, Ride The Ducks had transported 3 million passengers on its vessels.⁴⁴ In 2001, Ride The Ducks International partnered with Herschend Family Entertainment, which 3 years later became the sole owner.⁴⁵ Its affiliate, Amphibious Vehicle Manufacturing, began stretching and building vessels for subsidiaries and other independent operators throughout the country. Herschend owned the company until December 2017, when Ripley Entertainment Inc. bought the operation in Branson.⁴⁶ Ripley did not make any major changes in management, personnel, policies, or procedures. From the time of the purchase until when the accident occurred, Ride The Ducks and Ripley operated separately from Ride The Ducks International.⁴⁷ At the time of the accident, the Branson fleet included 22 vessels; all but one had valid COIs. Immediately following the accident,

⁴⁴ This passenger count was provided by Ride The Ducks’ president during an NTSB-sponsored public forum on amphibious passenger vessel safety held on December 8–9, 1999, in Memphis, Tennessee.

⁴⁵ At the time of the accident, Herschend also owned *Ride The Ducks Atlanta* and the *Showboat Branson Belle*.

⁴⁶ While Ripley operates several other entertainment venues, Ride The Ducks Branson was the company’s only duck boat operation.

⁴⁷ According to the company’s website accessed in September 2019, Ride The Ducks International’s fleet consisted of 95 vehicles, carrying over 1.5 million guests each year in six US locations. (The website was no longer active at the time of this report’s release.)

Ripley voluntarily suspended all duck boat operations for an undetermined time and sold several non-operational vessels to another duck boat operator. The 21 COIs have since lapsed.

Due to ongoing criminal investigations, interviews of several key personnel were limited, and investigators received limited information regarding the daily operations of the Branson operation. Crews and boats completed up to five trips daily. Several managers rotated as the manager-on-duty at Ride The Ducks' facility, known as the duck dock, handling the dispatch of the amphibious vessels. The general manager served in several capacities, as a driver, captain, and trainer.

1.8.2 Company Procedures

NVIC 1-01 recommended that owners and operators develop an operations manual establishing procedures on training, maintenance, and operations, as well as include a plan for emergency response, as required by 46 *CFR* Part 185.

The manual created by Ride The Ducks International for its subsidiary companies standardized certain operations across the fleet and provided support and clarification for day-to-day operations. Fifty-two pages long, *Operations Manual: 2012* applied to all Ride The Ducks' fleet operators, which comprised captains, drivers, mechanics, deckhands, and operations personnel. Included were procedures for touring on land, entering the water, responding during an emergency in both environments, and inspecting the vessel before and after each trip, along with photographs of common equipment and components fitted on various versions of the duck boat, which included detailed steps for the manual release of the side curtains during an emergency.

General managers and their staff were advised to amend the manual according to the environmental and operating conditions of their local sites, such as developing procedures for adverse weather plans and for ensuring crewmembers were informed on daily operating matters involving security, traffic, and weather. Ride The Ducks Branson developed a 21-page *Safety Procedure* manual that its amphibious vessels and personnel had to comply with. Nonetheless, according to multiple interviews of company personnel, the operations manual was the primary document to which the local site referred.

After reviewing the manual, investigators summarized specific operations that affected the *Stretch Duck 7* on the accident voyage, as noted below.

“When not to enter the water.” The operations manual listed restrictions for entering the water likely to be imposed by the Coast Guard including:

- Winds may not exceed 35 mph.
- Waves may not be higher than 2.5 feet.⁴⁸

Company policy was “to forego water entry” under a second category of conditions, as stated in the manual:

- There is lightning or low visibility.
- The vehicle has any mechanical issues.

⁴⁸ The *Stretch Duck 7*'s COI indicated winds may not exceed 35 mph and set the maximum wave height at 2 feet.

- Severe weather is approaching the area.
- The passengers are unprepared (this is the Captain's judgment).

The captain, as the manual advised, "never has to enter the water if, in his/her judgment, the conditions are unsafe or unsuitable." The general manager of Ride The Ducks Branson stated that the "operations team" decided whether to proceed with a tour altogether, considering that "thunderstorms here can pop up very quickly in the summer."⁴⁹ Earlier in the week before the accident, the team had postponed trips over a few days due to thunderstorms.

"Emergency procedures on the water." For any "abnormal situation" on the water, captains were directed to

1. assess the nature of the emergency,
2. instruct the passengers to remain calm and don PFDs,
3. notify the Coast Guard or emergency authorities, dispatch, and other vessels in the vicinity, and
4. attempt to head to shore and exit the water.

The operations manual provided further detail for certain situations, such as abandoning ship, bilge alarm soundings, intentional groundings, medical issues, mechanical failure, and severe weather on the water.

The section on *abandon ship* called for the captain to follow steps 2 and 3 summarized above, direct passengers to escape over the side where they are seated, establish a meeting point in the water, depart the vessel with a life ring, and conduct a head count.

Any time a *bilge alarm* was heard, the captain was charged to follow steps 2 through 4, and "immediately increase speed and head to the nearest shore or egress ramp." The captain also should raise the side curtains, monitor the vessel's freeboard and bilge pump discharge, and prepare for an intentional grounding if the freeboard lowers. Once the vessel reaches shore, dispatch should be updated on location and condition.

An *intentional grounding* was allowed for an emergency. In following steps 2 through 4, the captain should determine the closest place for a safe landing and increase speed.

If *severe weather* occurred while the vessel was on water, the captain was advised to instruct the passengers to remain calm and don PFDs; notify emergency authorities, dispatch, and other vessels nearby; immediately increase speed and head to shore, either to the egress or closest ramp; monitor freeboard and bilge pumps; close the main engine compartment hatch if the conditions exposed the bow to heavy waves; and notify dispatch when the vessel is out of the water and in a safe location. At the end of this section in the manual, a note was added warning the captain that "lowering the side curtains during high wind conditions creates an additional sail area which decreases the vessels maneuverability."

⁴⁹ The general manager did not identify the personnel who comprised the operations team.

The operations manual stated, “Nothing in this manual or any other directive shall prevent the Captain from making decisions he/she judges are necessary for safety in the event of an emergency.”

Ride The Ducks personnel were interviewed after the accident to determine their familiarity with the company’s safety policies and procedures. One driver stated he reviewed the manual annually and was assessed on his knowledge of it, and another driver, who had just completed a captain’s license examination, said she had studied the manual “a lot.” Other captains interviewed, however, had only read it once or had not looked at it in years. One driver had not read it all. An assistant manager, who had previously been a driver but not a captain, had not read the manual in 3 years.

Company manuals, along with approved drawings of the vessel, service bulletins, announcements, and discussions were available through an intranet site hosted by Ride The Ducks International called “Duck Central.” However, since some personnel did not have access to a computer to regularly visit the site, supervisors were responsible for keeping their employees up to date on relevant information.

1.8.3 Company Training

Ride The Ducks provided several training opportunities for its fleet personnel, who were considered to be the company’s “front-line entertainers” charged with “safety, customer service and managerial responsibilities.” Coast Guard regulations required that crew training on emergency procedures be conducted for new employees prior to their first trip and for existing employees at least once every 3 months.⁵⁰ According to Ride The Ducks’ operations manual, employees also received “refresher” training before the start of the season. Senior captains serving as trainers all stated they used the manual for both initial and annual training. In addition, topics from the operations manual were randomly chosen for discussion in monthly meetings. Operators had to demonstrate their ability to perform emergency procedures on an annual check ride, which typically took about 6 to 8 hours.

To meet federal license requirements for new captains, Ride The Ducks Branson developed a license program specifically for its duck vessel operators.⁵¹ The “Limited Master” course, which was approved by the Coast Guard, included about 275 hours of classroom and hands-on training. About one-third of the course was dedicated to water emergency and other waterborne training, including basic weather and meteorology for mariners, such as recognizing approaching storms and observing waves, wind, and current, as well as responding to severe weather while under way. On completion of the course and passing of the examination, employees earned a Coast Guard limited master credential subject to renewal every 5 years, without further testing.⁵²

⁵⁰ See 46 *CFR* 185.420.

⁵¹ See service requirements of 46 *CFR* 11.456(a) and the examination requirements of 46 *CFR* 11.456(c).

⁵² Customized for Ride The Ducks Branson operators only, this credential limited the master to vessels not more than 25 gross registered tons, specifically DUKWs operating on Coast Guard-approved routes on Lake Taneycomo and Table Rock Lake. Ride The Ducks also offered a course for operators to earn their CDL.

1.8.4 Coast Guard Weather-Training Criteria

The captain of the *Stretch Duck 7* obtained his merchant mariner's credential in 1993, which was endorsed for vessels not more than 100 tons on rivers routes. Thus, he did not need to attend Ride the Duck's in-house license program upon joining the company in 2001. Applicants for such a license must present evidence of one-year of sea time on vessels of the relevant tonnage, have training in first aid and CPR, and provide a letter of reference. Applicants then are required to take four examinations at one of the Coast Guard's regional examination centers.

Tables 1 and 2 in 46 *CFR* 11.910 prescribe the exam subjects for deck officers of various routes and tonnage restrictions. The tables include two meteorology related subjects: "Characteristics of Weather Systems" and "Weather Charts and Reports." While all applicants for master and mate endorsements are tested on "Characteristics of Weather Systems," those applicants restricted to rivers routes are not tested on "Weather Charts and Reports," regardless of tonnage.

The only formal training required of masters of small passenger vessels are classes for first aid and CPR. Applicants study the material on their own while collecting sea time. Formal training in meteorology is only required of those mariners seeking international endorsements.

1.8.5 Communications

The *Stretch Duck 7* was equipped with a single radio that could be used to communicate on VHF marine channels (for example, 13 and 16) while on the water or on UHF channels when on land. This radio system enabled company employees at the duck dock facility to communicate with vessels individually. The UHF system did not permit other duck boats to communicate with each other or hear radio communications between another duck boat and the duck dock. The manager-on-duty communicated with the vessels and with ticketing personnel on separate channels.

Before entering the water, the captains would switch the radio frequency to the marine band VHF channel 13. This channel enabled the captains to conduct a *sécurité* call to alert other vessels in the area and to communicate with any concerned marine traffic. Just after entering the water, the captain then would switch the radio to scan mode, which would allow the captain to monitor VHF channels 13, 16, 72, and 6, as well as to receive incoming calls from the duck dock on UHF channels and from other vessels communicating on the marine channels. The radio remained in scan mode during the entire waterborne voyage. If the captain picked up the radio to transmit an outgoing communication to another vessel, the radio automatically would stop scanning to transmit on VHF channel 13. To call the duck dock, the captain would have to manually switch from scan mode back to a UHF channel. Typically, once the vessel exited the water, the captain would switch the radio back to a UHF channel to communicate with land-based personnel only.

1.9 Personnel Information

For the land portion of the tour, Ride The Ducks was required to have a driver who held a CDL. The captain narrated the tour, which allowed the driver to focus on operating the vehicle. For the water portion, the *Stretch Duck 7*'s COI required one licensed crewmember (the captain) for manning purposes. When they entered the water, the captain both maneuvered the vessel and narrated the tour; the driver assisted as directed.

1.9.1 Captain

General. The 51-year-old captain held a merchant mariner’s credential endorsed as “Master of Steam or Motor Vessels of Not More Than 100 Gross Registered Tons (Domestic Tonnage) Above Mile 225.0 of the White River and Impoundments Thereon in Missouri and Arkansas.”⁵³ (White River above Table Rock Dam became Table Rock Lake after the installation of a dam.) His credential was renewed in January 2018 and valid through January 2023. He also held a Class B CDL valid through June 2020.

Ride The Ducks Branson hired the captain in 2001. Before this employment, he worked as a captain for another local boat tour company, which operated on Lake Taneycomo, as several interviewees working for Ride The Ducks stated.

Medical. According to his merchant marine medical file, the captain was in good health, with no chronic medical conditions, and used no medications. Toxicology testing of blood and urine samples obtained during the captain’s medical care after the sinking did not identify any tested-for substances.⁵⁴ Also, the result from Coast Guard-mandated urine testing postaccident was negative.⁵⁵ Alcohol testing performed on his breath about half past midnight on the day after the accident was negative. Ride The Ducks conducted urine drug testing eight times between February 2011 and February 2018 on the captain: he tested negative each time.

Training. Training records over the 18 years the captain worked for Ride The Ducks that were provided to investigators included several competency assessments. Each year the captain completed a “Captain’s/Deckhand’s Water Training Log” assessing performance of emergency procedures and other skills. This training included such areas as man overboard, fire on deck, medical emergency, loss of steering and propulsion, abandon ship, and collision, along with knowledge of COI restrictions and use of VHF radio and emergency equipment. His most recent training was completed in February 2018. As an experienced captain, he also conducted this waterborne training for new drivers. In addition, annual logs show the captain was assessed on a land version of the training, which included a segment on weather.

Over the summer in 2010, the captain took a 10-part “Captain’s Test” administered by Ride The Ducks. For the section “When Not to Enter the Water,” he had to identify one condition for each of the two categories of restrictions. Both his fill-in answers were correct regarding when to forego water entry: winds exceeding 35 mph, and there is lightning or low visibility.

Performance. The training records showed satisfactory annual check rides, familiarity with various company policy and emergency procedures, and proficiency on all facets of operation. In a November 9, 2017, letter to the Coast Guard for a license renewal, Ride The Ducks described the captain as a “reliable and conscientious employee in every capacity.”

⁵³ The captain did not earn his license through Ride The Ducks’ limited master program, which postdates the time of his hiring.

⁵⁴ Testing included more than 1,300 substances. See the [Forensic Toxicology’s Webdrugs website](#) under the Federal Aviation Administration for a complete listing.

⁵⁵ Required urine drug testing is limited to identifying urinary metabolites of amphetamine, methamphetamine, cocaine, codeine, morphine, heroin, phencyclidine (PCP), methylenedioxymethamphetamine (MDMA), methylenedioxyamphetamine (MDA), methylenedioxyethylamphetamine (MDEA), tetrahydrocannabinol (THC), oxycodone, oxymorphone, hydrocodone, and hydromorphone. See 33 *CFR* Part 5.

Other captains, drivers, and trainers in interviews consistently expressed high regard for his competency and safety awareness. One captain/trainer stated, “He would be the best, most experienced guy that we have. If there’s somebody else, I don’t know who it would be.” Another trainer shared, “I think he’s very professional...very safety conscious as far as...he’s been on the water for years.”

Work/Rest History. Ride The Ducks provided investigators with a log sheet tracking the captain’s trip history over a week, from July 12 to July 19, the day of the sinking. In the days before the accident, the captain typically made four to five trips a day: starting with either the 0830 or 0900 tour and ending with the last trip of the day, which varied from 1430 until 1800. His last day off was July 13. On the day of the accident, the captain made five trips, starting at 1000.

1.9.2 Driver

General. The 73-year-old male driver held a valid CDL that was issued on September 18, 2015, and valid for 3 years. Because of high blood pressure he reported during his last CDL medical examination on October 16, 2017, he was issued a medical certificate valid for 1 year.

Medical. According to the driver’s commercial driver’s medical records, he reported having high blood pressure, for which he used amlodipine.⁵⁶ He also reported having had a sleep study that did not identify any sleep issues. No significant abnormalities were identified during the examination.

According to the autopsy, the cause of the driver’s death was drowning. Toxicology testing performed on the driver’s blood at the request of the medical examiner did not identify any tested-for substances. Toxicology tests requested by the NTSB identified amlodipine in his urine and blood and pseudoephedrine in urine but not in blood.⁵⁷ Neither of these medications are considered impairing. During routine urine drug testing carried out by Ride The Ducks, he had negative results twice in 2016 and 2017.

Work/Rest History. Based on the company’s log sheet tracking the driver’s work history from July 12 to July 19, the driver averaged four to five trips a day in the days before the accident: typically starting with the 0930 or 1000 tour and concluding with the last trip varying from 1500 until 1800. His last day off was July 15. On the day of the accident, the driver made five trips, starting at 1000.

1.10 Waterway Information

Table Rock Lake, an over-40,000-acre lake in southwest Missouri, was created by the completion of Table Rock Dam on White River in 1958. The dam was 8 miles upriver of the City of Branson.⁵⁸ In this area, the lake’s bottom dropped off quickly from the shore. Prior to 1958, Duck Island was a hilltop connected by a ridge to the area where the *Showboat Branson Belle* was moored. The Long River flowed below and to the west into the White River.

⁵⁶ Amlodipine is often marketed with the name Norvasc. See the [DailyMed website](#) under the National Institutes of Health, US National Library of Medicine (accessed March 11, 2019).

⁵⁷ See the [DailyMed website](#) under the National Institutes of Health, US National Library of Medicine (accessed March 11, 2019).

⁵⁸ See [US Army Corps of Engineers website](#) (accessed November 16, 2018).

1.11 Meteorological Information

According to the National Weather Service Storm Prediction Center, the *Stretch Duck 7* accident was the largest “direct fatality wind event” on record in the United States and the deadliest severe thunderstorm or tornado event in the nation since May 2013.⁵⁹

1.11.1 Severe Weather Forecasts and Radar Imagery

The severe weather that impacted Table Rock Lake on the evening of July 19 was a convective weather system called a “derecho.” Pronounced “deh-REY-cho,” this widespread, long-lasting windstorm is associated with a continuous band of rapidly moving showers or intense thunderstorms and is characterized by damaging strong straight-line wind.⁶⁰ The swath of the storm can extend more than 250 miles with wind gusts of at least 58 mph (about 50 knots) and several well-separated gusts of 75 mph (about 65 knots) or greater along most of its path.

The National Weather Service Storm Prediction Center, which monitors non-severe and severe thunderstorm threats across the contiguous United States, concluded that the derecho impacting the accident site covered 473 miles (from north-central Kansas to northern Arkansas) and lasted for 9 hours 24 minutes. [Figure 14](#) depicts the progression of the storm system in a mosaic of edited radar images.

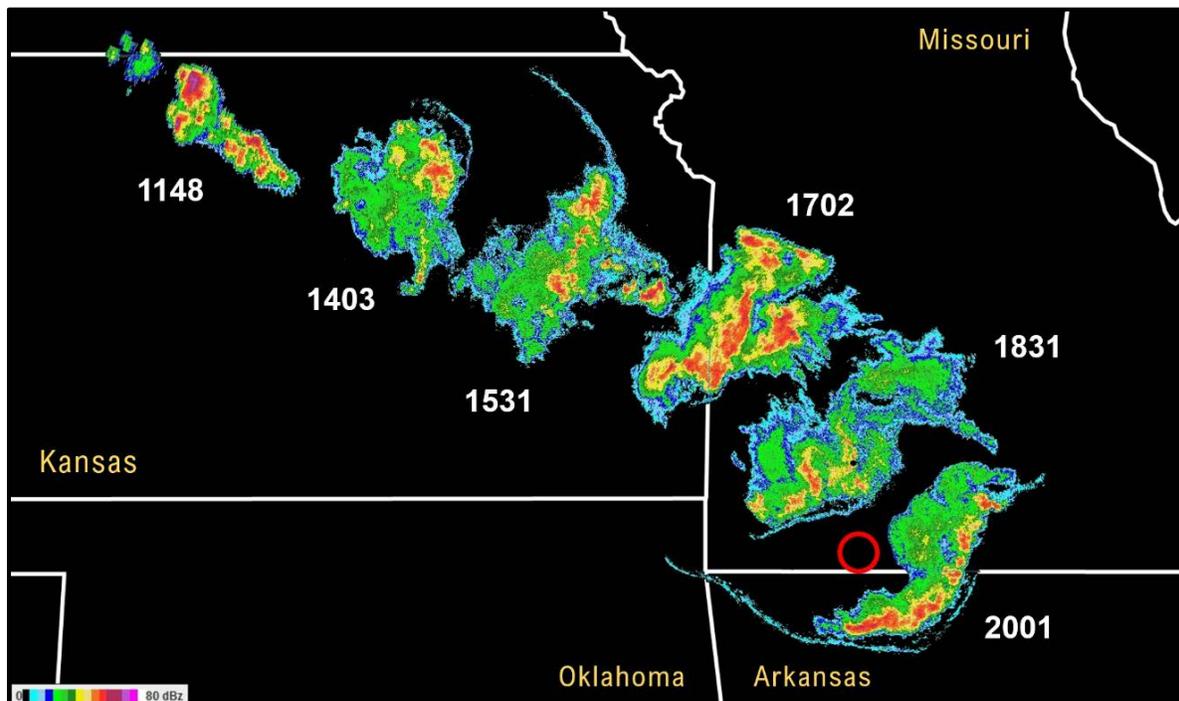


Figure 14. Mosaic of edited radar images depicting the progression of the derecho on July 19. Accident site is denoted by a red circle.

