

Parasailing Safety



Special Investigation Report

NTSB/SIR-14/02
PB2014-106341



**National
Transportation
Safety Board**

NTSB/SIR-14/02
PB2014-106341
Notation 8589
Adopted June 18, 2014

Special Investigation Report

Parasailing Safety



**National
Transportation
Safety Board**

490 L'Enfant Plaza, SW
Washington, DC 20594

National Transportation Safety Board. 2014. *Parasailing Safety*. Special Investigation Report NTSB/SIR-14/02. Washington, DC.

Abstract: This special investigation report examines issues involving parasailing safety and oversight. It discusses a number of recent accidents and the subsequent testing of parasailing equipment involved in these mishaps.

As a result of this special investigation, the National Transportation Safety Board makes new recommendations to the United States Coast Guard, the Federal Aviation Administration, and the National Association of State Boating Law Administrators.

The National Transportation Safety Board (NTSB) is an independent federal agency dedicated to promoting aviation, railroad, highway, marine, pipeline, and hazardous materials safety. Established in 1967, the agency is mandated by Congress through the Independent Safety Board Act of 1974 to investigate transportation accidents, determine the probable causes of the accidents, issue safety recommendations, study transportation safety issues, and evaluate the safety effectiveness of government agencies involved in transportation. The NTSB makes public its actions and decisions through accident reports, safety studies, special investigation reports, safety recommendations, and statistical reviews.

Recent publications are available in their entirety on the Internet at www.ntsb.gov. Other information about available publications also may be obtained from the website or by contacting:

**National Transportation Safety Board
Records Management Division, CIO-40
490 L'Enfant Plaza, SW
Washington, DC 20594
(800) 877-6799 or (202) 314-6551**

Copies of NTSB publications may be purchased from the National Technical Information Service. To purchase this publication, order product number PB2014-106341 from:

**National Technical Information Service
5301 Shawnee Road
Alexandria, Virginia 22312
(800) 553-6847 or (703) 605-6000
www.ntis.gov**

The Independent Safety Board Act, as codified at 49 *United States Code* Section 1154(b), precludes the admission into evidence or use of any part of an NTSB report related to an incident or accident in a civil action for damages resulting from a matter mentioned in the report.

Contents

Figures.....	iv
Acronyms and Abbreviations	v
Executive Summary	vi
1. Parasailing in the United States.....	1
1.1 Background.....	1
1.2 Parasailing Procedures and Equipment.....	1
1.3 Serious Parasailing Accidents Since 2009	4
2. Safety Oversight.....	7
2.1 Federal Level	7
2.1.1 Coast Guard Action	7
2.1.2 Federal Aviation Administration Action	10
2.2 State Level	12
2.2.1 National Association of State Boating Law Administrators Action.....	12
2.2.2 State of Florida Action.....	12
2.3 Parasailing Industry Associations	14
2.4 International Parasailing Safety	14
3. Postaccident Testing of Parasailing Equipment	16
3.1 Towline Strength Test.....	16
3.2 Winch Testing and Examination.....	21
3.3 Examination of Fractured Harness.....	23
3.4 Tensile Testing of Harness Waist Belts	26
4. Analysis	28
4.1 Coast Guard Effort.....	28
4.2 FAA Regulations	29
4.3 State Level Effort.....	31
5. Conclusions.....	32
5.1 Findings.....	32
5.2 Recommendations.....	32
Safety Alert.....	34
References.....	36

Figures

Figure 1. Parasail canopy and associated flight gear	2
Figure 2. Diagram of a typical parasail canopy and its 72 panels.....	3
Figure 3. Bowline knot, hitch knot, and spliced eye	17
Figure 4. Towline tension force at combined vessel and wind speeds.	20
Figure 5. Winch used on board the <i>Sky Screamer</i>	22
Figure 6. Splined drive pieces and bearing housing assembly.	23
Figure 7. Fractured harness	24
Figure 8. Accident flight bar	25
Figure 9. Intact harness	26

