



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
Chassis	DUKW	DUKW	DUKW	M35 ⁷
Modified	1940s–1990s	Mid-1990s	2003	2005
Exterior	Length: 30' Beam: 8'	Longer length, similar beam	Raised gunwales, ⁸ wider beam	Raised gunwales, wider beam
Hull thickness	14 gauge (.0747") on side walls	Similar to original design	Increased	Increased
Engine	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. All of the PFDs on the port side were found in their stowed position, as well as all but three of the PFDs on the starboard side. 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.

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

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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.¹⁶ 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.

¹⁶ 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.