⁵⁹ Records in the National Weather Service’s severe thunderstorm and tornado database date back to 1950 for tornados and to 1955 for thunderstorm wind and hail. In May 2013, a tornado in Moore, Oklahoma, killed 24 people.

⁶⁰ Although new definitions have been proposed, the criteria defining a derecho in this report has been generally accepted by the meteorological community. Corfidi, Stephen F. Michael C. Coniglio, Ariel E. Cohen, and Corey M. Mead, “[A Proposed Revision to the Definition of ‘Derecho,’](#)” *Bulletin of the American Meteorological Society (BAMS)*, June 2016.

Storm Watch Issued. Weather-radar identification of the storm system began more than 7 hours prior to the accident time when the system was in northern Kansas, hundreds of miles away from the accident site. At 1120, the Storm Prediction Center issued a severe thunderstorm watch for portions of western and central Missouri, which included Branson, effective through the evening until 2100.⁶¹ The primary threats in the forecast included the following: “Widespread damaging winds likely with isolated significant gusts to 75 mph possible. Scattered large hail likely with isolated very large hail events to 2.5 inches in diameter possible. A tornado or two possible.” The severe thunderstorms were described as an “an increasingly organized convective cluster” across central Missouri that “should continue to intensify and gradually accelerate east/southeastward through the afternoon.”

Storm Warning Issued. Severe thunderstorm warnings are issued by National Weather Service weather forecast offices, which are responsible for a specific geographic area known as a county warning area.⁶² As the storm progressed through Missouri, the Springfield weather forecast office issued a severe thunderstorm warning effective at 1832—23 minutes before the *Stretch Duck 7* entered the lake—until 1930 for an area that included Branson and Table Rock Lake among the impacted locations. The warning advised of thunderstorms moving at 50 mph with wind gusts of 60 mph.

Postaccident analysis of radar imagery indicated that the storm had an “outflow boundary,” or gust front, ahead of the heavy rainfall region.⁶³ Over the next hour leading up to the accident, the outflow boundary was depicted ahead of the derecho as the system advanced to the southeast.

According to the meteorologist-in-charge, text of the severe thunderstorm warning included a description of the hazard(s), risk(s), impact(s), and timing of anticipated weather within the threat area, or polygon. [Figure 15](#) shows radar imagery of the storm system captured about 1829 when it was 29 miles away from the accident site. Overlaid onto the image is (1) a solid white line identifying the storm’s front, as defined by the senior forecaster; (2) a dashed white line identifying the shortest path the storm would have taken to the accident site if it was moving southeast; and (3) a yellow rectangle representing the polygon identified in the warning issued at 1832.

According to onboard video, the *Stretch Duck 7* first encountered storm-force winds around 1900. Based on the radar imagery reviewed by the NTSB, the outflow boundary impacted the accident location between 1859 and 1902, at which times this gust front was approximately 10–15 miles ahead of the storm system’s heavy rainfall.

⁶¹ A *severe thunderstorm* is a “thunderstorm that produces a tornado, winds of at least 58 mph (50 knots or ~93 km/h), and/or hail at least 1” in diameter.” A severe thunderstorm watch is issued “when conditions are favorable for the development of severe thunderstorms in and close to the watch area” and is “normally issued well in advance of the actual occurrence of severe weather.” See the National Weather Service’s [Severe Weather Definitions website](#).

⁶² (a) A severe thunderstorm warning is issued, usually for a duration of one hour, “when either a severe thunderstorm is indicated by the WSR-88D radar or a spotter reports a thunderstorm producing hail one inch or larger in diameter and/or winds equal or exceed 58 miles an hour....Severe thunderstorms can produce tornadoes with little or no advance warning. Lightning frequency is not a criterion for issuing a severe thunderstorm warning.” (b) The National Weather Service operates 122 weather forecast offices in six regions.

⁶³ (a) Radar imagery was provided through a WSR-88D radar located at Springfield Regional Airport, which was about 39 miles north of the accident site. (b) An *outflow boundary* is a surface boundary formed by the horizontal spreading of thunderstorm-cooled air and is known to introduce strong and/or shifting winds.

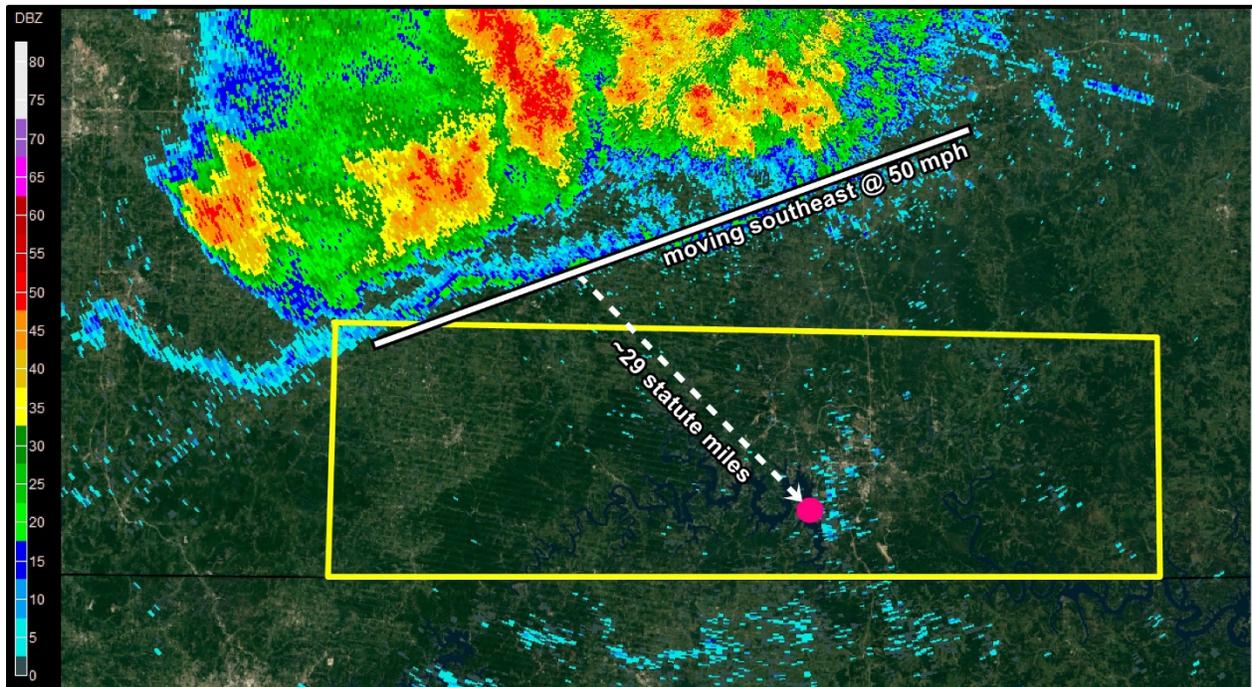


Figure 15. Radar image created postaccident from National Weather Service data captures the storm about 1829 as the gust front (solid white line) led the advancement of the system southeast toward Table Rock Lake (red dot). Yellow rectangle represents the threat area identified in the 1832 severe thunderstorm warning, which advised of 60-mph gusts.

1.11.2 Fetch and Wave Height

Wave height and period depend upon a number of factors, such as the speed and duration of the wind and its fetch.⁶⁴ The captain of the *Showboat Branson Belle*, which was docked within several hundred feet of the sinking, estimated that the wave height on Table Rock Lake during the time of the accident was 4 feet, trough-to-crest. The NTSB concluded that the estimated wave height was 3.5 feet, after performing a wave height study based on witness videos taken while the *Stretch Duck 7* was exposed to severe weather.

In the days following the accident, the National Weather Service calculated multiple values for fetch and the wave height on the lake. It concluded that Table Rock Lake has a very complex shoreline, so fetch was highly dependent on the direction of the wind, which was generally flowing from the north. Fetch distances ranged from as short as 1.55 miles to as long as 3.7 miles.

The National Weather Service estimated that, based on 45- to 55-knot winds for 30 minutes, wave heights were between 2.69 and 3.71 feet and could have been as high as 4.23 feet.⁶⁵ The wave period would have been between 2.7 and 3.6 seconds. According to the National Weather Service, the shorter the period, the more often the waves would have been affecting the vessel.

⁶⁴ *Fetch* is the straight distance the wind travels over the water's surface.

⁶⁵ The highest potential wave height was calculated by adding the longest fetch and 60-knot winds.

1.11.3 Anemometer Reading on *Showboat Branson Belle*

The *Showboat Branson Belle* was equipped with an anemometer, a weather instrument for measuring the speed of wind located approximately 60 feet above the vessel's waterline.⁶⁶ The maximum wind speed measured by the vessel's anemometer on the evening of the accident was 73 mph (about 63 knots) at 1910, which was an instantaneous reading. One of the showboat's captains estimated that over the course of the storm the wind speed was 50 mph (about 43 knots) with gusts to between 60 and 65 mph (about 52 and 56 knots).

1.11.4 Earth Networks' Data Available to Ride The Ducks

For its weather reports, Ride The Ducks had been subscribing to StreamerRT, a web-based application from Earth Networks, Inc., since January 2014. The general manager of Ride The Ducks informed NTSB investigators that StreamerRT was the company's "primary and sole source for weather information." A computer connected to a 50-inch monitor with constant access to StreamerRT was situated in the lounge at the Branson duck dock facility. While accessible by everyone in the company, the StreamerRT-designated computer was used primarily by crewmembers and management.

The operations manager also commended StreamerRT, saying that the application was much more accurate than anything they had used previously for weather information. Among the benefits, he stated, was the capability to identify their location on the map and to circumscribe it with a radius of 20 miles for impending storm identification.

Typically, the manager-on-duty would monitor the weather via StreamerRT, although there was no company requirement for doing so. Investigators were unable to determine whether the manager-on-duty assigned at the time that the *Stretch Duck 7* departed the facility was actively monitoring weather on the computer screen. After the accident, the operations manager stated that some of their vessel captains had the "KY3" application on their cell phones, which provided weather reports from the local news station, but they were not allowed to check their cell phones while on a duck boat.

StreamerRT provided various options for viewing local and national weather radar products based on data collected from all the WSR-88D radars from across the country.⁶⁷ The version 5.1 user guide stated—

StreamerRT is a real-time weather decision system that provides a fully interactive mapping platform with a comprehensive collection of weather data. Users have the ability to monitor real-time station observation data from the WeatherBug network and overlay numerous enhanced data sets to stay up-to-date with significant weather events before and after they develop.⁶⁸

⁶⁶ For specifications of the anemometer, see attachment 5 to the NTSB's meteorology group factual report in the public docket. The factual report provides details and references for the meteorological information summarized in this report.

⁶⁷ According to the National Weather Service, WSR-88D is "one of the most powerful and advanced Weather Surveillance Doppler Radar in the world" and is used at over 160 locations across the United States.

⁶⁸ Earth Networks sold WeatherBug in November 2016, after the manual was published in July 2015.

The data sets available for selection to overlay on a map included National Weather Service watches and warnings for severe weather; Earth Networks' "dangerous thunderstorm alerts"; surface-based wind observation information; weather radar imagery, including "Doppler radar 1km [kilometer] composite" and single-site 0.5-degree imagery; and lightning data.

However, it is not known what overlays were active on the StreamerRT display in the office lounge on the day of the accident (see [figure 16](#)). According to Earth Networks, there were no system or data anomalies that day, and StreamerRT was operating as designed.

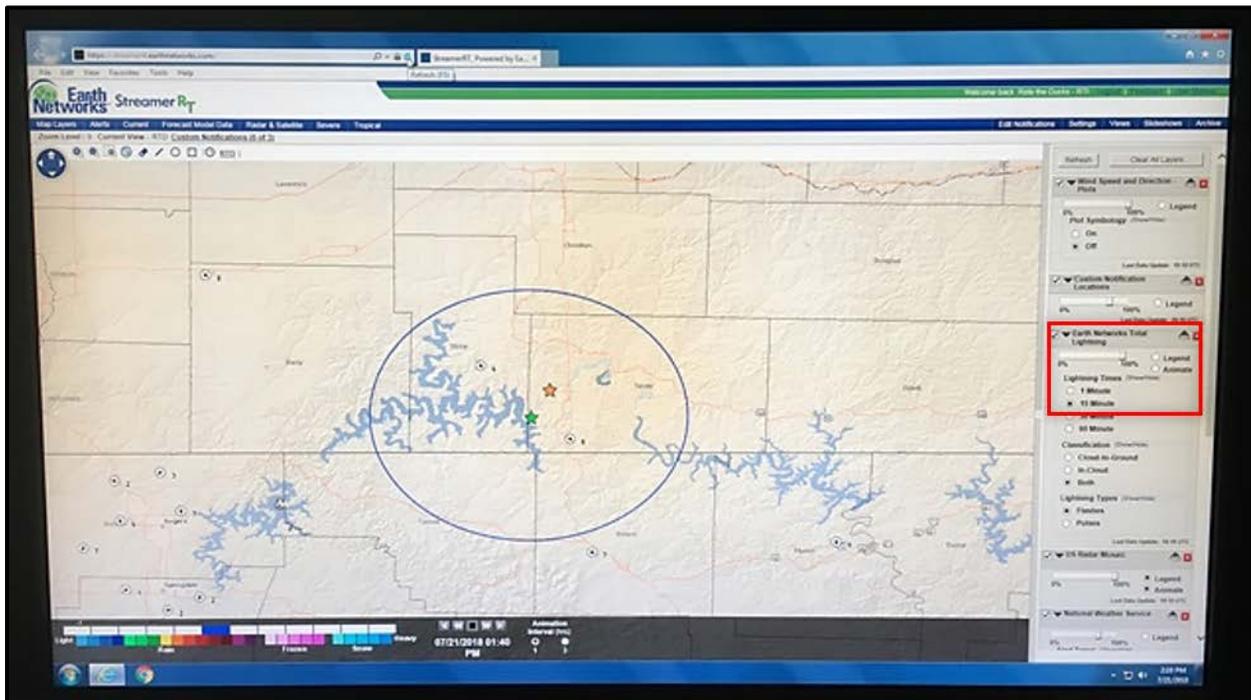


Figure 16. Screenshot of the StreamerRT display on the monitor in Ride The Ducks' lounge taken 2 days after the accident. Fifteen-minute lightning option was selected, as indicated by the red square.

Lightning Data. Lightning, including both cloud-to-ground and intracloud, was first identified as having occurred within 20 miles of the accident site at 1846 and within 10 miles at 1900.⁶⁹ A graphic of the data for the lightning, which was updated every minute, would have been displayed on the StreamerRT monitor in the Ride The Ducks' lounge. Although [figure 16](#) shows that the 15-minute lightning option in StreamerRT was selected, the operations manager said the 1-minute depiction was their preference. As he explained, the 1-minute lightning time was "as close to real time as we can get so that we know what is going to happen, not what has happened," compared to the 15-minute version, which "looks like hell is coming."

US Radar Mosaic. For the "Radar & Satellite" option in StreamerRT, Ride The Ducks personnel primarily used the "US Radar Mosaic" as standard. For other parameter options, most simply relied on the raw data presented on the screen, according to the operations manager. [Figure 17](#) shows one of the radar mosaic products displayed in StreamerRT that were available to users during

⁶⁹ See attachment 4 to the NTSB's meteorology group factual report for tabular lightning data between 1805 and 1905 obtained from the National Lightning Detection Network and the Earth Networks Total Lightning Network. Graphics depicting the lightning are also included.

the times surrounding the accident. It first was presented at 1825, 3 minutes before passengers began boarding the *Stretch Duck 7*.

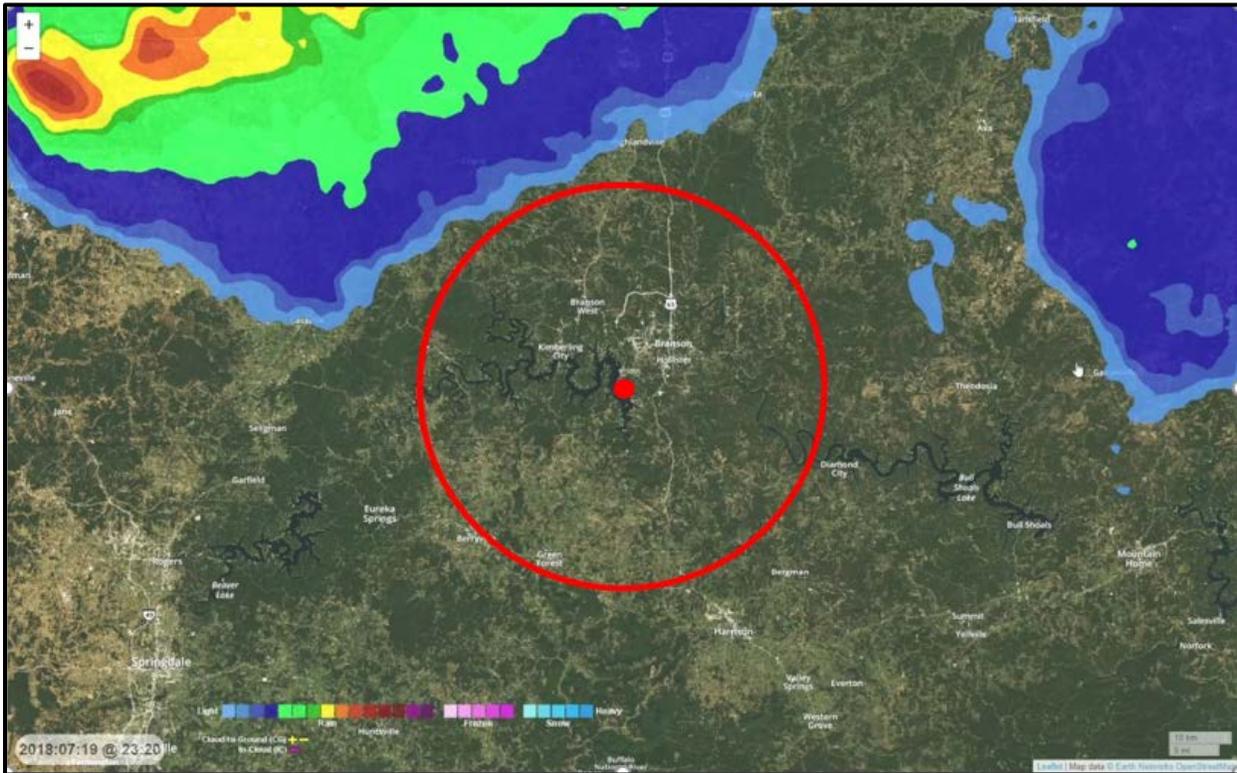


Figure 17. US Radar Mosaic product displayed on the StreamerRT monitor at 1825. Small red dot denotes a point very close to the accident location within a red circle that represents a radius of 20 miles. (The product has been mapped to a different background than what would have been seen in StreamerRT.)