Acronyms and Abbreviations

AGL	above ground level (altitude)
ASTM	American Society for Testing and Materials (formerly; now ASTM International)
CFR	<i>Code of Federal Regulations</i>
COA	Certificate of Waiver or Authorization
CSA	Central Service Area (FAA)
ESA	Eastern Service Area (FAA)
FAA	Federal Aviation Administration
FWC	Florida Fish and Wildlife Conservation Commission
HB	House Bill
MMC	merchant mariner credential
NASBLA	National Association of State Boating Law Administrators
NTSB	National Transportation Safety Board
OCMI	officer in charge [of] marine inspection
PAPO	Professional Association of Parasail Operators
PSC	Parasail Safety Council
PVA	Passenger Vessel Association
SB	Senate Bill
SPV	small passenger vessel
UPV	uninspected passenger vessel
USC	<i>United States Code</i>
WSA	Western Service Area (FAA)
WSIA	Water Sports Industry Association

Executive Summary

This special investigation report examines parasailing accidents in the United States and its territories, and identifies several areas where the risk associated with parasailing may be mitigated. Each year, an estimated 3 to 5 million people in the United States participate in parasailing; however, no federal regulations or guidelines establish specific training or certification for parasailing operators. There is no requirement for inspection of the parasailing equipment, and no requirement to suspend operations during inclement or unsuitable weather conditions. As this report will describe, passengers seeking to enjoy the thrill, adventure, and panoramic views of parasailing risk becoming accident victims. Due to the nature of parasailing, accidents usually result in either serious injury or death.

This investigation report strives to reduce the number of injuries and fatalities associated with parasailing through recommendations that will improve safety for parasailing passengers and operators. The report also examines operations, equipment, and the various dynamic forces that affect parasailing.

As a result of this investigation, the National Transportation Safety Board makes new safety recommendations to the United States Coast Guard, the Federal Aviation Administration, and the National Association of State Boating Law Administrators.

1. Parasailing in the United States

1.1 Background

In 1961, a parachute developer modified for the first time a canopy for ascent and towing behind a vehicle. At that time, the activity known as parascending was predominately land-based and taught people how to parachute, without having to use an aircraft in the training. In 1974, a Florida inventor began testing the first working prototype of a winch boat (which parasailing vessels are commonly called), where the launch and recovery of passengers took place from a vessel, and parasailing as we know it today began. Shortly thereafter, in 1977, the first recorded parasailing accident occurred off Treasure Island, Florida.

The United States Coast Guard estimates that in 2013, about 325 vessels were conducting parasailing operations in the United States and its territories, primarily along the coasts but also on some inland lakes. About one-third of the overall activity took place in Florida. Operators range from single owners with only one vessel to operators with a dozen or more vessels and multiple beach locations. In some locations, such as Hawaii, Puerto Rico, and the Caribbean basin, parasailing takes place year-round. In other locations, such as the Gulf of Mexico region and the Atlantic and Pacific coasts, parasailing takes place mostly during the summer. Passengers cover a wide demographic range.

1.2 Parasailing Procedures and Equipment

Passengers typically board the winch boat in one of two ways, depending on operator preference and the area of operation. In some cases, passengers board the vessel at a dock or other waterside mooring facility, and are then transported to open water. In other cases, passengers are shuttled from the beach to the winch boat via small watercraft. Depending on the operator and the logistics of the operation, the donning of lifejackets¹ and flight harnesses takes place either on the winch boat or earlier.

¹ Lifejackets are not federally required; however, most if not all parasailing operators require their passengers to wear them.