Dangerous Thunderstorm Alerts. Numerous dangerous thunderstorm alerts from Earth Networks were active in southwestern Missouri on the evening of the accident, and one such alert was active for the accident location. According to the StreamerRT user guide, these alerts were issued when “lightning rates exceed 25 flashes/minute” and there was “an increased threat of heavy rain rates, dangerous lightning, hail, strong winds and tornadic activity.”

Email Alerts. StreamerRT customers also could be notified of dangerous thunderstorm alerts by email, but Ride The Ducks had not established this type of alert. The operations manager told investigators that the dangerous thunderstorm alert feature can result in nuisance alerts.

The StreamerRT user guide indicated that customers could elect to receive email alerts when certain weather events or weather-related products (for example, National Weather Service watches or warnings) cover a specified point or occur within a selected distance of a specified point.⁷⁰ The operations manager at Ride The Ducks stated that some staff members were designated to receive email alerts for certain phenomena within 20 miles of their location. The range was for a 20-minute lead time, assuming a storm motion of 1 mile per minute (60 mph). According to the operations manager, if a hazard for which they would be alerted entered within the 20-mile radius, the workstation in the office lounge would make a “chirping” sound (three sessions of five chirps each

⁷⁰ See section 10.1 in the user guide, which is included as attachment 17 to the NTSB’s meteorology group factual report.

for a total of 15). In addition, an email would be sent to the operations manager, the general manager, a deckhand, and several others.

According to Earth Networks, Ride The Ducks had elected to receive alerts via email for the following events occurring at State Park Marina (the location the company chose for its point of notification):

- Lightning (cloud-to-ground or intracloud)
- Outdoor temperature greater than 95°F
- National Weather Service severe weather alerts (tornado warnings, tornado watches, severe thunderstorm warnings, severe thunderstorm watches, and flash flood warnings)
- Wind-speed (average) observation of greater than 35 mph
- Wind-speed observation of greater than 30 mph

The operations manager provided the NTSB with the email alerts he received on the day of the accident. Earth Networks also provided copies of all the alerts emailed to Ride The Ducks on that day. These emails are summarized below.⁷¹

Table 2. Summary of weather alerts emailed to Ride The Ducks.

Email Alert Time	Applicable Message(s) Selected
1128	Severe thunderstorm watch issued by the Storm Prediction Center at 1120 for an area that included Stone County and Taney County, Missouri
1226	Severe thunderstorm watch issued by the Storm Prediction Center at 1120 for an area that included Stone County and Taney County, Missouri
1617	Severe thunderstorm watch issued by the Storm Prediction Center at 1120 for an area that included Stone County and Taney County, Missouri
1810	Severe thunderstorm watch issued by the Storm Prediction Center at 1120 for an area that included Stone County and Taney County, Missouri
1832	Severe thunderstorm warning issued by the National Weather Service Springfield weather forecast office at 1832 for an area that included Stone County and Taney County, Missouri
1849	Lightning occurred 19.27 miles away
1902	Severe thunderstorm warning initially issued by the National Weather Service Springfield weather forecast office at 1832 for an area that included Stone County and Taney County, Missouri
1903	Severe thunderstorm watch issued by the Storm Prediction Center at 1120 for an area that included Stone County and Taney County, Missouri
1910	"Wind speed" observation of 31.07 mph occurred in Branson West, Missouri
1919	Severe thunderstorm warning initially issued by the National Weather Service Springfield weather forecast office at 1832 for an area that included Stone County and Taney County, Missouri
1936	"Wind speed (average)" observation of 41.43 mph occurred in Ridgedale, Missouri

⁷¹ The original emails are presented in attachment 18 to the meteorology group factual report. As established by Ride The Ducks, not all alerts were sent to the same email address.

StreamerRT Training. The operations manager stated that he and another manager received a two-hour virtual training session on StreamerRT and that Ride The Ducks management received training when the system was first purchased. Details of crew training were unknown by the general manager. According to Earth Networks, an hour-and-a-half online training/webinar on StreamerRT took place likely in March 2014. In September 2015, an email was sent from the assistant general manager at Ride The Ducks to Earth Networks requesting to schedule some training on StreamerRT to “better understand all the features.” It is not known what, if any, training was provided for this request.

1.12 Postaccident Tests

On July 25, 2018, the recovered *Stretch Duck 7* was inspected at a secure facility in Missouri by NTSB investigators and party representatives.

1.12.1 Curtain Release

A test of the starboard-side curtain release was conducted. The curtain released from the side of the vessel in about one second.

1.12.2 Bilge System

An external battery was connected to the bilge alarm system, which was located on the starboard side of the captain’s station. Each bilge float was tested and successfully registered on the panel with audio and red visible alarms for the following four areas: sea chest, mid-section, forward, and aft. The only issue was that the audible alarm was unable to be silenced.

The battery was connected to the automatic bilge-float activation function for each of the bilge pumps on the vessel. When the water level was raised to activate the bilge switch, the pump automatically started in each case. When the level dropped below the activation level, the pumps automatically stopped. The external battery was then relocated to the engine compartment and connected to each bilge circuit to test the operation of the indicating lights on the dashboard console. In each of the three pump locations, the yellow (amber) indicating lights were illuminated when the pumps were operational.

Each bilge pump was operationally tested using an external 12-volt battery connected to the electrical wires locally at each pump. The pumps, which were tested using existing bilge water that had accumulated during the sinking, operated near rated capacity.

1.12.3 Engine Compartment Air Shutoff System

The closing system for the port- and starboard-side air intake dampers was tested by pulling each lever at the driver’s console to inboard. In both cases, the dampers shut closed. The vessel was found at the bottom of the lake with the side dampers in the open position, and the hood cover in the closed position. The bow hatch was also found with the damper in the closed position. Investigators applied weights to the top of the bow air intake damper and determined that approximately 3 pounds opened the damper.

1.12.4 Steering System

The steering system was tested after jacking up the front wheels. Using the steering wheel, the front wheels and rudder properly responded to the input commands of the steering wheel.

1.12.5 DVR Recovery/Transcription

The *Stretch Duck 7* was equipped with a mobile digital recorder. The unit was a DVR with audio recording capabilities for vehicle-mounted application that could receive and record footage from up to eight cameras simultaneously, as well as record parametric data such as GPS position, wheel speed, and “G force.” The device used both a hard disk drive (HDD) and a removeable Secure Digital (SD) card for video and audio recordkeeping. The HDD stored the complete dataset from the mobile digital recorder (video, audio, and parametric data). The SD card only stored video and audio data due to memory limitations of the disk.

The *Stretch Duck 7*'s HDD was recovered from Table Rock Lake by Missouri State Highway Patrol divers on July 20, 2018, in 85 feet of water. The SD card was recovered by the state's highway patrol divers 3 days later. Both devices were transported to the NTSB vehicle recorder laboratory in Washington, DC.

After rinsing and evaluating the HDD, NTSB specialists determined that it showed signs of water exposure and slight corrosion damage. The damage required repair in a clean room facility. An assisting federal agency with a clean room attempted to repair the HDD but was unsuccessful. No data thereby was recovered from the HDD. The SD card recovered was rinsed and dried using a vacuum drying oven. It was read using the manufacturer's software and suggested procedures, normally and without difficulty. HDD and SD cards associated with the *Stretch Duck 17*, *Stretch Duck 27*, and *Stretch Duck 54* were read on scene via a personal computer using the manufacturer's software, normally and without difficulty. The drives were then transported to the NTSB's lab for further analysis.

In September 2018, a transcription group convened to transcribe the video and the audible comments deemed pertinent to the accident investigation.

1.12.6 Video Study

GPS data, which included position and speed, was downloaded from the *Stretch Duck 54*'s DVR system but could not be obtained from the *Stretch Duck 7*'s DVR hard drive due to water damage. The NTSB therefore conducted a video study to estimate the locations and speed of the *Stretch Duck 7* along its path from the lake entry ramp to the location where it sank. Two videos were used in the analysis. The first video was recorded by a rear-facing camera mounted on the *Stretch Duck 54*, which entered the lake shortly before the *Stretch Duck 7* and made it successfully to the exit ramp. The second video was recorded by a person on board the moored *Showboat Branson Belle* using a handheld smartphone. The video recordings from the devices allowed the NTSB to calculate a trackline for the *Stretch Duck 7* along with accurate speed estimates.

1.13 Postaccident Actions

1.13.1 Ride The Ducks

In July 2018, Ride The Ducks ceased operations in Branson for the remainder of the season. In March 2019, the company announced that it was not going to operate its amphibious vessels and that it would be replacing the duck dock building with an amusement facility. The next month, Ride The Ducks sold 18 DUKW vessels to another operator and placed the remaining Branson vessels into storage.

1.13.2 Coast Guard

On August 1, 2018, the Coast Guard issued an “Amphibious Passenger Vessel (APV) Inspection Direction,” which announced the convening of its Marine Board of Investigation to determine the cause of the *Stretch Duck 7* sinking. (At the time of this report, the hearings have not yet been scheduled.) The guidance directed Officers-in-Charge, Marine Inspection and the marine inspectors under their direction to “immediately focus” on the vessels’ crews and operating conditions, as well as owners or operating companies, and to take action that involves

- A “concentrated review” of APVs, restrictions on the COIs, and operating manuals, including ensuring crewmembers’ awareness of their obligations under existing regulations and NVIC 1-01.
- Possibly amending the operating requirements of the vessels’ COIs to require the captain to (1) conduct a voyage risk assessment no more than 30 minutes prior to departure that evaluates the capability of the vessel within the forecasted environmental and operational conditions; (2) identify methods and locations for escape options along the route; and (3) evaluate the vessel’s loaded condition. These assessments and evaluations were to be logged and transmitted to a designated person ashore.

The Coast Guard also published the Marine Safety Information Bulletin *Amphibious Passenger Vessel Operations* summarizing these guidelines (USCG 2018).⁷²

In the interim of investigating the *Stretch Duck 7* sinking, the NTSB issued two recommendations to the Coast Guard on November 13, 2019, addressing the insufficient reserve buoyancy of DUKW amphibious vessels and their impediments to passenger emergency egress. The Coast Guard concurred with one of the recommendations and “partially” concurred with the other in an April 15, 2020, letter. A summary of the Coast Guard’s response to these and previously issued recommendations concerning DUKW vessels is covered in the next section, [1.14](#), “Related Safety Recommendations Previously Issued.”

1.14 Related Safety Recommendations Previously Issued

From 1999 to the time of the *Stretch Duck 7* sinking, the NTSB issued 22 safety recommendations related to modified WWII-era DUKW amphibious passenger vessels that were addressed to the Coast Guard, National Highway Traffic Safety Administration, several states,

⁷² See [Marine Safety Information Bulletin number 06-18](#).

numerous APV operators/owners, and other stakeholders.⁷³ Nine of the recommendations received responses that either complied with, met the objective of, or surpassed what the NTSB recommended; four remained pending, indicating a planned action that, when completed, would comply with the safety recommendation; and for the other nine, the recipient either disagreed with the recommendation or otherwise did not plan to satisfy it. The overall status of these recommendations as classified by the NTSB is identified in the table below.

Table 3. Status of APV-related safety recommendations issued 1999–2017.

Overall Status	Subtotal	Total
<i>Closed—Acceptable Action</i>	7	
<i>Closed—Acceptable Alternate Action</i>	1	9
<i>Closed—Exceeds Recommended Action</i>	1	
<i>Open—Acceptable Response</i>	4	4
<i>Open—Unacceptable Response</i>	2	
<i>Closed—Unacceptable Action/No Response Received</i>	2	9
<i>Closed—Unacceptable Action</i>	5	

Five of the safety recommendations were issued nearly two decades ago in response to the sinking of the *Miss Majestic*. In one of the deadliest accidents involving a modified WWII DUKW at the time, 13 of the 20 passengers on board the *Miss Majestic* lost their lives during an excursion tour in Lake Hamilton near Hot Springs, Arkansas, on May 1, 1999, about 7 minutes after entering the lake. Most of the passengers and the operator were trapped by the vessel’s canopy and drawn under water, except one passenger who escaped before it submerged. The lack of reserve buoyancy on the vessel and the danger of the canopy installed were identified as important safety issues. However, nearly all the recommendations issued after the accident were classified “Closed—Unacceptable Action,” indicating that the recipient did not take the recommended action. The one recommendation that was closed acceptably requested the Coast Guard develop and promulgate guidance for all amphibious passenger vessels similar to its NVIC 1-01 guidance, which was published after the accident.

The first two of the safety recommendations issued after the *Miss Majestic* sinking addressed the insufficient reserve buoyancy of amphibious passenger vessels, in light of the NTSB’s immediate concerns about the risk of flooding and the vulnerability to sinking for these types of vessels. Safety Recommendation M-00-5, however, was classified overall “Closed—Unacceptable Action/No Response Received,” because almost half of the 30 APV operators and refurbishers to which it was addressed never responded.⁷⁴ Safety Recommendation M-02-1, which was issued subsequently to

⁷³ The 22 safety recommendations were issued in response to the following three accidents: (1) *Sinking of the Amphibious Passenger Vehicle Miss Majestic, Lake Hamilton, Near Hot Springs, Arkansas, May 1, 1999.* [MAR-02/01](#). Washington, DC: NTSB. (2) *Collision of TugBoat/Barge Caribbean Sea/The Resource with Amphibious Passenger Vehicle DUKW 34, Philadelphia, Pennsylvania, July 7, 2010.* [MAR-11/02](#). Washington, DC: NTSB. (3) *Amphibious Passenger Vehicle DUCK 6 Lane Crossover Collision With Motorcoach on State Route 99, Aurora Bridge, Seattle, Washington, September 24, 2015.* [HAR-16/02](#). Washington, DC: NTSB. For more information, see www.nts.gov. While most of the recommendations addressed the operation and design of APVs or DUKW vessels, four addressed the use of cell phones during operation. For a complete listing of the recommendations, see [appendix B](#).

⁷⁴ Although Safety Recommendation M-00-5 was classified overall “Closed—Unacceptable Action/No Response Received” based on the majority of responses, the classifications for the individual recipients included the following:

the Coast Guard among addressees, was classified similarly, as “Closed—Unacceptable Action.” The Coast Guard did not concur with the recommendation, stating in its response that “sufficient requirements and guidance are in place to provide to amphibious passenger vessels a level of safety equivalent to other passenger vessels of similar size and capacity,” such as certain *CFR* regulations and its NVIC 1-01 guidance.

As the third recommendation in the series, Safety Recommendation M-02-2 required the “removal of canopies for waterborne operations or installation of a Coast Guard-approved canopy that does not restrict either horizontal or vertical escape” until the sufficient reserve buoyancy requirement was met. Referring again to the NVIC, the Coast Guard stated that it believed the guidance was “sufficient” for the safety concerns discussed in the recommendation. The NTSB disagreed, as it sought to establish a requirement for removing canopies, or installing Coast Guard-approved versions, rather than for voluntary compliance with previous guidance. As a result, the recommendation was classified “Closed—Unacceptable Action.”

Due to the significant loss of life in the *Miss Majestic* and, more recently, the *Stretch Duck 7* accidents, on November 6, 2019, the NTSB issued the following two similar recommendations to the Coast Guard in the safety recommendation report *Improving Vessel Survivability and Passenger Emergency Egress of DUKW Amphibious Passenger Vessels* (MSR-19-01):⁷⁵

Require DUKW amphibious passenger vessels (commonly referred to as original and/or “stretch” DUKWs) to have sufficient reserve buoyancy through passive means, so that they remain upright and afloat with a full complement of passengers and crewmembers in the event of damage or flooding. (M-19-15)

For DUKW amphibious passenger vessels without sufficient reserve buoyancy (commonly referred to as original and/or “stretch” DUKWs), require the removal of canopies, side curtains, and their associated framing during waterborne operations to improve emergency egress in the event of sinking. (M-19-16)

Currently, both recommendations are classified “Open—Initial Response Received.” In an April 15, 2020, letter to the NTSB, the Coast Guard stated that it partially concurred with Safety Recommendation M-19-15, explaining

While we agree that providing reserve buoyancy through passive means would increase the safety of the amphibious passenger vessel fleet, we are concerned that there may not be a feasible solution to achieve the stated goal. Modeling analysis conducted on DUKWs by the USCG has indicated that there is not sufficient below deck volume to provide reserve buoyancy using foam or watertight subdivision to

14 “Closed—Unacceptable Action/No Response Received,” 13 “Closed—Acceptable Alternate Action,” 1 “Closed—Acceptable Action,” and 2 “Closed—No Longer Applicable.”

Ride The Ducks International was one of the 13 operators whose recommendation was closed as an acceptable alternate action. The NTSB stated in a February 4, 2008, letter to Ride The Ducks International that the company’s intention to improve the survivability of its vessels, “in conjunction with the use of NVIC 1-01 as the primary guidance document for all APV inspections and operations, satisfy the intent of the recommendation.”

⁷⁵ The report discusses in greater detail the earlier safety recommendations associated with the *Miss Majestic* sinking regarding reserve buoyancy and impediments, as well as includes a brief summary of the six accidents involving amphibious passenger vessels the NTSB has investigated. In many of these accidents, at least one fatality resulted. A copy of the safety recommendation report is available in [appendix C](#).

enable the vessels to remain afloat and upright in the damaged condition. This would create a requirement that is not technically and/or practically achievable. As such, we are not convinced at this time that pursuing such a requirement is the appropriate course of action.

The Coast Guard pointed to NVIC 1-01 and additional safety guidance it issued on August 1, 2018, as current efforts for assessing the safety of amphibious passenger vessels and their operation. “Any future consideration,” it said, “will be guided by the findings and recommendations provided from the investigations” by the NTSB and the Coast Guard’s Marine Board of Investigation into the sinking of the *Stretch Duck 7*.

Regarding Safety Recommendation M-19-16, which addressed the removal of canopies, the Coast Guard fully concurred in its letter. On April 22, 2020, the Coast Guard issued a Marine Safety Information Bulletin entitled *Recommendation for DUKW Passenger Vessel Canopy Removal* as a “first step” in addressing the canopy issue or identifying “other engineering solutions” to improve emergency egress (USCG 2020).⁷⁶ The notice instructed owners and operators choosing to remove canopies to arrange an inspection and stability review “prior to recommencing operations.” In addition, it announced the Coast Guard’s intention to update NVIC 1-01 with input from the public and industry stakeholders.

⁷⁶ See [Marine Safety Information Bulletin number 15-20](#).

2 Analysis

2.1 General

The analysis first identifies factors that can be eliminated as causal or contributory to the cause of the sinking of the *Stretch Duck 7*. The following issues are discussed next:

- Company oversight
- Engine compartment ventilation closures
- Reserve buoyancy
- Survivability
- Coast Guard oversight

2.2 Exclusions

2.2.1 Propulsion, Steering, and Bilge Systems

Investigators reviewed the DVR recordings from the sunken *Stretch Duck 7*. The aft camera recorded propeller wash (thrust) coming from the stern of the vessel throughout the waterborne portion of the tour. There were no comments heard from the captain indicating that there was a loss of propulsion. A video study conducted by the NTSB estimated that once the winds increased, the vessel was consistently moving ahead into the wind at about 1.7 knots while trying to exit the lake; the speed did not drop to zero until the end of the recording.

The vessel was examined after recovery, and the steering system was tested after jacking up the front wheels. Investigators found that the front wheels and rudder properly responded to the input commands from the steering wheel.

The interior video camera on board the *Stretch Duck 7* recorded bilge alarms sounding minutes after the vessel encountered severe weather. The exterior video camera on the port side recorded bilge water being pumped overboard, indicating that a bilge pump was operating. After the vessel was recovered, the bilge pumps' auto-start function and associated alarms were tested with an external power source: all functioned properly. Based on these findings, the NTSB concludes that the *Stretch Duck 7*'s propulsion, steering, and bilge systems operated normally and thus were not factors in this accident.

2.2.2 Drugs/Alcohol

Ride The Ducks provided investigators with log sheets tracking the trip histories of the captain and driver for more than a week before the accident. These sheets indicated that the captain made four to five trips per day, starting with either the 0830 or 0900 tour and ending the day from 1430 until 1800. The driver also averaged four to five trips each day, typically starting with the 0930 or 1000 tour and concluding with the last trip, which varied from 1500 until 1800. Hours of rest were not recorded, and investigators were not able to interview the captain.

Toxicological tests conducted on the captain postaccident indicated that there were no alcohol or other drugs in his system. Postmortem tests of the driver indicated that there were no

alcohol or potentially impairing drugs in his system. The NTSB concludes that neither alcohol nor other impairing drugs were factors in this accident.

2.3 Company Oversight

2.3.1 Severe Thunderstorm Watch and Warning

The National Weather Service Storm Prediction Center issued a severe thunderstorm watch at 1120 effective until 2100 for an area that included the accident location. The watch advised that “an increasingly organized convective cluster across central Missouri should continue to intensify and gradually accelerate east/southeastward through the afternoon.” One of the primary threats identified was “widespread damaging winds...with isolated significant gusts to 75 mph.” The possibility of hail 2.5 inches in diameter and a “tornado or two” also was forecasted.

At 1832, the National Weather Service weather forecast office in Springfield, Missouri, issued a severe thunderstorm warning effective until 1930 advising of 60-mph wind gusts for an area that included specifically Table Rock Lake. By 1900, the storm had reached the lake, as winds had increased from 5 to over 50 mph. About 1910, the anemometer aboard the *Showboat Branson Belle* recorded the highest gust at 73 mph. Considering the severe thunderstorm watch issued more than 7 hours before the sinking of the *Stretch Duck 7* and later the warning forecasting the weather events that occurred through the time it sank, the National Weather Service provided appropriate public notification of a specific severe thunderstorm threat to the accident region. The NTSB therefore concludes that on the day of the accident, the National Weather Service accurately forecasted and issued timely notifications of a severe thunderstorm that would impact the accident location.

2.3.2 Weather Monitoring

Given the accurate forecast and sufficient amount of weather information sources available to Ride The Ducks, investigators sought to understand why the company did not suspend water operations as the storm approached. Although the *Stretch Duck 7* was the only vessel to sink, the other three duck boats operating around that time were put at risk too. The *Stretch Duck 54*, which was also on the lake when the storm arrived, struggled to reach shore. The *Stretch Duck 27* and the *Stretch Duck 17*, having just exited the lake, narrowly escaped the effects of the storm on the water.

Although investigators were not able to interview key personnel from Ride The Ducks, the manager-on-duty working on the evening of the accident was aware of the threat of inclement weather for the final tour of the *Stretch Duck 7*, before the vessel departed the roadside duck dock facility 6 miles away from the lake. The fact that the manager-on-duty instructed the driver and captain to conduct the waterborne portion of the tour first as an attempt to complete the tour on the lake before the storm arrived reveals his foreknowledge of the weather event. More than likely, he was aware of the severe thunderstorm watch calling for the possibility of damaging winds and gusts to 75 mph that had been in effect since 1120, although investigators were unable to determine exactly what weather tools or forecasts he may have relied on throughout the day.

About a minute before the *Stretch Duck 7* departed the duck dock on the accident tour, the National Weather Service issued a severe thunderstorm warning at 1832 indicating that the storm system was moving southeast toward Table Rock Lake with 60-mph wind gusts. Whether the manager-on-duty was aware of this warning, investigators were unable to determine; however, given

that the severe thunderstorm watch was effective throughout the day, Ride The Ducks should have been monitoring the approaching storm. Had the company's operations team seen the warning, they could have predicted that all the tours under way could be impacted by the weather while on the water. In fact, all four duck boats conducting tours on the evening of the accident entered the water *after* the warning was issued: the first one, 13 minutes afterward; the *Stretch Duck 7*, 23 minutes later.

Even if the manager-on-duty did not see the severe thunderstorm warning, there were other opportunities for Ride The Ducks to recognize the risk that the approaching storm posed to its duck boats and passengers. The company's weather service, StreamerRT, provided email alerts to certain company personnel, including the manager-on-duty. Email alerts were sent for the severe thunderstorm warning at 1832, as well as for an observation of lightning (within 20 miles) at 1849 (investigators were unable to determine whether these emails were read by Ride The Ducks personnel). Furthermore, at 1850, a passenger on the *Stretch Duck 27* while under way reported seeing lightning to the captain, who was also Ride The Ducks' general manager. Yet, despite acknowledging to the passenger that lightning was one of the conditions that would cease operations, the general manager did not report this information to the duck dock or to the crews of the other nearby duck boats, two of which were about to enter the water.

Although investigators were not able to determine what weather resources the manager-on-duty used for decision-making, he likely relied on the StreamerRT radar display in the company's lounge. This display would have shown a color depiction of the storm as it approached. However, relying solely on such radar imagery can be misleading. Weather information processed by providers like StreamerRT can introduce timing delays. In addition, radar imagery does not typically show the leading edge of the storm (outflow boundary). In this case, the rapidly moving storm produced strong and sustained winds that reached the accident location minutes ahead of the main storm, as depicted by the orange and red colors on the StreamerRT storm intensity graphic. Relying solely on the radar display, therefore, may have given the impression that there was sufficient time for vessels to complete the waterborne tour before the storm would reach the lake.

Sufficient information was available regarding the anticipated intensity and timing of the approaching storm through various means, including broadcasted severe thunderstorm watches and warnings, local media, and in-house weather software alerts. Despite the available information, Ride The Ducks allowed four of its vessels to enter the water in close proximity to the approaching weather. Therefore, the NTSB concludes that Ride The Ducks did not effectively use all available weather information to monitor the approaching severe weather and assess the risk it posed to its waterborne operations.

2.3.3 Water-Entry Restrictions

The restrictions placed on Ride The Ducks' vessels by their COIs were clear, prohibiting them from operating in winds of over 35 knots or in waves greater than 2 feet. These COI restrictions were intended to prevent vessel operations during severe weather, which could be hazardous to amphibious vessels—vessels with low freeboard and subject to rapid sinking. In addition, the company's operations manual prohibited water entry when lightning was present or severe weather was approaching the area.

Based on the weather forecasts, Ride The Ducks' vessels would have been exposed to conditions that exceeded those limits. While the severe thunderstorm warning issued at 1832 was in

effect until 1930, the *Stretch Duck 27* entered the lake at 1845, the *Stretch Duck 17* at 1847, the *Stretch Duck 54* at 1854, and the *Stretch Duck 7* at 1855. (Figure 18 provides a graphic timeline of their water entry and exit during the period of the warning as well as the watch that was previously issued.) This span of 13 to 23 minutes after issuance of the severe thunderstorm warning provided sufficient time to suspend operations for the last tours of the evening. Furthermore, considering that the waterborne tours typically took about 20–25 minutes to complete, the last tour, which was the *Stretch Duck 7*'s, would not have been expected to finish until about 1915 to 1920, about 45–50 minutes after the warning was issued. Continuing with the tour would have placed the *Stretch Duck 7* on the water throughout the latter half of the warning.

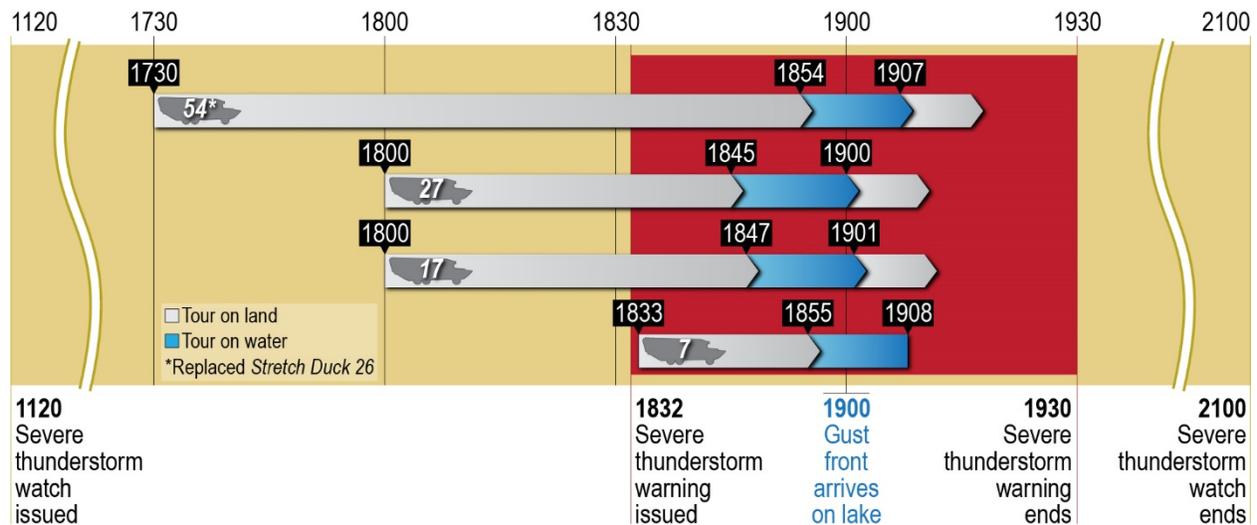


Figure 18. Timeline tracking the tours of the four duck boats while on land (gray bar) and on water (blue bar) in relation to the severe thunderstorm watch and warning issued at 1120 and 1832, respectively. Tours begin with departure from Ride the Ducks' passenger boarding facility, follow to entry in Table Rock Lake, and complete with return to the duck dock, except for the *Stretch Duck 7*.

The operator of the passenger vessel *Showboat Branson Belle*, which was moored between the entry and exit ramps during the duck boats' lake tour, stopped the boarding process that had begun at 1850 after encountering the 60-mph winds. The evening cruise was subsequently cancelled.

Considering that Ride The Ducks was aware of the severe thunderstorm watch, active monitoring of the weather in anticipation of a potential severe thunderstorm warning would have been prudent. Yet, knowing that severe thunderstorms were approaching the area, the manager-on-duty allowed three duck tours to continue the waterborne portion of the tour as scheduled and modified the tour for the *Stretch Duck 7* with the intent to complete the waterborne portion prior to the arrival of the storm. Although the storm's outflow boundary was not visible on the StreamerRT radar display available to Ride The Ducks' operations team, the time between the gust front and the storm following it that was captured on radar was only a matter of about 10 minutes. More consideration should have been given to the risks involved, especially since the forecast called for conditions that exceeded the wind-speed restrictions on the vessels' COIs. Trying to squeeze in tours ahead of the oncoming weather did not allow for a sufficient margin of safety on the water, nor did it account for operational emergencies or casualties that could occur, such as a vessel's loss of propulsion. Therefore, the NTSB concludes that Ride The Ducks should have suspended waterborne operations for the *Stretch Duck 7* and the other last tours of the day in anticipation of imminent severe weather.

2.3.4 Company's Actions

Ride The Ducks' company policy directed operational decision-making to the captains of its vessels. The operations manual instructed captains to forego water entry when severe weather was approaching the area or when conditions exceeded the restrictions on the COI. However, once the captain of the *Stretch Duck 7* began the tour, his source of weather information was based solely on a visual assessment of the conditions upon his arrival at the entry ramp. Although the lake was calm when the vessel entered the water, the arrival of the derecho quickly produced wind and wave conditions that exceeded the operating limits on the vessel's COI. The manager-on-duty, by contrast, had continual access to tools for monitoring the oncoming weather, such as radar images on the StreamerRT monitor, weather alert emails, and local broadcasts. Although the manager-on-duty recognized some level of risk from the approaching weather based on his decision to have the *Stretch Duck 7* complete the lake tour first, there is no evidence that the company assessed the risk that the forecasted weather would have on conditions throughout the duration of the waterborne segment of the tour, nor was it evident that its operations team continued to monitor the approaching weather after the tour commenced.

The company's policy not only directed the decision-making to the captains, rather than the managers-on-duty who had greater access to weather information, but, given the operational limitations of the duck boats, it did not include specific guidance for determining whether it was safe to commence waterborne operations. For instance, there were no specific instructions on how to respond to an immediate weather alert, such as the 1832 severe thunderstorm warning, which, if received, should have been a sufficient and timely notice to cease further operations. Ride The Ducks did not have a "go/no-go" policy to determine whether to leave the duck dock or enter the water in the advent, or forecasting, of adverse weather conditions. If such a policy existed that factored in the timing of approaching severe weather (based on severe weather watches and warnings) and the risk to the safe operations of the waterborne portion of the tour, the manager-on-duty would have been relieved from having to make a subjective decision to continue with the tours.

Operating procedures that strictly delineate the conditions under which vessels will be allowed to operate are frequently referred to as go/no-go specifications. Although Ride The Ducks' operations manual referenced "severe weather" as a criterion, it did not specify the parameters of weather events with quantifiable measures. For example, if a threshold had been established based on the severity of the storm, and its distance and/or timing of its arrival to the area, Ride The Ducks' duty managers and captains would have had a clear mandate to advise passengers that forecasted conditions were in excess of their policy and to suspend operations in a timely manner before arrival of the storm. Also, a go/no-go policy would provide a means to negate personal and professional pressure to accommodate expectant passengers who have booked and paid for tours. Decision-makers thereby are relieved from having to make decisions based on individual assessments or subjective decisions rather than well-defined and established criteria.

According to interviews, Ride The Ducks' management had postponed tours in the week before the accident due to thunderstorms, indicating their ability to assess the weather and their willingness to take action. However, without specific and actionable guidance, as found in a go/no-go policy, managers relied on previous experience and individual assessment of conditions while being subject to commercial pressure and passenger expectations for completing the tour. Thus, the NTSB concludes that Ride The Ducks should have had specific guidance for the operations team to determine when to suspend waterborne operations due to approaching severe weather (a go/no-go

policy). Although Ride The Ducks' vessel operations have been suspended as of the date of this report, there is no certainty the company will not resume operations. Therefore, the NTSB recommends that Ripley Entertainment Inc., dba Ride The Ducks Branson, using the operating restrictions found in vessel COIs, review and revise its current operating policy to provide specific guidance on vessel operations when adverse conditions could be encountered during any part of the waterborne tour by implementing a go/no-go policy.

2.3.5 Captain's Actions

No additional weather information was communicated to the *Stretch Duck 7* once it began the tour. The vessel did not have equipment aboard for monitoring the National Weather Service's weather radio, and company policy discouraged the use of mobile devices while driving. None of the crewmembers aboard the three other duck boats under way when the *Stretch Duck 7* entered the water, including the one with the general manager serving as captain, reported any weather-related hazards. In fact, duck boat crewmembers ahead of the *Stretch Duck 7* described the water on entering the lake as "crystal clear" and "glassy" to the degree it reflected the surrounding trees.

The captain of the *Stretch Duck 7* was one of Ride The Ducks' senior and most experienced captains and was highly respected by fellow employees. Although investigators were not able to interview him, evidence indicates that he was aware of the operating restrictions in the COI. Had those conditions been present when he reached the lake, which he described as being "calm" with "light winds" when he entered the water, he likely would not have started the tour. Despite being aware of oncoming weather that he had observed on weather radar before leaving the duck dock, he was not aware of the storm's intensity. Thus, there was no indication that he thought he should not enter the water based on the manager-on-duty's orders to go to the lake first, the captain's visual assessment of the conditions of the lake from the entry ramp, the state of the weather prevailing at the time, the presence of other Ride The Ducks vessels on the water, and his previous operating experience and training. If the captain had arrived at the lake several minutes later, at which time he would have observed large waves and high winds associated with the storm, he likely would have not entered the water. Therefore, the NTSB concludes that it is likely that the captain believed he could safely complete the waterborne portion of the tour before the thunderstorm arrived.

Given the benign conditions when the *Stretch Duck 7* entered the water, the captain proceeded with the usual tour. Normally, the waterborne route proceeded around Duck Island and then north to the exit ramp. However, as the wind began to increase and strengthened, the captain of the *Stretch Duck 7* altered his course, by turning north instead of going around the island and heading straight to the exit ramp. According to the operations manual, captains were advised to increase the vessel's speed and immediately head to either the exit or closest ramp when encountering severe weather on the water. As he stated during a postaccident interview, he was "far enough around" to be closer to the exit ramp. Turning back toward the entry ramp consequently would have placed the wind and waves on the port beam of the *Stretch Duck 7* and risked boarding waves over the vessel's relatively low freeboard along the gunwales of the passenger compartment. Additionally, company procedures directed captains to keep the bow into the waves in those conditions. The captain of the nearby *Stretch Duck 54*, likewise, bypassed the trip around the island and instead headed north into the waves along a parallel course toward the exit ramp. In the weather conditions at the time, the captain of the *Stretch Duck 7* decided to head north likely because he believed he could reach the exit ramp. Therefore, the NTSB concludes that the captain's decision to head toward the exit ramp when encountering the severe weather was appropriate.

2.4 The Sinking

When the high winds reached the vessel, and the waves began to build, the captain of the *Stretch Duck 7* attempted to reach shore, but the vessel took on water and sank rapidly. Investigators sought to determine how water entered the vessel in enough quantity to cause the sinking. A review of video from the vessel's interior camera showed that the bilge alarm sounded about 4 minutes after the onset of the weather, but no water was seen entering into the passenger compartment from the sides of the vessel or its stern by the end of video recording. As captured on shoreside witness videos, wind-driven waves were exceeding the height of the *Stretch Duck 7*'s bow. Water intermittently washed over the bow as it dipped under the waves several times.

A postaccident float test and survey of the vessel found no damage, holes, or leaks that would have allowed water to enter the vessel. With the hull's watertight integrity intact, investigators focused on through-hull openings on the bow of the vessel related to the engine compartment (as identified in [figure 19](#)), including the cooling air discharge ducts on the port and starboard sides; the access cover (hood) on the topside of the bow; and the air intake hatch and damper, located just forward of the hood.

2.4.1 Engine Compartment Ventilation Closures

Side Air Discharge Ducts. The dampers in the air discharge ducts on the port and starboard sides of the vessel could be closed from the captain's station by individual levers. After the vessel was recovered, both dampers were found in the open position. The operations manual stated that in response to a fire on the water, captains were to "close all vent closures, engine hatch, side hatches and floor flaps." Additionally, the manual included a generic excerpt from 46 *CFR* 185.512 providing emergency instruction response for "rough weather at sea...close all weathertight doors, hatches, and airports to prevent taking water aboard or further flooding in the vessel." There were no specific instructions in the operations manual directing captains to specifically close the side dampers in the event of severe weather or water ingress. Although evidence shows the captain closed the bow hood, investigators were unable to interview the captain to determine why he did not close the port- and starboard-side dampers.

When asked if the engine would continue to run after the dampers were closed, the fleet operations manager stated that it wasn't a "great idea to continue under normal operation like that." And that "it would run for a while, but eventually you're going to start to experience some overheating, probably." It is not known if the captain believed that by closing all dampers, he would have starved the engine of air, which would have resulted in reduced engine speed or caused an engine shutdown. Regardless, the side dampers were located below the windshield, several inches higher than the bow deck and were protected by a steel plate from waves or water splashing from the bow. Witness video reveals that waves intermittently covering the bow were not reaching the side vents. Water likely did not enter the side vents until the vessel was swamped after substantial flooding.

Bow Air Intake Hatch and Hood. The purpose of the engine compartment hood and air intake hatch, when opened, was to allow air to the engine for combustion as well as to the radiator for cooling into the engine space during normal operations. The engine compartment was fitted with a hinged cover (hood) above the engine, and the air intake hatch was equipped with a spring-loaded, hinged damper that was held open in the downward position by a latch. The hood and hatch damper were able to be remotely closed from the captain's station by pulling the same lever. The operations manual provided specific instructions for captains to close the hood "in anticipation of taking water

over the bow...to prevent engine water ingestion” or in the event of a fire. The *Stretch Duck 7*’s captain stated that he remotely “dropped the hood” after the winds increased, which, as he stated, “helps prevent water from going into the engine compartment.” Supporting his statement, investigators found the hood and air intake damper in the closed position after salvage, and the vessel’s DVR system detected a sound similar to the engine hood hatch slamming at 19:02:09.