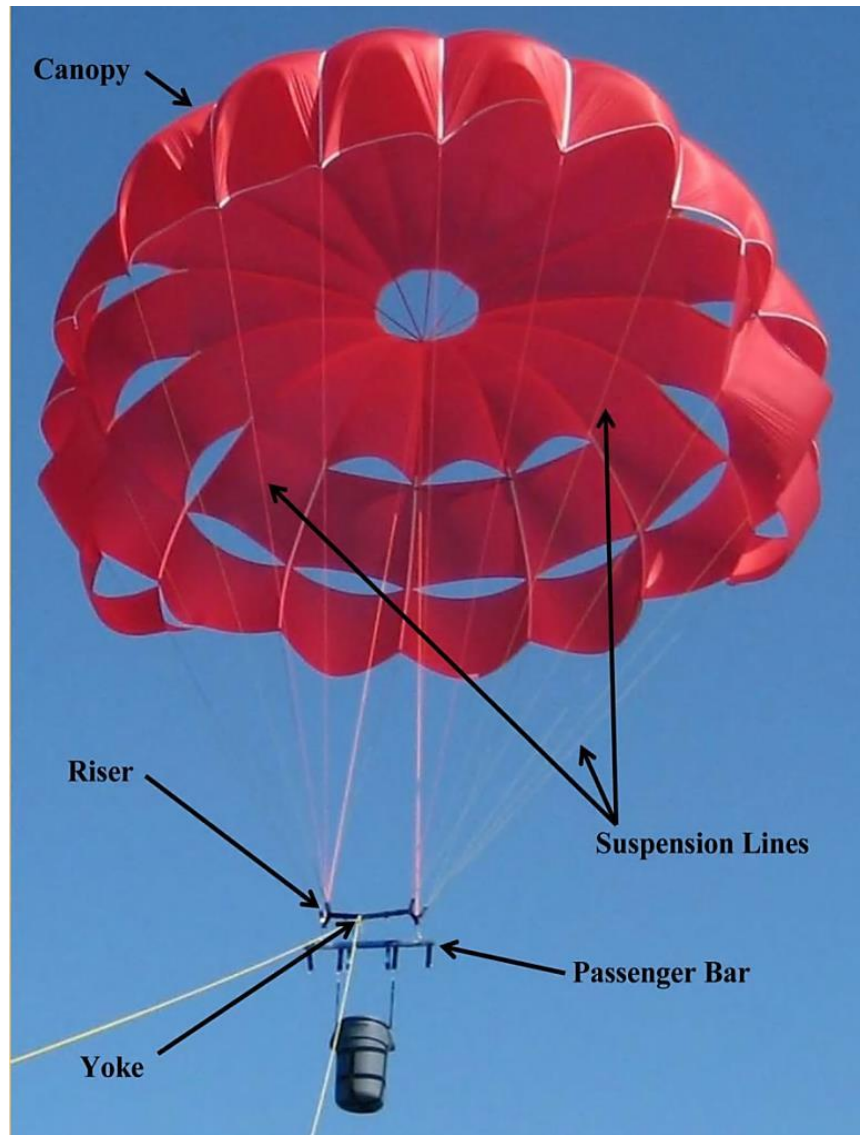


Figure 1. Parasail canopy and associated flight gear shown during operational testing.

Generally, a parasail canopy has a total of 72 panels—16 main panels or “gores” shaped as pie slices, and two stabilizer panels, one on each side of the canopy. Each gore and stabilizer panel comprises four individual panels sewn together (figure 2). Suspension lines are located between each gore. Two lines, called centerlines, are attached to the inside top of the canopy. As shown in the photo in figure 1, openings between gores in the rear of the canopy, called lifting slots, direct the incoming air downward to provide lift. Similar openings on the sides of the canopy, called turn slots or air management systems, provide stability and trim during flight; however, they are zippered slots and must be set by the operator before flight. Canopy manufacturers label the canopy with information such as manufacture date, recommended range of wind speed, and minimum and maximum passenger weights. Canopies are made of ripstop nylon fabric, usually between 1.3 and 1.9 ounces of material weight per square yard. Manufacturers apply silicone or urethane sealants to make the fabric more water resistant and often apply ultraviolet inhibitors as well.