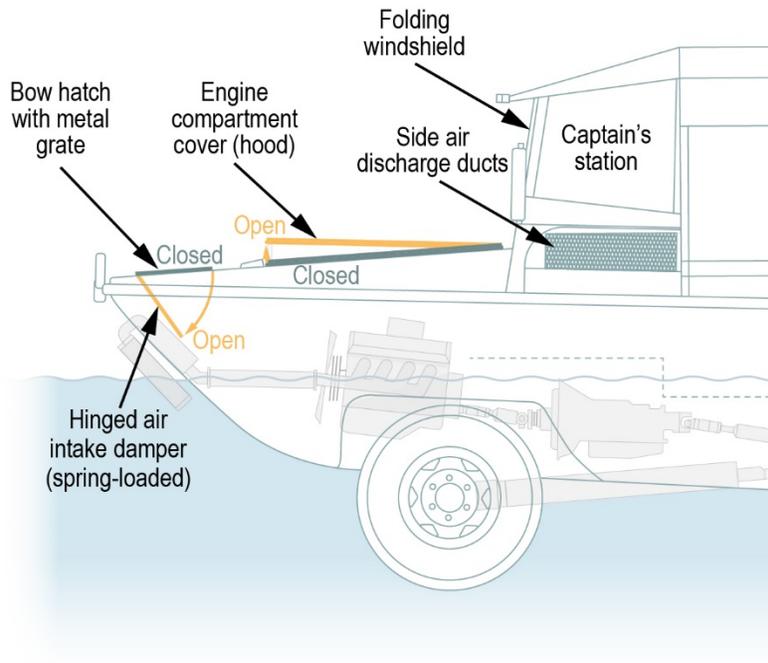


Figure 19. Engine compartment ventilation closures on the *Stretch Duck 7*, including the bow hatch that was likely the initial source of water ingress.

As the bow dipped beneath successive waves, a substantial amount of water likely entered the vessel through it. As the water accumulated in the engine space, the *Stretch Duck 7*’s bow sank lower, and as relatively higher waves rolled across the air intake hatch, the rate of flooding would have increased. The NTSB concludes that initial water ingress to the *Stretch Duck 7* was likely from waves rolling over the air intake hatch’s spring-loaded damper and intermittently opening it, thereby allowing water into the engine compartment.

2.4.2 Reserve Buoyancy

The *Stretch Duck 7* was exposed to severe weather for about 8 minutes before sinking. For a portion of this time, the vessel was exposed to 3- to 5-foot waves and winds over 70 mph. As it continued to take on water at an increasing rate through the hatch on the bow, the weight of the floodwater began decreasing the vessel’s freeboard and, as witness video revealed, allowing additional water to enter through the side air discharge ducts by the captain’s station and beneath the side curtains over the gunwales into the passenger space, swamping and rapidly sinking the vessel by the stern in seconds.

In pulling the lever to release the air intake damper latch, the spring would rotate the damper upward to the closed position, which would prevent air from entering the engine compartment. However, the spring-loaded damper was held in the upward (closed) position only by spring force, not with a pin or other mechanical device. Investigators determined that a static weight of about 3 pounds acting on the damper could open it. Therefore, the damper spring could easily be overcome by a small weight of water on top of the damper, which would open the damper and thereby allow water to enter the engine space through the hatch. With this hatch located in the most forward point of the bow while water washed over the nearly 3-square-foot opening as the

The *Stretch Duck 7* did not have any compartmentalization or subdivision that would have contained the floodwater entering the engine compartment. The initial flooding through the forward bow hatch trimmed the vessel down by the bow (lowered the bow into the water). As the vessel headed into the wind and waves, its pitching motion increased, allowing floodwater to travel from the engine compartment throughout the length of the vessel. With the rate of flooding exceeding the capacity of the bilge pumps, water eventually rose above the floorboards and began filling the passenger compartment. Around this time, the *Stretch Duck 7*, which did not have built-in flotation or other reserve buoyancy to counter the flooding, started listing to starboard. As the vessel's reserve buoyancy was overcome, its freeboard was reduced to zero. Had the *Stretch Duck 7* been fitted with watertight compartmentalization, the incoming water most likely would have been contained in the engine compartment, or in other smaller sections of the vessel, thus preventing uncontrolled progressive flooding throughout the vessel. Therefore, the NTSB concludes that the rapid sinking of the *Stretch Duck 7* resulted from uncontrolled progressive flooding due to a lack of subdivision.

DUKW amphibious passenger vessels were originally constructed with a low freeboard, an open hull, and no compartmentalization or subdivision, resulting in a design without adequate reserve buoyancy. The NTSB has been concerned with the lack of sufficient reserve buoyancy of these vessels since the 1999 sinking of the *Miss Majestic*, another DUKW vessel that also had no subdivision or flotation. The *Miss Majestic* flooded progressively from a relatively small gap at the driveshaft below the waterline. Once it flooded, the vessel rapidly sank, leaving little opportunity for passengers to escape, which resulted in 13 fatalities of the 21 persons on board.

As a result of the *Miss Majestic* sinking, in 2002, the NTSB issued Safety Recommendation M-02-1 to the Coast Guard, which recommended that reserve buoyancy be provided on APVs through "passive means, such as watertight compartmentalization, built-in flotation, or equivalent measures." On September 5, 2002, the Coast Guard replied that it did not concur with this recommendation, indicating its belief that sufficient requirements and guidance were in place to provide APVs with a level of safety equivalent to other passenger vessels of similar size and capacity. The NTSB did not agree and, on May 6, 2003, stated that because DUKWs have open interiors and a very low freeboard at the stern, they are vulnerable to rapid swamping and sinking. Once the stern is immersed, water quickly swamps the interior of the DUKW, causing it to sink rapidly. Because the Coast Guard did not concur with this recommendation and therefore did not intend to take any action, Safety Recommendation M-02-1 was classified "Closed—Unacceptable Action."

At the time of the sinking of the *Stretch Duck 7*, the vessel met all requirements for stability, as configured. However, if the *Stretch Duck 7* had been modified to include several subdivided compartments, as recommended in Safety Recommendation M-02-1, the flooding could have been contained to individual sections of the vessel, thus increasing the vessel's ability to remain afloat. Furthermore, the vessel could have remained afloat and upright indefinitely if it was fitted with built-in flotation or watertight compartmentalization, which can be designed and sized to provide a vessel with sufficient reserve buoyancy even when the hull is fully flooded. The Coast Guard had almost 20 years since the *Miss Majestic* sinking to require owners and operators of APVs to be fitted with flotation and subdivision. Therefore, the NTSB concludes that had the Coast Guard implemented Safety Recommendation M-02-1 to require sufficient reserve buoyancy through passive means, the *Stretch Duck 7* likely would not have sunk. The NTSB maintains the belief that subdivision, compartmentalization, or flotation would increase the safety of amphibious passenger vessels. In *Improving Vessel Survivability and Passenger Emergency Egress of DUKW Amphibious Passenger Vessels* (see [appendix B](#)), the NTSB issued Safety Recommendation M-19-15, which is similar to

Safety Recommendation M-02-1, issued to the Coast Guard 17 years earlier as a result of sinking of the *Miss Majestic*.

2.4.3 *Stretch Duck 54* Comparison

Investigators sought to understand why the *Stretch Duck 54* was able to exit the lake despite experiencing the same conditions as the nearby *Stretch Duck 7* along a similar route. Although both vessels were equipped with 235-hp gasoline engines, the *Stretch Duck 54* consistently maintained a speed about twice that of the *Stretch Duck 7* from the time the captains reacted to the wind and headed toward the exit ramp. There was no evidence revealing any mechanical issues with either vessel's propulsion systems. The captain of the *Stretch Duck 54* stated that at some point during the storm, he brought the vessel to maximum speed to reach the exit ramp, as the company operations manual instructed. In fact, the *Stretch Duck 54* was about 500 feet farther away from the exit ramp when the wind increased but was able to pass the *Stretch Duck 7* on a nearly parallel path. Had the *Stretch Duck 7* been able to maintain speed similar to that of the *Stretch Duck 54*, it may have reached the exit ramp. However, investigators were unable to interview the captain of the *Stretch Duck 7* to review the decisions he made or actions he took regarding the speed of the vessel.

The *Stretch Duck 54* was a master jig model, which was designed with a 6-inch wider beam that increased the vessel's displacement slightly and increased the reserve buoyancy relative to the earlier version of stretch ducks, such as the *Stretch Duck 7*. Additionally, the master jigs had about a 6-inch higher gunwale. In comparing the stretch duck version with an equal load of fuel and persons on board, the master jig would have higher freeboard and increased reserve buoyancy.

On the evening of the accident, the *Stretch Duck 54* was carrying one more passenger than the *Stretch Duck 7*, or about the same weight load. Similarly loaded, the *Stretch Duck 54* would be expected to have a higher freeboard than the *Stretch Duck 7*. Shoreside witness video confirmed this difference: the *Stretch Duck 54* maintained a greater freeboard than the *Stretch Duck 7* in similar conditions and at similar times. The higher freeboard of the *Stretch Duck 54* enabled its bow to sit higher in the water, and the higher bow would have reduced the amount of water rolling across it. Thus, the *Stretch Duck 54*'s higher freeboard and larger reserve buoyancy would have required a greater volume of floodwater (and therefore a longer period of time) to swamp the vessel over the gunwale.

Moreover, the *Stretch Duck 54* was equipped with a hinged, solid-steel cover over the forward air intake hatch, which closed downward (by gravity), and was held in place with two fasteners, whereas the *Stretch Duck 7*'s spring-loaded damper (also a solid-steel cover) was held closed in the upward position only by spring force and therefore could not be fastened closed. The *Stretch Duck 54* was typically operated with the hatch cover in the closed position, for both the land and waterborne portions of the tour, as witness video indicated on the evening of the accident. The cover also was found bolted closed. The fixed air intake hatch cover on the bow of the *Stretch Duck 54* prevented waves on the bow from flooding down into the engine compartment, as they likely did through the un-securable air intake hatch damper on the *Stretch Duck 7*. Therefore, the NTSB concludes that the *Stretch Duck 54* was able to exit the lake while exposed to the same conditions as the *Stretch Duck 7* due to the increased freeboard, greater reserve buoyancy, and a securable bow hatch that prevented the ingress of water. Although impracticable to modify a vessel's hull dimensions, the damper design of the bow air intake hatch can be modified easily. Therefore, the NTSB recommends that Ripley Entertainment Inc., dba Ride The Ducks Branson, modify spring-loaded forward hatches of modified DUKW amphibious passenger vessels to enable their closure

during waterborne operations as a prevention for water ingress. Similarly, the NTSB recommends that the Coast Guard require that amphibious passenger vessels equipped with forward hatches enable operators to securely close them during waterborne operations to prevent water ingress.

2.5 Survivability

2.5.1 Side Curtains

Open APVs fitted with canopies may also be outfitted with side curtains. Side curtains can be an impediment to passenger egress during an abandonment of a vessel. When closed, the curtains obstruct the “over the side” escape route to be used by passengers, prompting the Coast Guard to recommend in NVIC 1-01 that curtains (if installed) should be able to be opened “from a point located at the control station.”

The *Stretch Duck 7* and the *Stretch Duck 54* were equipped with side curtains that were fitted with a means accessible from the captain’s station to lower (close), raise (open), and release (during an emergency) them. In reviewing video recordings from the two vessels, investigators determined that less than a minute after the onset of the storm, the captains of the *Stretch Duck 7* and *Stretch Duck 54* lowered the side curtains. This action was contrary to the operations manual that stated “under extreme wind conditions you should not lower the side curtains,” because doing so can create “an additional sail area which decreases the vessel’s maneuverability.”

With the side curtains closed, the over-the-side escape described in the NVIC would not have been possible unless the curtains were released. The *Stretch Duck 7* captain did not release the portside curtain until just before the vessel sank, and because the vessel sank so quickly, he was not able to activate the starboard-side release handle. With the starboard-side curtain closed as the vessel began sinking by the stern, the closest over-the-side escape was blocked for passengers on the starboard side. Once the vessel was submerged, escape was possible only through the port side where the curtain was released or, by making one’s way forward, through the windshield, which had been opened by the force of the water. Although there were openings on the stern on either side of the passenger-loading ramp, it is unlikely that passengers would have been able to overcome the force of the incoming water and escape over the stern. The NTSB concludes that when the vessel sank, the closed starboard-side curtain aboard the *Stretch Duck 7* impeded egress and likely resulted in additional fatalities.

2.5.2 Donning Lifejackets within Fixed Canopies

Neither the captain nor the driver of the *Stretch Duck 7* instructed the passengers to don lifejackets when they encountered severe weather or when bilge alarms were activated, as required by the company’s operations manual. Because of the rapid sinking of the vessel, passengers had no opportunity to retrieve and don lifejackets. Based on their statements, passengers floated toward the “roof” (canopy) where they faced difficulty escaping. Wearing a lifejacket would have impeded mobility, making it difficult, if not impossible, to exit through the windshield opening or on the port side where the curtain had been released, and likely would have delayed an escape. Instead of donning lifejackets, passengers in this case may have been better served by the crew distributing lifejackets to them when severe weather was encountered or when bilge alarms were activated, which would have enabled them to have the lifejackets ready upon preparing to abandon the vessel. When the vessel sank, the lifejackets could have functioned as a flotation device after they escaped the

vessel and reached the surface. Of the 56 lifejackets investigators counted postaccident, the majority of them (41 in total) were still connected to the vessel's canopy framing by their straps.

In the case of the *Miss Majestic* sinking, whose passenger space was also covered by an overhead canopy, the NTSB was "particularly concerned that both adults and children wearing life jackets are at risk of being drowned if entrapped by the overhead canopy." To mitigate the risk to passengers, the NTSB concluded that canopies on amphibious passenger vessels that cannot remain afloat while flooded must be removed and that passengers should wear lifejackets on open vessels when they enter the water.

The NTSB has investigated other accidents involving small passenger vessels (not amphibious vessels) with fixed canopies or enclosed passenger areas, including the capsizing of the *Lady D* in 2004 and the *Ethan Allen* in 2005.⁷⁷ In both cases, surviving passengers recalled not having enough time to retrieve a lifejacket once the vessel capsized. Yet, they realized that wearing a lifejacket while enclosed in a rapidly flooding deckhouse with such impediments as canopies and curtains (windows) may have reduced their likelihood for survival. As explained in the *Lady D* report, "the buoyant safety device" would have carried "a wearer upward when most people had to swim downward to escape." Furthermore, if a parent with a young child had to take the time to locate a child-size lifejacket, neither might have had a chance for escape. Although normally a strong proponent of lifejacket use in marine emergencies, the NTSB concluded that "donning lifejackets in the *Lady D*'s enclosed deckhouse before the capsizing could have resulted in additional fatalities.", If a passenger could reach the water's surface, however, holding onto the lifejacket when the vessel overturned could have rendered it a flotation device. Likewise, survivors in the *Ethan Allen* accident predicted that more fatalities would have resulted if lifejackets had been donned, because "the only way for those trapped in the vessel to escape was to 'swim down' and go through the open windows, which were now below water."

The circumstances in the *Stretch Duck 7* accident also indicate that donning a lifejacket inside the rapidly sinking vessel would have resulted in the buoyant safety device pushing a person upward against the top of the enclosed space formed by the canopy and the closed side curtain. Although Ride The Ducks' operations manual required lifejackets to be donned during any "abnormal situation" on the water, the NTSB concludes that donning lifejackets on the *Stretch Duck 7* while fitted with an overhead canopy would have created an impediment to escape, would have increased the risk of persons being entrapped, and could have resulted in additional fatalities. Therefore, the NTSB recommends that Ripley Entertainment Inc., dba Ride The Ducks Branson, re-evaluate emergency procedures regarding the donning of lifejackets aboard modified DUKW amphibious passenger vessels when equipped with fixed canopies.

After the *Miss Majestic* sinking, the Coast Guard attempted to address emergency escape from canopies through NVIC 1-01. In its 2002 report on the *Miss Majestic*, the NTSB issued Safety Recommendation M-02-2 which recommended that the Coast Guard require removal of canopies for waterborne operations or install a Coast Guard-approved canopy that does not restrict either horizontal or vertical escape by passengers in the event of sinking. The Coast Guard initially replied on September 5, 2002, saying that it concurred with the intent of this recommendation and that its approach to the unique design and operational risks of APVs was to require that owners of APVs

⁷⁷ (1) *Capsizing of U.S. Small Passenger Vessel Lady D, Northwest Harbor, Baltimore, Maryland, March 6, 2004.* [MAR-06/01](#). Washington, DC: NTSB. (2) *Capsizing of New York State-Certificated Vessel Ethan Allen, Lake George, New York, October 2, 2005.* [MAR-06/03](#). Washington, DC: NTSB.

implement the recommendations in NVIC 1- 01 or demonstrate to the local Officer-in-Charge, Marine Inspection that their APVs attained an “equivalent level of safety through other means.” In its May 6, 2003, response, the NTSB pointed out that the recommendation called for requirements and not just the voluntary guidance specified in NVIC 1-01. The NTSB asked that the Coast Guard clarify to what extent the industry, operator by operator, was in compliance with Safety Recommendation M-02-2.

On January 30, 2007, the Coast Guard restated its earlier response that owners of APVs may implement the recommendations in NVIC 1-01 or demonstrate to the cognizant Officer-in-Charge, Marine Inspection that their vehicles have attained an “equivalent level of safety through other means.” The Coast Guard also said that it did not plan to take any further action. On October 5, 2007, the NTSB replied that because the Coast Guard only reiterated the position it had held since 2002 and did not clarify to what extent the industry, operator by operator, was in compliance with the recommendation, and planned no further action, Safety Recommendation M-02-2 was classified “Closed—Unacceptable Action.” The NTSB’s investigation of the *Stretch Duck 7* accident shows that the issue of fixed canopies impeding emergency egress on vessels lacking adequate reserve buoyancy remains unresolved almost 20 years after the sinking of the *Miss Majestic*. As a result, on November 13, 2019, the NTSB issued Safety Recommendation M-19-16 to the Coast Guard to require removal of canopies, side curtains, and their associated framing on original and stretch DUKWs lacking sufficient reserve buoyancy. That recommendation was recently classified “Open—Initial Response Received.”

2.5.3 Search-and-Rescue Efforts

The *Stretch Duck 7* foundered north and upwind of the *Showboat Branson Belle*. The crew and passengers of the *Showboat Branson Belle* reacted immediately to the *Stretch Duck 7*’s sinking, by calling emergency services, stopping the rotating paddle wheels, throwing PFDs to survivors in the water, and pulling people from the water near the showboat’s dock. The first call to 911 was made by a *Showboat Branson Belle* crewmember who remained on the phone line until first responders arrived. The paddle wheels were tied off to prevent rotation as the wind attempted to spin it, which otherwise would have endangered people in the water. *Showboat Branson Belle* crewmembers climbed down the paddle wheels in high winds to retrieve one exhausted survivor. Survivors, who reported being exhausted after their underwater escape and having to swim in high waves on the surface, were pulled to safety by showboat crewmembers before first responders arrived. At least two showboat crewmembers, along with a sheriff’s deputy and a passenger, entered the water to assist victims, and two other crewmembers that entered the water in an attempt to reach one survivor were swept out into the lake. The crew rendered first aid to survivors, including CPR on at least four victims.

None of the four victims that were swept downwind and outboard of the *Showboat Branson Belle* survived. Had the *Stretch Duck 7* sunk farther outboard or south of the showboat, it is less likely that *Showboat Branson Belle* crewmembers could have reached and assisted survivors. First responders and survivors who were interviewed consistently praised efforts by the showboat’s crew, most of whom were deckhands or steward department personnel. Therefore, the NTSB concludes that the actions of the crew and passengers aboard the *Showboat Branson Belle* prevented more fatalities.

The Stone County public-safety access point fielded calls for several weather-related incidents before the *Stretch Duck 7*’s sinking. The first 911 call related to the *Stretch Duck 7* was

logged at 19:08:32 from a *Showboat Branson Belle* crewmember. Southern Stone County Fire Protection District units were dispatched in less than 2 minutes. The units were en route a minute later, and Stone County notified Missouri State Highway Patrol and issued an “all call” for off-duty fire department personnel. While en route to the scene, the incident commander called for all available ambulances and mutual aid from neighboring departments. The first fire land and water rescue units were on scene at 1925, despite the heavy rain, downed trees, 3- to 5-foot waves, a travel distance of 3 miles by water and 11 miles by road.

The one survivor triaged as immediate, who received CPR on scene, was the first to be transported to the hospital at 1955. Of the four *Stretch Duck 7* passengers transported with minor injuries, two accompanied higher-priority family members. The remaining two were a 13- and a 14-year-old with no surviving family. The last patient was transported at 2011. All of those transported survived. The remaining survivors, all from one family group, were transported by bus to a family assistance center.

The overall unified command facilitated coordination between affected agencies throughout this incident and was effective considering the magnitude of the incident, harsh weather affecting response times, and demanding dispatcher workload. Representatives from the responding agencies all worked together to organize the complexities of each agency’s ability to contribute based on the needs of the incident. Triage, treatment, and transport of survivors was effective by first responders. The NTSB concludes that the response by emergency services was timely and effective.

2.6 Coast Guard Oversight

2.6.1 Weather-Training Requirements

In reviewing the limited master’s requirements in 46 *CFR* 11.910 and in NVIC 1-01, investigators found they did not contain prescribed meteorology training or guidance on how to apply meteorology knowledge to making go/no-go decisions. The material covering basic weather and meteorology through Ride The Ducks’ in-house training for new captains obtaining a 25-ton license (restricted to operating duck boats) was more than the Coast Guard-mandated training for 100-ton captains on rivers routes. In addition, investigators found limited weather training requirements for decision-makers in their review of NVIC 1-01 guidance and the company’s operations manual.

Given the operational restrictions related to wind and wave conditions on duck boat COIs, the NTSB believes that additional weather-related training for operators is warranted. The two meteorological subjects required in the exam for deck officers under 46 *CFR* 11.910, “Characteristics of Weather Systems” and “Weather Charts and Reports,” were likely intended for mariners on near-coastal and ocean voyages who must interpret a variety of weather service products. However, mariners on rivers routes could also benefit from a better understanding of such weather products, notably severe thunderstorm watches and warnings. Furthermore, these mariners should be competent in the following areas: assessing information from the National Weather Service and commercial weather services, recognizing weather hazards, assessing risk, and implementing controls that would prevent vulnerable vessels and passengers from being exposed to danger (hence, a go/no-go policy).

The National Weather Service offers several programs that would assist operators in enhancing their readiness for extreme weather and water events. Initiatives such as the StormReady®

and Weather-Ready Nation Ambassadors™ programs, and the SKYWARN® program that provides training in severe weather-spotting of such events as thunderstorms, tornadoes, and lightning, could assist Ride The Ducks in ensuring its personnel was better prepared for weather-related contingencies.⁷⁸ Requiring participation in such weather training and planning would benefit captains, considering the limited requirements in the regulations for masters on rivers routes, the vulnerability of duck boats to severe weather, and the opportunity to better train mariners. Therefore, the NTSB concludes that improved training is needed for small passenger vessel operators on rivers routes to recognize and better understand weather conditions. The NTSB recommends that the Coast Guard examine existing training and knowledge requirements for understanding and applying fundamental weather principles to waterborne operations for Coast Guard-credentialed masters who operate small passenger vessels; and, if warranted, require additional training requirements for these ratings on recognition of critical weather situations in pre-departure planning and while under way.

2.6.2 NVIC 1-01

As a result of the NTSB and the Coast Guard Marine Board of Investigation's recommendations after the sinking of the *Miss Majestic*, the Coast Guard issued NVIC 1-01 in December 2000. The Passenger Vessel Association and members of the amphibious vessel industry participated in the development of the NVIC. The purpose of the NVIC was to provide guidance to operators for the safe operation of passenger-carrying amphibious vessels requiring certification. The Coast Guard incorporated risk management into the NVIC to address the unique design and operational hazards of amphibious vessels and to consider the entire vessel and its equipment as a complete safety system. Because the NVIC was developed with the participation of the industry, the Coast Guard intended vessel operators to meet the guidelines and inspectors/examiners to verify that vessel operators met the NVIC when issuing a COI for such vessels, as was done during the certification of the *Stretch Duck 7*.

Canopies. Following the *Miss Majestic* accident, the NTSB recommended that the Coast Guard require the removal of canopies for waterborne operations or installation of a Coast Guard-approved canopy that does not restrict either horizontal or vertical escape by passengers in the event of sinking (Safety Recommendation M-02-2). However, the Coast Guard did not concur with this recommendation and did not take action requiring either removal of canopies or use of only approved canopies. The Coast Guard stated in a September 5, 2002, letter to the NTSB, "For amphibious vessels that present additional flooding, sinking and egress risks, guidance on attaining an equivalent level of safety has been promulgated through Navigation and Vessel Inspection Circular (NVIC) 1-01," which it believed was "sufficient." The NVIC provided guidance on canopy installation and means of escape (egress) over the side. However, as demonstrated in this accident when the *Stretch Duck 7* sank in Table Rock Lake in 2018 almost 15 years later, emergency egress was still impeded by the canopy and a side curtain during the rapid sinking, indicating a deficiency in the guidance and/or application to the *Stretch Duck 7*. Therefore, the NTSB concludes that NVIC 1-01 did not effectively address the NTSB's 2002 recommendation (M-02-2) recommendation to require the removal of, or Coast Guard's approval of, fixed canopies and likely increased the number of fatalities consequently.

Operational Guidance. NVIC 1-01 called for a company to have an operating manual that provides guidance on operations, training, maintenance, and emergency procedures. The NVIC does

⁷⁸ For additional information about these National Weather Service programs, see <https://www.weather.gov/>.

not address weather abort points (risk assessment must include the worst case predicted scenarios for the entire voyage) or risk management. Companies are advised to use the NVIC as a guide to create operating manuals.

The equipment and procedures designed to prevent the loss of life from the sinking of a vessel were not used or initiated by the crew when the *Stretch Duck 7* sank. The Coast Guard standards and guidance anticipate the captain directing an organized abandonment before the vessel sinks below the water's surface. When the captain decided "we weren't going to make it," he did not have time to begin the abandonment procedures, because the *Stretch Duck 7* sank so quickly. Based on interviews, immediately after the captain released the portside curtain, the force of the water rushing in over the stern pushed him through the windshield.

In an organized abandonment of the vessel envisioned by the Coast Guard standards, the captain of an amphibious vessel would have time to make a distress call, ensure the passengers retrieved and donned their lifejackets, inform passengers their egress was over the side, establish a point for the passengers to swim, take a head count before leaving the vessel, assist passengers egress over the side, and grab a life ring before swimming to join the passengers. Considering that amphibious vessels lacking reserve buoyancy sink quickly, realistic guidance for emergency egress is needed to prevent passengers from being trapped in the vessel and still have access to lifejackets. As found in the *Miss Majestic* and this accident, once it becomes apparent the vessel is in distress, a DUKW amphibious vessel sinks rapidly from swamping, not allowing time to prepare for or begin an organized abandonment. Additionally, the NVIC provided guidance on canopy installation and means of escape (egress) over the side. As demonstrated in this accident, emergency egress was still impeded by the canopy and a side curtain during the rapid sinking, indicating a deficiency in the guidance and/or application to the *Stretch Duck 7*.

NVIC 1-01 currently addresses various issues including some specific to lessons learned in the *Miss Majestic* accident, but the circumstances found in the *Stretch Duck 7* sinking have raised additional areas of concern regarding escape and waterborne operations with approaching severe weather that should be addressed and incorporated in an updated revision of the NVIC. Therefore, the NTSB concludes that NVIC 1-01 does not account for circumstances found in the *Stretch Duck 7* accident, including operations during approaching severe weather and emergency egress during rapid sinking, and should be updated to provide guidance accordingly. There have been several casualties involving amphibious passenger vessels accidents since the NVIC's initial issuance in December 2000, and it has not been revised since. Therefore, the NTSB recommends that the Coast Guard review the circumstances of the *Stretch Duck 7* sinking and other amphibious passenger vessel accidents, and revise NVIC 1-01 to address the issues found in these accidents, including operations during imminent severe weather and emergency egress during rapid sinking.

3 Conclusions

3.1 Findings

1. The *Stretch Duck 7*'s propulsion, steering, and bilge systems operated normally and thus were not factors in this accident.
2. Neither alcohol nor other impairing drugs were factors in this accident.
3. On the day of the accident, the National Weather Service accurately forecasted and issued timely notifications of a severe thunderstorm that would impact the accident location.
4. Ride The Ducks did not effectively use all available weather information to monitor the approaching severe weather and assess the risk it posed to its waterborne operations.
5. Ride The Ducks should have suspended waterborne operations for the *Stretch Duck 7* and the other last tours of the day in anticipation of imminent severe weather.
6. Ride The Ducks should have had specific guidance for the operations team to determine when to suspend waterborne operations due to approaching severe weather (go/no-go policy).
7. It is likely that the captain believed he could safely complete the waterborne portion of the tour before the thunderstorm arrived.
8. The captain's decision to head toward the exit ramp when encountering the severe weather was appropriate.
9. Initial water ingress to the *Stretch Duck 7* was likely from waves rolling over the air intake hatch's spring-loaded damper and intermittently opening it, thereby allowing water into the engine compartment.
10. The rapid sinking of the *Stretch Duck 7* resulted from uncontrolled progressive flooding due to a lack of subdivision.
11. Had the Coast Guard implemented Safety Recommendation M-02-1 to require sufficient reserve buoyancy through passive means, the *Stretch Duck 7* likely would not have sunk.
12. The *Stretch Duck 54* was able to exit the lake while exposed to the same conditions as the *Stretch Duck 7* due to the increased freeboard, greater reserve buoyancy, and a securable bow hatch that prevented the ingress of water.
13. When the vessel sank, the closed starboard-side curtain aboard the *Stretch Duck 7* impeded egress and likely resulted in additional fatalities.
14. Donning lifejackets on the *Stretch Duck 7* while fitted with an overhead canopy would have created an impediment to escape, would have increased the risk of persons being entrapped, and could have resulted in additional fatalities.
15. The actions of the crew and passengers aboard the *Showboat Branson Belle* prevented more fatalities.
16. The response by emergency services was timely and effective.
17. Improved training is needed for small passenger vessel operators on rivers routes to recognize and better understand weather conditions.

18. Coast Guard Navigation and Vessel Inspection Circular 1-01 (*Inspection of Amphibious Passenger Carrying Vehicles*) did not effectively address the National Transportation Safety Board's 2002 recommendation (M-02-2) to require the removal of, or Coast Guard's approval of, fixed canopies and likely increased the number of fatalities consequently.
19. Coast Guard Navigation and Vessel Inspection Circular 1-01 (*Inspection of Amphibious Passenger Carrying Vehicles*) does not account for circumstances found in the *Stretch Duck 7* accident, including operations during approaching severe weather and emergency egress during rapid sinking, and should be updated to provide guidance accordingly.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of the sinking of the amphibious passenger vessel *Stretch Duck 7* was Ripley Entertainment Inc. dba Ride The Ducks Branson's continued operation of waterborne tours after a severe thunderstorm warning was issued for Table Rock Lake, exposing the vessel to a derecho, which resulted in waves flooding through a non-weather-tight air intake hatch on the bow. Contributing to the sinking was the Coast Guard's failure to require sufficient reserve buoyancy in amphibious vessels. Contributing to the loss of life was the Coast Guard's ineffective action to address emergency egress on amphibious passenger vessels with fixed canopies, such as the *Stretch Duck 7*, which impeded passenger escape.

4 Recommendations

4.1 New Recommendations

As a result of its investigation of this accident, the National Transportation Safety Board makes the following six new safety recommendations:

To the US Coast Guard

Require that amphibious passenger vessels equipped with forward hatches enable operators to securely close them during waterborne operations to prevent water ingress. (M-20-1)

Review the circumstances of the *Stretch Duck 7* sinking and other amphibious passenger vessel accidents, and revise Navigation and Vessel Inspection Circular (NVIC) 1-01 to address the issues found in these accidents, including operations during imminent severe weather and emergency egress during rapid sinking. (M-20-2)

Examine existing training and knowledge requirements for understanding and applying fundamental weather principles to waterborne operations for Coast Guard-credentialed masters who operate small passenger vessels; and, if warranted, require additional training requirements for these ratings on recognition of critical weather situations in pre-departure planning and while under way. (M-20-3)

To Ripley Entertainment Inc., dba Ride The Ducks Branson

Using the operating restrictions found in vessel certificates of inspection, review and revise your current operating policy to provide specific guidance on vessel operations when adverse conditions could be encountered during any part of the waterborne tour by implementing a go/no-go policy. (M-20-4)

Modify spring-loaded forward hatches of modified DUKW amphibious passenger vessels to enable their closure during waterborne operations as a prevention for water ingress. (M-20-5)

Re-evaluate emergency procedures regarding the donning of lifejackets aboard modified DUKW amphibious passenger vessels when equipped with fixed canopies. (M-20-6)

4.2 Previously Issued Recommendations

As a result of its investigation of this accident, the National Transportation Safety Board issued the following two safety recommendations, which currently are classified as “Open—Initial Response Received”:

To the US Coast Guard

Require DUKW amphibious passenger vessels (commonly referred to as original and/or “stretch” DUKWs) to have sufficient reserve buoyancy through passive means, so that they remain upright and afloat with a full complement of passengers and crewmembers in the event of damage or flooding. (M-19-15)

For DUKW amphibious passenger vessels without sufficient reserve buoyancy (commonly referred to as original and/or “stretch” DUKWs), require the removal of canopies, side curtains, and their associated framing during waterborne operations to improve emergency egress in the event of sinking. (M-19-16)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

ROBERT L. SUMWALT, III
Chairman

JENNIFER HOMENDY
Member

BRUCE LANDSBERG
Vice Chairman

MICHAEL GRAHAM
Member

THOMAS B. CHAPMAN
Member

Report Date: April 28, 2020

Board Member Statement

Vice Chairman Bruce Landsberg filed the following concurring statement on April 29, 2020:

The tragedy that occurred in Branson, Missouri, was a predictable event. The NTSB has investigated duck boats on several occasions, resulting in multiple recommendations to operators and to their regulatory authority, the US Coast Guard. Many of the recommendations have been closed as “unacceptable,” that is, they were never acted upon. That may be changing—finally.

These World War II vehicles were designed as amphibious assault craft and never intended as commercial tour boats. There are a number of significant flaws, some previously recognized and a few new ones that came to light in the Branson sinking. But the novelty of amphibious operations is alluring so tourists and families, interested in a unique excursion, are willing to pay for the experience. They expect it to be safe and for operators to understand the limitations of their boats when severe weather is approaching. Ride The Ducks did not meet those expectations.

The NTSB previously recommended that reserve buoyancy be added so the vehicles will float, even when full of water. After the sinking in Branson, we issued interim recommendations to the Coast Guard. (See Safety Recommendation M-19-15 in [section 4.2](#), “Previously Issued Recommendations,” and in the safety recommendation report provided in [appendix C](#) of this report.)

We’ve also recommended that the overhead canopies be modified or removed, along with the side curtains which have been shown to trap passengers when the boat sinks or capsizes. That has not been adequately addressed, but after this tragedy the Coast Guard has indicated that it will act to improve safety in this area. (See Safety Recommendation M-19-16 in the aforementioned section and report.)

Based on prior disasters, not just involving duck boats, the Coast Guard required operators to develop detailed operations manuals to provide safety guidance to dispatchers and captains. However, I believe there was insufficient direction on inclement weather and when/how to make a go/no-go decision. The Coast Guard is reviewing NTSB recommendations on this issue, and action will improve passenger safety.

Some believe that the derecho “suddenly developed.” It did not. The National Weather Service had been tracking the storm across several states and for several hours and issued a severe thunderstorm warning at least 20 minutes before the boat entered the water. The boats are limited to maximum winds of 35 mph. The available weather information showed the storms moving at about 50 mph with surface winds potentially in excess of 60 mph. This severe weather event was well announced and should have surprised to no one. It was clearly not duck weather!

Neither the captain nor the operations manager took action. They were aware that something was going on because the tour was directed to enter the lake first, before conducting the land portion of the tour. Perhaps it was just another “garden variety” Midwestern thunderstorm. There are lots of those in Missouri, and the water was described as “glassy” and “calm” when the *Stretch Duck 7* entered the water. But professionals who operate weather-intolerant vehicles in the air, on land, or in the water have an obligation to understand convective weather conditions, which can become dangerous very quickly. A severe thunderstorm warning is to be heeded!

The NTSB has recommended that the Coast Guard consider additional weather education as part of their initial and recurrent qualification testing for licensed mariners.

The captain is always the final authority as to the safe operation of the vessel. But as the NTSB investigators were not allowed to speak to him or to the operations manager to learn what they knew about this weather system, we did not include the captain in the Probable Cause. Helpful and necessary information, which benefit the future safety of us all, was inaccessible because of a concurrent criminal investigation. Safety investigation and the criminal justice system have distinctly different goals—a conversation for another day.

Humans tend to react with hindsight bias. That is, we're certain we would have been able to predict something after all the pieces of a crash/tragedy are laid out before us. The data from prior events make it clear that this tragedy was, sadly, highly predictable.

Appendix A

Investigation

The National Transportation Safety Board (NTSB) learned of the accident from the Coast Guard on the evening of July 19, 2018. A team of five investigators, Board Member Earl F. Weener, and support staff arrived on scene in Branson, Missouri, the following day. The investigative team consisted of specialists in engineering, operations, survival factors, emergency response, meteorology, and electronic data.

While on scene, investigators interviewed almost a dozen passengers from the *Stretch Duck 7*, crewmembers from other Ride The Ducks Branson vessels and the *Showboat Branson Belle*, and first responders from the Branson area. On July 23, the *Stretch Duck 7* was salvaged by a crane barge from a depth of 85 feet. Investigators documented the accident vessel's characteristics and damage, as well as retrieved and reviewed recorded video/audio data from the vessel's digital video recorder. The on-scene part of the investigation, led by the NTSB, was completed on July 27, 2018. Investigators returned to Branson about a month later, August 21–23, to participate in the post-casualty examination and surveys of lifesaving equipment, bilge pumping systems, and alarm systems.

The NTSB investigated the accident under the authority of the *Independent Safety Board Act of 1974*, according to NTSB rules. Parties to the investigation were the Coast Guard; Ripley Entertainment Inc., dba Ride The Ducks Branson; Missouri State Highway Patrol; National Weather Service; and Federal Aviation Administration. The Coast Guard announced that it would convene a Marine Board of Investigation formal hearing but has not scheduled the hearing, as of the date of this report.