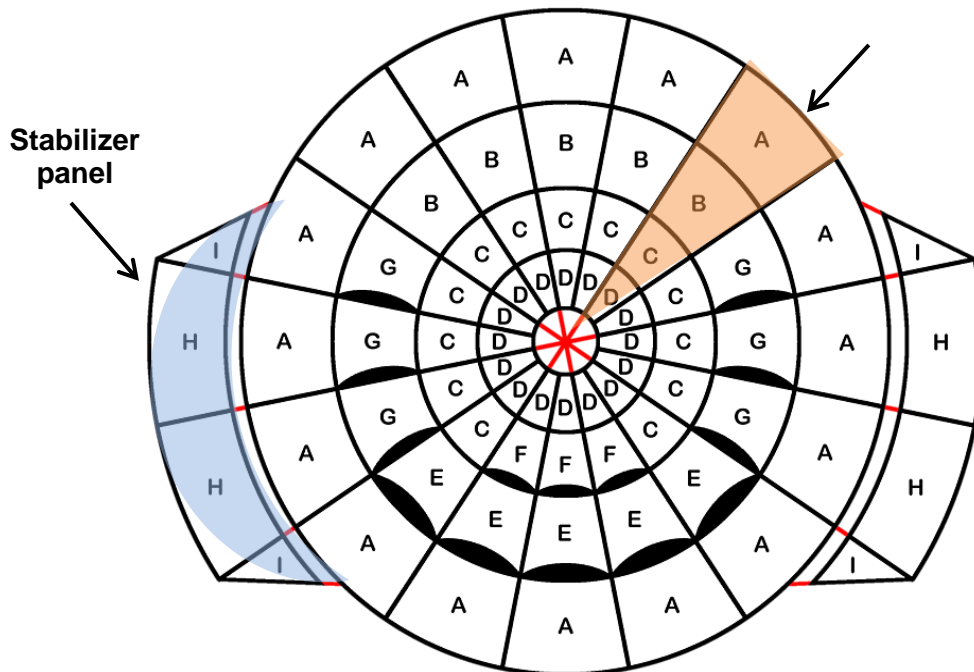


Figure 2. Diagram of a typical parasail canopy and its 72 panels. (Diagram by Custom Chutes, Inc.)

The canopy lines are attached to the riser, which also has a built-in yoke for attaching the towline. Below the riser is the passenger/flight bar, which can be configured to carry one to three people, depending on canopy and flight bar weight limits (because of current parasailing equipment designs, the number of passengers that may be flown at any one time is limited to three). Each passenger's harness attaches by two straps to the bar, and the passengers hang below the bar during flight. In some cases, the harnesses of up to two passengers can be attached directly to a different riser when a flight bar is not used.

The parasailing towline is attached on one end to the yoke on the riser, and on the other end to a hydraulic winch located aft on the vessel, usually below deck. Towlines vary in size, material, and construction (see section "3. Postaccident Testing of Parasailing Equipment" for further information). The winch controls the length of the deployed towline, which, combined with wind and vessel speeds, controls the altitude of the canopy. The winch also provides a controllable takeoff and recovery of the passengers from and onto the "flight deck" at the stern of the vessel.

To inflate the canopy, the operator stages it on the vessel's flight deck, turns the vessel into the wind, and pays out enough towline to set the passenger bar overhead of the flight deck. Depending on the number of passengers and the configuration of the gear, passengers are moved from the seating area to the flight deck, where their personal flight harnesses are connected to the system being used. The towline is then paid out in various lengths to achieve the desired altitude. Passengers are launched and recovered in either a standing or seated position from the flight deck. Operators frequently offer flight packages based on either altitude or flight time, or a combination of both.

While aloft, passengers have no control mechanisms by which to steer, deflate, or otherwise control the direction or lift of the canopy. Passengers are entirely dependent on the

vessel crew for all aspects of flight, including altitude and speed. Further, in none of the accidents that the National Transportation Safety Board (NTSB) examined was any communication devices used, such as portable two-way radios or similar devices, that would have allowed passengers while aloft to communicate with the winch boat.

In the event of a towline failure during flight, parasail canopies that are operated within the manufacturer's stated weight and wind speed ranges are designed to slow the passengers' rate of descent to the surface, similar to a parachute. In the flight system, the towline is designed to be the first point of failure to preserve more critical components, such as the canopy. However, in a towline failure—depending on wind conditions and other factors—inflated canopies can drag passengers in an uncontrolled manner through the water and even over land. Some equipment manufacturers have developed a system in which a deflation line can be installed into the canopy and, if needed, deployed by a passenger. These systems are not widely in use at present, and because they rely on passengers to have the physical and mental capacity to deploy such a system in an emergency and without formal training, the systems may not be useful.

No federal statutory or regulatory provisions currently require operators to brief passengers on parasailing safety. However, the Water Sports Industry Association (WSIA, to which many parasailing operators belong) does require its parasailing members to show a 5-minute safety video to passengers before flight. This video serves as a vessel safety briefing and also addresses parasailing aspects such as launch, flight, and recovery modes.

1.3 Serious Parasailing Accidents Since 2009

In 2009, the NTSB began actively monitoring parasailing accidents. In all but one of the following cases that the NTSB reviewed, the parasailing equipment itself failed and led to the injuries and death. All of these accidents occurred on waters subject to Coast Guard jurisdiction:

Honolulu, Hawaii, April 29, 2009

Vessel: *HA1405CP*

A 24-year-old employee of the parasailing operating company fell to his death after reportedly trying to ride down the towline as if on a zipline—which is not standard procedure—and the rope broke.