Appendix B

APV-Related Safety Recommendations

	Number	Classification	Date Closed	Recommendation
<i>Miss Majestic</i>				
1	M-00-005	Closed— Unacceptable Action/No Response Received	2/4/2008	To the Operators and Manufacturers/Refurbishers of Amphibious Passenger Vessels: Without delay, alter your amphibious passenger vessels to provide reserve buoyancy through passive means, such as watertight compartmentalization, built-in flotation, or equivalent measures, so that they will remain afloat and upright in the event of flooding, even when carrying a full complement of passengers and crew.
2	M-02-001	Closed— Unacceptable Action	9/17/2007	To the States of New York and Wisconsin, as well as the US Coast Guard: Require that amphibious passenger vehicle operators provide reserve buoyancy through passive means, such as watertight compartmentalization, built-in flotation, or equivalent measures, so that the vehicles will remain afloat and upright in the event of flooding, even when carrying a full complement of passengers and crew.
3	M-02-002	Closed— Unacceptable Action	10/5/2007	To the States of New York and Wisconsin, as well as the US Coast Guard: Until such time that owners provide sufficient reserve buoyancy in their amphibious passenger vehicles so that they will remain upright and afloat in a fully flooded condition (by M-02-1), require the following: (1) removal of canopies for waterborne operations or installation of a Coast Guard-approved canopy that does not restrict either horizontal or vertical escape by passengers in the event of sinking, (2) reengineering of each amphibious vehicle to permanently close all unnecessary access plugs and to reduce all necessary through-hull penetrations to the minimum size necessary for operation, (3) installation of independently powered electric bilge pumps that are capable of dewatering the craft at the volume of the largest remaining penetration to supplement either an operable Higgins pump or a dewatering pump of equivalent or greater capacity, (4) installation of four independently powered bilge alarms, (5) inspection of the vehicle in water after each time a through-hull penetration has been removed or uncovered, (6) verification of a vehicle's watertight condition in the water at the outset of each waterborne departure, and (7) compliance with all remaining provisions of Navigation and Vessel Inspection Circular 1-01. (M-02-2)
4	M-02-003	Closed— Unacceptable Action	10/5/2007	To the States of New York and Wisconsin, as well as the US Coast Guard: Where canopies have been removed on amphibious passenger vehicles for which there is no adequate reserve buoyancy, require that all passengers don lifejackets before the onset of waterborne operations.

	Number	Classification	Date Closed	Recommendation
5	M-02-004	Closed—Acceptable Action	10/5/2007	To the US Coast Guard: Develop and promulgate guidance for all amphibious passenger vehicles similar in purpose to the Navigation and Vessel Inspection Circular 1-01.
<i>DUKW 34</i>				
6	M-11-001	Closed—Acceptable Action	2/8/2013	To the US Coast Guard: Develop and implement an investigative protocol that directs your investigation officers to routinely check for nonoperational use of cell phones and other wireless electronic devices by on-duty crewmembers in safety-critical positions involved in marine accidents.
7	M-11-002	Closed—Acceptable Action	2/8/2013	To the US Coast Guard: Revise your commercial vessel accident database (MISLE) to maintain a record of nonoperational use of cell phones and other wireless electronic devices by on-duty crewmembers in safety-critical positions when such use is causal or contributory to marine accidents.
8	M-11-003	Closed—Unacceptable Action	2/16/2017	To the US Coast Guard: Regulate and enforce the restriction on nonoperational use of cell phones and other wireless electronic devices by on-duty crewmembers in safety-critical positions so that such use does not adversely affect vessel operational safety.
9	M-11-004	Closed—Acceptable Alternate Action	2/16/2017	To the US Coast Guard: Until you can develop regulations governing nonoperational use of cell phones and other wireless electronic devices by on-duty crewmembers in safety-critical positions, continue your outreach program of information and education to the maritime industry on this issue.
10	M-11-005	Closed—Unacceptable Action/No Response Received	5/12/2015	To Ride The Ducks International, LLC: Review Ride The Ducks International's existing safety management program and develop improved means to ensure that your company's safety and emergency procedures are understood and adhered to by employees in safety-critical positions.
11	M-11-006	Closed—Acceptable Action	12/22/2011	To K-Sea Transportation Partners, LP: Review K-Sea Transportation's existing safety management program and develop improved means to ensure that the company's safety and emergency procedures are understood and adhered to by employees in safety-critical positions.
12	M-11-007	Closed—Acceptable Action	1/11/2012	To American Waterways Operators: Notify your members of the circumstances of this accident, and encourage them to ensure that their safety and emergency procedures are understood and adhered to by employees in safety-critical positions.

	Number	Classification	Date Closed	Recommendation
DUKW 6				
13	M-16-026	Open—Acceptable Response	N/A	To the US Coast Guard: Amend Navigation and Vessel Inspection Circular 1-01 to ensure that (1) amphibious passenger vehicle (APV) operators tell passengers that seat belts must not be worn while the vessel/vehicle is operated in the water and (2) before the APV enters the water or departs the dock, the master or other crewmember visually checks that each passenger has unbuckled his or her seat belt.
14	M-16-027	Open—Acceptable Response	N/A	To the US Coast Guard: Distribute a safety alert on amphibious passenger vehicle operations that addresses the role of risk assessment to mitigate driver distraction, as well as the need to tell passengers to remove seat belts before waterborne operations begin.
15	M-16-028	Closed—Exceeds Recommended Action	12/7/2018	To the Passenger Vessel Association: Notify all your amphibious passenger vehicle (APV) operator members of the importance of the following: (1) learning the lessons from the Seattle, Washington, and Boston, Massachusetts, crashes; (2) completing proper maintenance and service bulletin repairs; (3) using the pretrip safety orientation to tell passengers of APVs equipped with passenger seat belts to unbuckle their belts before the APV begins any marine operations; (4) conducting a visual inspection to ensure that passengers have unbuckled their seat belts prior to water entry; (5) reducing the risk of driver distraction by having a tour guide conduct each tour; (6) managing risk in tour operations by addressing such factors as driver distraction, route planning, vehicle characteristics, traffic density, and vehicle speed; and (7) conducting operations according to Navigation and Vessel Inspection Circular 1-01 guidance and US Coast Guard safety alerts.
16	H-16-017	Closed—Acceptable Action	11/13/2017	To the National Highway Traffic Safety Administration: Require that Ride The Ducks International, as a manufacturer, issue a recall for the stretch amphibious passenger vehicle front axle safety defect to provide owners a remedy as required under the Safety Recall Campaign.
17	H-16-018	Open—Unacceptable Response	N/A	To the National Highway Traffic Safety Administration: Adopt the US Coast Guard's assumed average weight per person and amend the certification regulation in 49 <i>Code of Federal Regulations</i> Part 567 to specify that the gross vehicle weight rating for an amphibious passenger vehicle "shall not be less than the sum of the unloaded vehicle weight, the rated cargo load, and 185 pounds times the vehicle's number of designated seating positions."

	Number	Classification	Date Closed	Recommendation
18	H-16-019	Open—Unacceptable Response	N/A	To the National Highway Traffic Safety Administration: Classify all amphibious passenger vehicles (APV) as non-over-the-road buses and, under the authority of the National Traffic and Motor Vehicle Safety Act of 1966, make newly manufactured APVs subject to applicable Federal Motor Vehicle Safety Standards in effect at the time of manufacture.
19	H-16-020	Open—Acceptable Response	N/A	To Ride The Ducks International: Develop a thoroughly verified and tested repair or alternative axle housing for the front axles of your stretch amphibious passenger vehicles (APV), and repair or replace the axle housings on your own stretch APVs as necessary.
20	H-16-021	Open—Acceptable Response	N/A	To Ride The Ducks International: Communicate the repair or replacement information concerning the front axle housings of your stretch amphibious passenger vehicles, developed in response to Safety Recommendation H-16-20, to your franchisees and licensees.
21	H-16-022	Closed—Unacceptable Action	4/10/2018	To Ride The Ducks International: Instruct your franchisees and licensees to immediately halt operation of their stretch amphibious passenger vehicles and not resume operations until they complete the axle housing repair or replacement process developed in response to Safety Recommendation H-16-20. (Urgent)
22	H-16-023	Closed—Acceptable Action	5/11/2017	To Ride The Ducks of Seattle: Add to your 250-hour and annual inspection processes a procedure to verify that all actions indicated in service bulletins have been completed on all inspected vehicles.

Appendix C

Safety Recommendation Report



National Transportation Safety Board
Washington, DC 20594

Safety Recommendation Report

Improving Vessel Survivability and Passenger Emergency Egress of DUKW Amphibious Passenger Vessels

Accident No.	DCA18MM028
Location	Table Rock Lake, near Branson, Missouri
Date	July 19, 2018
Recommendation Nos.	M-19-15 and -16
Adopted	November 6, 2019

On the evening of July 19, 2018, seventeen of the thirty-one persons aboard the *Stretch Duck 7* died when the amphibious passenger vessel (APV) sank during a high-wind storm that developed rapidly on Table Rock Lake near Branson, Missouri. The National Transportation Safety Board (NTSB) is investigating the sinking of the *Stretch Duck 7*, which originally was built in 1944 as a DUKW landing craft to carry military personnel and cargo during World War II and was then modified for commercial purposes to carry passengers on excursion tours (see **figure 1**).¹



Figure 1. *Stretch Duck 7* after salvage from Table Rock Lake, July 2018.

¹ *DUKW* (pronounced “duck”) is an acronym that signifies the characteristics of the WWII amphibious vessel: D=1942, the year of design; U=utility; K=front-wheel drive; and W=two rear-driving axles.

A criminal investigation by other federal and state agencies into the sinking of the *Stretch Duck 7* also began shortly after the accident. As a result, sharing of factual information between parties has been limited, several key witnesses have declined requests to be interviewed by investigators from the NTSB's Office of Marine Safety, and the US Coast Guard's Marine Board of Investigation hearings have not been scheduled as of the date of this report. Consequently, to date, the NTSB has not yet completed this investigation.

In the interim, the NTSB is releasing this safety recommendation report to address the insufficient reserve buoyancy of DUKW amphibious passenger vessels along with their impediments to passenger emergency egress.² These safety issues were identified almost 20 years prior to the sinking of the *Stretch Duck 7* and remain relevant to this accident. The 1999 sinking of the *Miss Majestic*, another accident involving a DUKW amphibious passenger vessel that resulted in multiple fatalities, prompted the NTSB to issue several recommendations addressing these and other safety concerns. In a February 18, 2000, letter requesting the Coast Guard take immediate action on the first of five related safety recommendations, the NTSB warned:

Amphibious vessels are vulnerable to rapid sinking because they lack reserve buoyancy; consequently, the Safety Board concludes that the potential exists for another life-threatening accident similar to the sinking of the *Miss Majestic*, unless the vulnerability to flooding and sinking is addressed.

Due to the significant loss of life in the sinking of the *Miss Majestic* and, more recently, the *Stretch Duck 7*, the issuance of early recommendations for the types of DUKW amphibious vessels involved in these accidents is warranted. The NTSB nevertheless will continue its investigation of the *Stretch Duck 7* accident to explore safety issues in its final report and, if necessary, issue additional safety recommendations.

2018 Sinking of *Stretch Duck 7*

About 1908 central daylight time on July 19, 2018, the 33-foot-long, modified WWII amphibious passenger vessel *Stretch Duck 7*, part of a fleet of vessels operated by Ride The Ducks Branson, sank during a storm with heavy winds that developed rapidly on Table Rock Lake near Branson, Missouri. Of the 31 persons aboard, 17 fatalities resulted. Prior to the accident, the National Weather Service had issued a severe thunderstorm warning for the area advising of wind gusts of 60 mph. The manager-on-duty advised the captain and driver before departing the shoreside boarding facility to complete the lake portion of the tour before the land tour (which normally occurred first) due to the approaching weather. About 5 minutes after the vessel entered the water, the leading edge of a storm front, later determined to be a "derecho," passed through the area generating strong winds and waves reportedly 3- to 5-feet high, with the highest wind gust recorded at 73 mph.³ The *Stretch Duck 54*, another vessel from the company's fleet that had also been conducting a tour on the lake at this time, was able to exit the water after experiencing the severe weather. During its effort to reach land, the *Stretch Duck 7* took on water and sank approximately 250 feet away from the exit ramp. Several first responders, along with the crewmembers and passengers aboard a paddlewheeler moored nearby, rescued and triaged

² Reserve buoyancy is the internal volume of a vessel that is not flooded or capable of being flooded.

³ Pronounced "deh-REY-cho," this widespread, long-lasting windstorm is associated with a continuous band of rapidly moving showers or intense thunderstorms and is characterized by a rapid increase of damaging, strong winds.

14 passengers, 7 of whom were transported to local hospitals. Loss of the vessel was estimated at \$184,000.

Four days after the accident, the *Stretch Duck 7* was salvaged from a depth of 85 feet in the lake. Once the remaining water was pumped out and the vessel was refloated, investigators observed no hull breach. The canopy on the *Stretch Duck 7* was found torn along the center support beam, and the vessel's engine and electronic components were water damaged. Investigators also found that the vessel's side curtain had been released on the port side, but the curtain on the starboard side was closed.

1999 Sinking of *Miss Majestic*

In one of the deadliest accidents involving a modified WWII DUKW at the time, 13 passengers lost their lives during an excursion tour aboard the *Miss Majestic* in Lake Hamilton near Hot Springs, Arkansas, shortly before noon on May 1, 1999.⁴ About 7 minutes after entering the lake, the 31-foot-long vessel (see **figure 2**) listed to port and rapidly sank by the stern in 60 feet of water. The operator and most of the 20 passengers were trapped by the vessel's canopy and drawn under water, except one passenger who escaped before it submerged. As the vessel descended to the bottom of the lake, six passengers and the operator were able to escape and, upon reaching the water's surface, were rescued by recreational boaters in the area. Damage to the *Miss Majestic* was estimated at \$100,000.

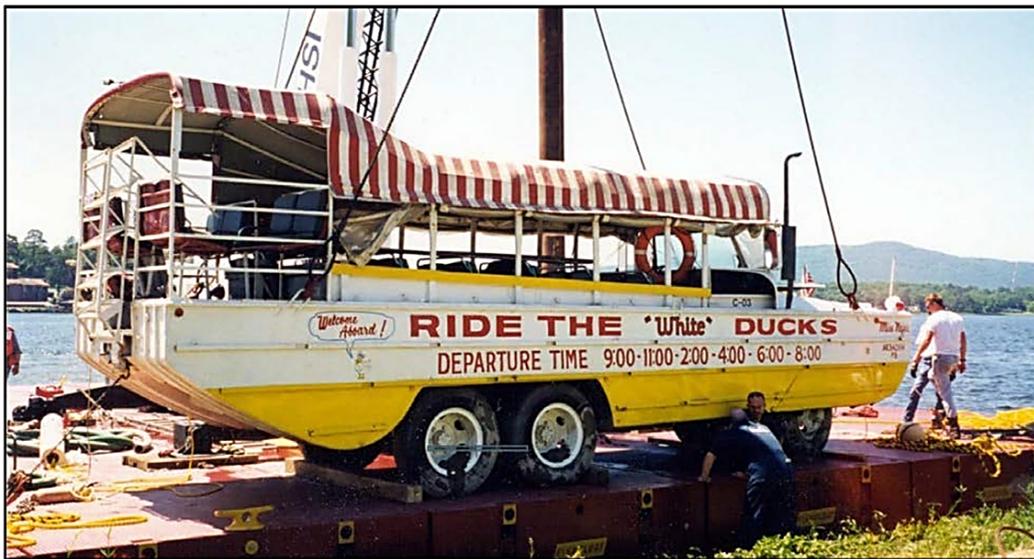


Figure 2. *Miss Majestic* post-salvage, 1999.

Vessel maintenance, reserve buoyancy, and survivability—specifically regarding the impediment of the vessel's canopy to the egress of passengers—were among the major safety issues identified by the NTSB's investigation of the accident. Investigators determined that water

⁴ *Sinking of the Amphibious Passenger Vehicle Miss Majestic, Lake Hamilton, Near Hot Springs, Arkansas, May 1, 1999.* MAR-02/01. Washington, DC: NTSB. For more information, see www.nts.gov.

initially entered the *Miss Majestic* through the gap between the driveshaft and its housing via an unsecured clamp for the watertight rubber boot. Once the weight of floodwater in the aft portion of the hull reduced the freeboard at the stern to zero, water poured over the immersed transom and into the interior of the *Miss Majestic*, causing it to sink rapidly by the stern.⁵

Types of DUKW Amphibious Vessels

The NTSB has investigated several accidents involving commercial APVs within the United States, including the current investigation of the *Stretch Duck 7*. Whether the incident occurred on land or in the water, in 5 out of 6 of these investigations the vessel involved shared similar dimensions and/or characteristics with the World War II-era DUKW amphibious vessel (see **figure 3**).⁶ In total, 37 deaths and 104 injuries resulted from these six DUKW-related accidents.



Figure 3. DUKW in military use before conversion to passenger service.

While there are multiple models of passenger-carrying amphibious vessels built by various manufacturers, those sharing similar characteristics with the WWII DUKW amphibious vessel have been widely used in tour operations. Further, this subtype exists in several variations that can be distinguished by the following characteristics:

	Original	Stretch	Master Jig	Truck
<i>Chassis</i>	DUKW	DUKW	DUKW	M35 ⁷
<i>Modified</i>	1940s–1990s	Mid-1990s	2003	2005
<i>Exterior</i>	Length: 30’ Beam: 8’	Longer length, similar beam	Raised gunwales, ⁸ wider beam	Raised gunwales, wider beam
<i>Hull thickness</i>	14 gauge (.0747”) on side walls	Similar to original design	Increased	Increased
<i>Engine</i>	Gas	Gas	Gas	Diesel

⁵ *Freeboard* is the distance between the deck edge and the waterline.

⁶ See appendix A for a brief summary of the six NTSB-investigated accidents involving amphibious passenger vessels.

⁷ M35 military trucks were built in different variations from 1950 to 1999.

⁸ *Gunwales* are the upper edge of the vessel’s sides.

The *Stretch Duck 7*, the *Stretch Duck 54*, and the *Miss Majestic* were all modified WWII DUKWs. However, the *Stretch Duck 7*, as its name intimates, specifically was a “stretch” DUKW, while the *Stretch Duck 54*, which encountered the same severe weather as the *Stretch Duck 7* but was able to exit the water, was a “master jig” DUKW with dimensions similar to a “truck duck.” The *Miss Majestic*, a model similar to the *Stretch Duck 7*, was an original DUKW. Based on previous accidents involving modified WWII DUKW vessels, particularly the original and stretch DUKW models, the NTSB is focusing this report on these two types of vessels due to their insufficient reserve buoyancy as well as impediments to passenger egress, which compromise not merely the survivability of such vessels but their occupants as well.

Previous Recommendations

Since 1999, the NTSB has issued 22 safety recommendations related to modified WWII DUKW amphibious passenger vessels. At the time of the *Stretch Duck 7* sinking, nine of these safety recommendations had been classified “Closed—Acceptable Action,” “Closed—Acceptable Alternate Action,” or “Closed—Exceeds Recommended Action,” indicating the completion of a response that either complied with, met the objective of, or surpassed what the NTSB recommended, respectively. Four remained pending and were classified “Open—Acceptable Response,” indicating a planned action that, when completed, would comply with the safety recommendations. For nine other recommendations, the recipient either disagreed with the recommendation, or otherwise did not plan to satisfy the recommendation, and thus they were classified “Open—Unacceptable Response,” “Closed—Unacceptable Action/No Response Received,” or “Closed—Unacceptable Action.”