Ocean Isle Beach, North Carolina, August 28, 2009

Vessel: *Tied High*

Two female passengers (ages 56 and 60) died when the towline parted in high winds. The inflated canopy dragged the women violently through the water and they eventually crashed into a pier. The vessel master had not checked the weather forecast before departing the dock nor did he have his radio set to monitor the weather. The Coast Guard referred this case to the US Department of Justice for prosecution of the master under the Seaman's Manslaughter Act, 18 *United States Code* (USC) § 1115. The master pled guilty to a violation of the Seaman's Manslaughter Act in November 2012. The NTSB and the Coast Guard performed strength testing on the vessel's towline; for details, see section "3. Postaccident Testing of Parasailing Equipment."

Clearwater Beach, Florida, September 5, 2010**Vessel: *Sky Screamer***

A 27-year-old woman died and her fiancé (age 31) was injured when their towline parted in high winds. The male passenger landed in the water, but the woman's inflated canopy dragged her across the beach and she eventually collided with the pole of a volleyball net. The NTSB and the Coast Guard performed strength testing on the towline involved in this accident and also examined the vessel's winch; for details, see section "3. Postaccident Testing of Parasailing Equipment."

Longboat Key, Florida, June 27, 2011**Vessel: *Almost Heaven***

After an engine failure caused the parasailing vessel to lose speed, a 31-year-old male passenger landed in the water. Despite landing gently and wearing a lifejacket, he had lost consciousness by the time the crew pulled him from the water. An autopsy listed his cause of death as drowning.

St. Thomas, US Virgin Islands, November 15, 2011**Vessel: *Turtle***

A 60-year-old woman died and her 34-year-old daughter was seriously injured when the towline parted in high winds, and the women landed hard in the water. The vessel master had hoisted the women into the air even though the weather conditions were deteriorating and the winds were increasing. The Coast Guard referred this case to the Department of Justice for prosecution of the master under the Seaman's Manslaughter Act, 18 USC § 1115. In June 2013, the master pled guilty to operating in a negligent manner.

Honolulu, Hawaii, January 29, 2012**Vessel: *X-Treme***

Two male passengers (ages 51 and 68) were being reeled back in when the towline parted. The inflated canopy dragged the men through the water for about 1,000 feet before they were rescued. Both men were injured in the accident; the 68-year-old later died from his injuries.

Pompano Beach, Florida, August 16, 2012**Vessel: *FL0238HY***

A 28-year-old female passenger died after the harness she was wearing parted from the flight bar, causing her to plummet some 450 feet into the ocean. Her husband remained attached to the flight bar and was successfully brought back to the flight deck. The NTSB and the Coast Guard examined the harnesses and flight bar involved in this accident, and found that the victim's harness was worn out and had failed due to overload. For more details, see section "3. Postaccident Testing of Parasailing Equipment."

Panama City Beach, Florida, July 1, 2013**Vessel: *Why Knot***

Two female passengers (both age 17) were seriously hurt after the towline parted in high winds. They did not descend into the water but instead remained adrift in the air, crashing into buildings and power lines before finally falling onto a parked car. An NTSB investigator assisted the Coast Guard and the Florida Fish and Wildlife Conservation Commission (FWC) on scene and participated in testing the vessel's winch. For further information, see section "3. Postaccident Testing of Parasailing Equipment."

2. Safety Oversight

2.1 Federal Level

2.1.1 Coast Guard Action

At this time, the Coast Guard does not regulate parasailing operations, nor does the agency inspect or approve parasailing equipment. Currently, the only requirement for individuals wishing to conduct parasailing operations on waters subject to Coast Guard jurisdiction is to hold a Coast Guard merchant mariner credential (MMC) as master of motor vessels of appropriate tonnage and type of waters on which the vessel is to be operated, or, for an uninspected vessel, an MMC as operator of uninspected passenger vessels.² In addition, the Coast Guard does not currently require specialized endorsement for parasailing operators, such as those presently required for masters who conduct commercial assistance towing or operate a sailing vessel.³ On inland lakes or other waters on which the Coast Guard does not have jurisdiction, parasailing operators do not need even a master's license or any other certification, unless state laws stipulate it (for more information on state involvement in parasailing safety, see section "2.2 State Level").

Parasailing vessels that operate on waters subject to Coast Guard jurisdiction are classified by the Coast Guard as either small passenger vessels (SPV) or uninspected passenger vessels (UPV). SPVs are less than 100 gross tons and allowed to carry seven or more passengers. The Coast Guard conducts annual inspections of SPVs according to regulations at 46 *Code of Federal Regulations* (CFR) Parts 175–185. These annual inspections cover aspects such as vessel design, steering, propulsion, stability, and lifesaving and firefighting equipment. UPVs are allowed to carry only up to six passengers, and most parasailing vessels fall in this category. The Coast Guard has not promulgated regulations to inspect parasailing equipment, and therefore does not inspect this equipment on either SPVs or UPVs.