Of the total number of safety recommendations related to modified APVs, five were issued nearly two decades ago in response to the sinking of the *Miss Majestic*—the largest number of marine safety recommendations issued as a result of a single APV accident. The lack of reserve buoyancy on modified DUKW amphibious passenger vessels and the dangers of canopies installed on these vessels were identified as important safety issues. Recommendations addressing these issues were directed to operators, manufacturers, and/or refurbishers of DUKW vessels; individual states that had DUKW vessels operating in their jurisdictions; and the Coast Guard. Four out of five were classified “Closed—Unacceptable Action,” indicating that the recommendation recipient did not take the recommended action. The one recommendation that was closed acceptably requested the Coast Guard develop and promulgate guidance for all amphibious passenger vessels similar to its Navigation and Vessel Inspection Circular (NVIC) 1-01, which was published after the sinking.⁹

The NTSB believes that the failure to implement the safety recommendations related to providing reserve buoyancy for DUKW amphibious passenger vessels contributed to the sinking of the *Stretch Duck 7* on Table Rock Lake on July 19, 2018. Additionally, the failure to implement the recommendation concerning fixed canopies likely increased the number of fatalities that resulted. Therefore, this report addresses two recommendations issued as a result of the NTSB’s investigation of the *Miss Majestic* sinking that were classified “Closed—Unacceptable Action,” by issuing two updated safety recommendations urging the Coast Guard to address the same risks

⁹ The objective of NVIC 1-01 (“Inspection of Amphibious Passenger Carrying Vehicles”), which was published on December 11, 2000, was to disseminate to Coast Guard marine inspectors, vehicle owners/operators, and repair facilities information relating to good marine practice in the inspection, operation, and repair of amphibious vehicles. For more information, see <https://www.dco.uscg.mil>.

to passengers on board modified DUKW amphibious passenger vessels that were found 20 years later in the *Stretch Duck 7* sinking.

Prior to completing its investigation of the *Miss Majestic*, the NTSB assembled key stakeholders in the industry, including the Coast Guard, for a public forum on APV safety in December 1999 and issued an urgent recommendation soon afterward. Having immediate concerns about the risk of flooding and the vulnerability to sinking for all types of APVs, the NTSB issued the following safety recommendation to the operators, manufacturers, and/or refurbishers of APVs:

Without delay, alter your amphibious passenger vessels to provide reserve buoyancy through passive means, such as watertight compartmentalization, built-in flotation, or equivalent measures, so that they will remain afloat and upright in the event of flooding, even when carrying a full complement of passengers and crew. (M-00-5)

The NTSB followed its urgent recommendation with multiple letters (in late 2000, 2002, and 2008) requesting a response from the 30 DUKW operators addressed. In February 2008, eight years after its issuance, Safety Recommendation M-00-5 was closed. Given that almost half of the addressees never responded, the recommendation was classified overall “Closed—Unacceptable Action/No Response Received.” Only one operator completed the recommended action; that recommendation was classified “Closed—Acceptable Action.”¹⁰ Two other organizations ceased operating APVs; their recommendations were classified “Closed—No Longer Applicable.” Thirteen of the 30 companies that responded chose to complete an alternate course of action, such as installing flow-restrictor plates, additional bilge pumps, additional high-water bilge alarms, or other approaches to improvements. For these operators, the recommendation was classified “Closed—Acceptable Alternate Action.”

In the final report on the *Miss Majestic* sinking, the NTSB issued the above recommendation to the Coast Guard, as well as to the states of New York and Wisconsin (M-02-1).¹¹ In its May 2, 2002, letter issuing Safety Recommendation M-02-1, the NTSB said, “Because the industry has, by and large, refused to take voluntary action to address this risk, the Safety Board considers it imperative that a regulatory authority takes steps to ensure that all amphibious passenger vehicles will not sink in the event of an uncontrolled flooding event.”¹²

The Coast Guard did not concur with the recommendation, stating in a September 5, 2002, letter to the NTSB:

Requirements for subdivision, damage stability, and watertight integrity for small passenger vessels of less than 100 gross tons were given at Title 46, *Code of Federal Regulations*, Part 179 (46 CFR 179). There are no subdivision or damage stability requirements for vessels less than 65 feet in length carrying fewer than 50 passengers on protected waters. For amphibious vessels that present additional

¹⁰ The sole operator whose response was considered to be acceptable built and operated only one type of amphibious passenger vessel with an aluminum hull and foam-filled compartments. This flotation feature was confirmed during visits by the NTSB.

¹¹ Although the commercial amphibious passenger vessels in New York and Wisconsin were not subject to Coast Guard regulation, they posed the same risk as those operating on navigable waters under Coast Guard authority by carrying thousands of passengers annually.

¹² DUKW *vessels* are also referred to as *vehicles* due to their dual function of being operated on land and in water.

flooding, sinking and egress risks, guidance on attaining an equivalent level of safety has been promulgated through Navigation and Vessel Inspection Circular (NVIC) 1-01. An equivalent level of safety is required by 46 CFR 175.550. We believe that sufficient requirements and guidance are in place to provide to amphibious passenger vessels a level of safety equivalent to other passenger vessels of similar size and capacity. We intend to take no other action on this recommendation and request that it be closed.

The NTSB did not agree with the Coast Guard's position, believing that APVs are involved in "unique operations" and therefore require "unique safety considerations." As the NTSB pointed out in its May 6, 2003, reply, APVs can be flooded through several mechanisms and are subject to hull loadings and stresses not traditionally associated with conventional marine vessel operations. These stresses include highway and off-the-road travel, as well as stresses to the hull and appendages during repeated water entry and exit. Such operations can accelerate wear on the APV's hull and loosen mechanical joints and connections, thereby compromising the watertight integrity of the hull. Furthermore, because DUKWs have open interiors and a low freeboard, they are vulnerable to rapid swamping and sinking. Once the stern or gunwales are immersed (i.e., the freeboard is reduced to zero), water quickly swamps the DUKW and causes it to sink rapidly.

Safety Issue No. 1: Providing Reserve Buoyancy

Survivors of the *Miss Majestic* accident confirmed that the vehicle sank by the stern less than a minute after the deck edge was submerged, leaving insufficient opportunity for passengers to escape before the vessel sank. Accordingly, the NTSB issued Safety Recommendation M-02-1 to the Coast Guard, addressing the safety issue of reserve buoyancy to make all APVs more survivable and stable in the event of flooding. However, because the Coast Guard did not concur with this recommendation and did not take any action, Safety Recommendation M-02-1 was classified "Closed—Unacceptable Action" in the NTSB's May 6, 2003, response letter.

DUKW vessels were originally constructed with a low freeboard, an open hull, and no compartmentalization or subdivision, resulting in a design without adequate reserve buoyancy.¹³ In order to reduce the volume of water that could accumulate in these low-freeboard vessels, particularly during beaching and combat operations, the original DUKW design included the installation of a large-capacity bilge pump, referred to as a "Higgins" pump, which was rated at a maximum pumping capacity of about 250 gallons per minute (gpm). Driven by a chain connected to the DUKW's propulsion shaft, the pump would run at a speed proportional to the propeller speed and operate whether the bilges contained water or were dry. In order to operate the Higgins pump at full capacity, the operator would be required to engage the propeller shaft in the forward direction and operate the engine at full throttle. This action by the operator would be an "active" means of dewatering the vessel, compared to a "passive" safety system, which requires no deliberate action or operation to deploy and generally facilitates fail-safe performance of a vessel.

After the *Miss Majestic* accident, the Coast Guard approved a modification to remove the Higgins pump in DUKW vessels.¹⁴ As an alternative, a sea chest, or watertight containment, was

¹³ *Subdivision* is the concept of dividing a vessel's hull into watertight compartments using transverse watertight bulkheads so that, in the event of damage, flooding is restricted to the damaged compartments and the vessel will be less likely to sink.

¹⁴ The pump on the *Miss Majestic* was found to have been inoperable due to a mechanical issue.

installed around hull penetrations to contain any flooding through them. In addition, these modified vessels were outfitted with high-level alarms and electrically operated bilge pumps that started automatically. On the *Stretch Duck 7*, the Higgins pump had been removed; installed in its place were a sea chest and three 33-gpm bilge pumps.¹⁵ These pumps were found to be in working condition after the accident.

During the waterborne portion of its final voyage, the *Stretch Duck 7* was exposed to high winds and waves estimated at 3 to 5 feet. The video recorder on board captured bilge alarms sounding 4 minutes after the vessel encountered severe weather, signaling an ingress of water. About 4 minutes later, the *Stretch Duck 7* sank. Witness videos showed the vessel pitching in the storm with white-capped waves covering the bow several times (see **figure 4**). In the forward section of the vessel, the ventilation openings that supplied combustion and cooling air to and from the engine most likely permitted water to enter the engine compartment, from where it would have flowed freely throughout the rest of the hull. The additional water weight would have further lowered the vessel's freeboard and thereby subjected it to more rapid flooding.



Figure 4. *Stretch Duck 7* moments before sinking. (Source: Jennie Carr)

Surviving passengers who were interviewed after the accident recalled water quickly rising from under the floorboards of the *Stretch Duck 7*. They described how waves pushed in the starboard-side curtain and water entered from the bottom rail of the curtain where it met the gunwale. Once the water started filling the vessel, it quickly flooded and sank within seconds after covering the passengers' feet. Most passengers recalled the *Stretch Duck 7* had a starboard list in the final moments of the voyage and rapidly sank by the stern. If the *Stretch Duck 7* had been modified to include several subdivided compartments—one approach to a passive safety system—the flooding could have been contained to individual sections of the vessel, thus increasing the vessel's ability to remain afloat. The vessel could have remained afloat and upright indefinitely had it been fitted with built-in flotation or watertight compartmentalization, which can be designed and sized to provide a boat with sufficient reserve buoyancy even when the hull is fully flooded.

¹⁵ The equivalent of 2,000 gallons per hour.

Safety Issue No. 2: Removing Canopies and Side Curtains

In the *Miss Majestic* accident report, the NTSB determined that one of the contributing factors to the high number of fatalities was a continuous canopy that entrapped passengers within the sinking vessel. Accordingly, the NTSB issued Safety Recommendation M-02-2 to the Coast Guard, as well as to the states of New York and Wisconsin:

Until such time that owners provide sufficient reserve buoyancy in their amphibious passenger vehicles so that they will remain upright and afloat in a fully flooded condition (by M-02-1), require the following:

- (1) removal of canopies for waterborne operations or installation of a Coast Guard-approved canopy that does not restrict either horizontal or vertical escape by passengers in the event of sinking,
- (2) reengineering of each amphibious vehicle to permanently close all unnecessary access plugs and to reduce all necessary through-hull penetrations to the minimum size necessary for operation,
- (3) installation of independently powered electric bilge pumps that are capable of dewatering the craft at the volume of the largest remaining penetration to supplement either an operable Higgins pump or a dewatering pump of equivalent or greater capacity,
- (4) installation of four independently powered bilge alarms,
- (5) inspection of the vehicle in water after each time a through-hull penetration has been removed or uncovered,
- (6) verification of a vehicle's watertight condition in the water at the outset of each waterborne departure, and
- (7) compliance with all remaining provisions of Navigation and Vessel Inspection Circular 1-01.

In its September 5, 2002, letter, the Coast Guard concurred with the intent of the recommendation, stating:

[Our] approach to the unique design and operational risks of amphibious vehicles is to require a level of safety equivalent to other small passenger vessels of similar size and service. This is accomplished in part through a combination of design requirements and operational restrictions. Additionally, risk management is incorporated by considering the entire vehicle and its equipment as a complete safety system.

Regarding the installation of canopies, the Coast Guard advised, however:

In addition to the guidance provided on the design and installation of canopies, NVIC 1-01 also provides extensive guidance for Officers in Charge, Marine Inspection (OCMI) and owners of amphibious passenger vehicles to evaluate the design and installation of associated arrangements such as seating, deck rails, windshields and windows. All of these items, including the canopy, are to be evaluated as a system to

ensure that the overall arrangement does not restrict the ability of passengers to escape. Additionally, NVIC 1-01 provides guidance on the importance of addressing emergency egress during the passenger safety orientation. We believe the guidance contained in NVIC 1-01 is sufficient to ensure that adequate means of escape are provided on amphibious passenger vehicles that have canopies installed.

In its May 6, 2003, reply, the NTSB pointed out to the Coast Guard that the recommendation called for establishing a *requirement* to remove canopies, or install Coast Guard-approved versions, not for voluntary compliance with guidance in NVIC 1-01. The Coast Guard, nonetheless, maintained its stance that the NVIC provided sufficient guidance and therefore stated that the agency did not intend to take further action. As a result, on October 5, 2007, the NTSB classified Safety Recommendation M-02-2 “Closed—Unacceptable Action.”

The entire passenger and crew space of the *Stretch Duck 7* had been covered by a fixed canopy. Upon recovery of the vessel, the canopy was found torn from front to back (see **figure 5**). It was peeled back over the starboard side but largely remained intact on the port side. The canopy was constructed of vinyl measuring .032 inches thick and pressed into a seam along the horizontal support at the center of the vessel. Underneath the canopy, the *Stretch Duck 7*'s personal flotation devices (PFDs, commonly called lifejackets) were stored above the seating compartment. Of the 56 lifejackets investigators counted postaccident, the majority of them—a total of 41—were still connected to the vessel's canopy framing by their straps.¹⁶ With the PFDs in their storage locations above the passengers, vertical egress was blocked during the sinking, despite the canopy being peeled back over the starboard side.



Figure 5. Torn canopy of the *Stretch Duck 7* found during recovery operations.

¹⁶ The remaining lifejackets were recovered from the lake's surface or within the vessel outside of their storage locations.

The canopy framing also created obstructions for clear egress from the vessel. Several surviving passengers recalled hitting various impediments and being pinned against the canopy before they could break through it to escape upward from the submerged vessel. The NTSB believes that some of the fatalities likely resulted from the presence of the canopy and its associated framing.

The NTSB's position on the installation of canopies on modified WWII DUKW amphibious passenger vessels has not changed since the *Miss Majestic* sinking. The number of fatalities resulting from the sinking of the *Stretch Duck 7* is further evidence of the continuing, unacceptable risks posed by canopies currently installed on modified WWII DUKW vessels. Given their lack of adequate reserve buoyancy and low freeboard, these vessels are vulnerable to rapid swamping and sinking, leaving passengers and crewmembers little time to evacuate. The NTSB has determined that canopies and their associated supports installed on these vessels impede escape and therefore should be removed before waterborne operations.

The sinking of the *Stretch Duck 7* raised awareness of another impediment to passenger emergency escape. Each side of the *Stretch Duck 7* was outfitted with a clear vinyl side curtain, which was comprised of a continuous sheet of plastic on a reel spanning the entire length of the passenger space. With an electric motor, these two adjustable curtains, designed to be used as protection for passengers during inclement weather, could be lowered (closed) and raised (opened). When lowered, the curtains' bottom rail was held by brackets on the forward and aft sides of the vessel. In an emergency situation, each curtain could be separated from the vessel with manual release levers: the portside curtain could be released from a handle directly above the captain's seat near the top of the portside curtain, and the starboard-side curtain could be released from the corresponding location on the starboard side.

During salvage operations, the *Stretch Duck 7*'s portside curtain was found apart from the vessel at the lake's bottom; survivors recalled the captain had manually released it by using a lever above his head just before the vessel sank. However, the starboard-side curtain was found closed; its bottom rail was engaged into the gunwale side brackets, and the lever for releasing the curtain had not been moved into position for that function. Having the side curtain closed created another impediment that prevented emergency escape from the starboard side of the vessel. Although surviving passengers of the *Stretch Duck 7* could not determine whether the curtains, canopy, or other obstructions blocked their escape, the NTSB believes that side curtains employed during waterborne operations further impede egress from the passenger seating area over the gunwale and out the sides of the vessel, especially large curtains that span the length of the vessel.

Findings

1. Having been constructed with a low freeboard and without compartmentalization, or subdivision, the *Stretch Duck 7* lacked adequate reserve buoyancy and therefore quickly sank once water entered the vessel after it encountered severe weather.
2. Both the fixed canopy and a closed side curtain spanning the starboard side of the passenger compartment on the *Stretch Duck 7* impeded passenger escape, which likely resulted in an increased number of fatalities.

Recommendations**To the US Coast Guard**

Require DUKW amphibious passenger vessels (commonly referred to as original and/or “stretch” DUKWs) to have sufficient reserve buoyancy through passive means, so that they remain upright and afloat with a full complement of passengers and crewmembers in the event of damage or flooding. (M-19-15)

For DUKW amphibious passenger vessels without sufficient reserve buoyancy (commonly referred to as original and/or “stretch” DUKWs), require the removal of canopies, side curtains, and their associated framing during waterborne operations to improve emergency egress in the event of sinking. (M-19-16)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

ROBERT L. SUMWALT, III
Chairman

JENNIFER HOMENDY
Member

BRUCE LANDSBERG
Vice Chairman

Adopted: November 6, 2019

Appendix A

NTSB-Investigated Accidents Involving Amphibious Passenger Vessels

Miss Majestic, Lake Hamilton, Near Hot Springs, Arkansas, May 1, 1999

The *Miss Majestic*, an original WWII DUKW vessel that had been modified for passenger service, sank in Lake Hamilton near Hot Springs, Arkansas, on May 1, 1999. Of the 21 people on board, 13 passengers, including 3 children, died. The vehicle damage was estimated at \$100,000. *Sinking of the Amphibious Passenger Vehicle Miss Majestic, Lake Hamilton, Near Hot Springs, Arkansas, May 1, 1999*, MAR-02/01. Washington, DC: NTSB.

Minnow, Milwaukee Harbor, Lake Michigan, September 18, 2000

On September 18, 2000, the *Minnow*, an Alvis Stalwart amphibious vessel, sank in Milwaukee Harbor of Lake Michigan with 19 people on board after experiencing mechanical issues.¹⁷ There were no fatalities. Damage to the vessel was estimated at \$170,000. The accident brief was published in the appendix of the report *Sinking of the Amphibious Passenger Vehicle Miss Majestic, Lake Hamilton, Near Hot Springs, Arkansas, May 1, 1999*, MAR-02/01. Washington, DC: NTSB.

DUKW No. 1, Lake Union, Seattle, Washington, December 8, 2001

The *DUKW No. 1*, an original WWII DUKW vessel, sank in Lake Union, Seattle, Washington, on December 8, 2001, when a missing access plug allowed water to flood the hull. No fatalities resulted. Estimated damage was \$100,000. The accident brief was published in the appendix of the report *Sinking of the Amphibious Passenger Vehicle Miss Majestic, Lake Hamilton, Near Hot Springs, Arkansas, May 1, 1999*, MAR-02/01. Washington, DC: NTSB.

DUKW 34, Delaware River, Philadelphia, Pennsylvania, July 7, 2010

On July 7, 2010, the tugboat/barge combination *Caribbean Sea/The Resource* collided with the *DUKW 34*, an amphibious vessel modified into a “stretch” DUKW, while carrying 37 persons on board on the Delaware River in Philadelphia, Pennsylvania. Two passengers on board the *DUKW 34* were fatally injured, and several other passengers sustained minor injuries. Damage totaled \$130,470. *Collision of TugBoat/Barge Caribbean Sea/The Resource with Amphibious Passenger Vehicle DUKW 34, Philadelphia, Pennsylvania, July 7, 2010*, MAR-11/02. Washington, DC: NTSB.

DUCK 6, Seattle, Washington, September 24, 2015

On September 24, 2015, the *DUCK 6*, an amphibious vessel modified into a “stretch” DUKW, crossed the center line into oncoming traffic and struck a motorcoach while traveling on a state bridge in Seattle, Washington. Three other vehicles were damaged. As a result of the crash, five motorcoach passengers died. Seventy-one motorcoach and *DUCK 6* occupants reported injuries. *Amphibious Passenger Vehicle DUCK 6 Lane Crossover Collision With Motorcoach on State Route 99, Aurora Bridge, Seattle, Washington, September 24, 2015*, HAR-16/02. Washington, DC: NTSB.

¹⁷ Larger than a DUKW, the Alvis Stalwart model originally was a 5-ton, 6-wheel amphibious military truck used by the British Army from 1966 until 1992.

Stretch Duck 7, Table Rock Lake, Near Branson, Missouri, July 19, 2018

The *Stretch Duck 7*, an amphibious vessel modified into a “stretch” DUKW, sank on Table Rock Lake near Branson, Missouri, during severe weather that approached about 5 minutes after the vessel entered the water on July 19, 2018. Seventeen of the 31 persons on board died. Damage to the vessel was estimated at \$184,000. The NTSB is continuing its investigation of the accident, as of the date of this report.

For more information, see www.nts.gov.

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