In the early 2000s, the Coast Guard released an analysis of US parasailing accidents that had occurred in the calendar years 1992–2001 (Coast Guard, undated). The analysis was in part prompted by a July 11, 2001, accident in which a mother and her 13-year-old daughter died. In the 10-year time span cited in the analysis, 59 casualties, resulting in a total of 64 injuries and 3 deaths, had been reported. At the time, the Coast Guard stated that the total number of vessels in parasailing operations was unknown, and that the data used in the analysis could not be "normalized" to determine the number of injuries per thousand vessels. The Coast Guard concluded, "the apparent infrequency of accidents doesn't beckon for special involvement of the . . . Coast Guard in this area," and that based on the data, "there doesn't appear to be a major problem with deaths or injuries to personnel or casualties to vessels within the parasail industry."

² Per 46 USC Sections 8902 and 8903.

³ To receive an MMC endorsement to conduct commercial assistance towing, a mariner must attend a Coast Guard-approved course or complete the Coast Guard exam on the topic. To receive an endorsement for sail or auxiliary sail on an MMC, the mariner must meet a minimum level of service on such vessels and complete a Coast Guard exam on the topic. To date, nothing beyond an MMC is required for parasailing operators.

However, in 2007, a Coast Guard officer from the Office of Vessel Activities wrote an article identifying a need to improve parasailing safety in Sector St. Petersburg's area of responsibility (Coast Guard 2007). The article lauded a local Coast Guard effort, initiated in 2004 by personnel at Sector St. Petersburg in Florida, called the Voluntary Commercial Parasailing Vessel Safety Exam Program. This program, based in part on a risk guide developed by the Passenger Vessel Association (PVA), aimed to reduce the risk associated with parasailing. Operators who voluntarily signed on to the program would be required to keep parasailing equipment maintenance logs, daily weather logs, and personnel training and qualification records. The program also required parasailing operators to develop operating policy that covered wind and wave restrictions, inclement weather, flight altitude limitations, and operations near shoreline and obstructions. Further, the program required examination of the winch system, towline, parasailing equipment stowage, protective railings, and padding. Operators and vessels that successfully completed the examination were issued decals valid for 2 years, with a mid-period examination to verify that the vessel remained in compliance (Coast Guard 2004).

In response to an NTSB inquiry about the status of Sector St. Petersburg's voluntary program and whether it was ever implemented on a national level, the Coast Guard replied that the program had been terminated in March 2010, because the Coast Guard did not promulgate regulations to inspect parasailing equipment or operations.

In late 2009, after the August 28, 2009, parasailing accident off Ocean Isle Beach, North Carolina, in which two female passengers died (mentioned in Section 1.3; vessel *Tied High*), the Coast Guard released a second study. This time, it covered 27 parasailing casualties that occurred in the calendar years 2002 through August 2009 (Coast Guard 2009; updated 2010). That second study noted that towline failures, in which the line connecting the vessel with the parasail canopy parted and sent the passengers adrift, accounted for over half of the total injuries and all three of the deaths reported during that time. Failure of the vessel's hydraulic winch was a contributing factor in 11 of the cases.⁴

This Coast Guard study recommended that Coast Guard marine safety units in areas with parasailing operations implement standards similar to those of Sector St. Petersburg's voluntary program, and develop a marine inspection and casualty investigation guide to address issues associated with parasailing operations. However, these recommendations were not binding. As of the date of this report, a draft of the recommended investigation guide—titled “Special Considerations for Parasail Investigations”—has been completed and is pending review and approval by senior Coast Guard leadership.

In May 2011, the Coast Guard's Office of Vessel Activities encouraged ASTM International (formerly the American Society for Testing and Materials [ASTM]) to develop minimum standards for parasailing equipment and a safe practices guide for parasailing operators.⁵ In that request, the Coast Guard stated that the agency would not be inspecting parasailing vessels to enforce compliance with those standards, but that it would support and promote the standards and “strongly encourage” parasailing operators and their insurers to institute them. In response,

⁴ In these cases, high winds placed strains on the winch beyond its capability, and the winch failed to reel in the passengers.

⁵ ASTM International is a globally recognized association that develops international voluntary consensus standards for a wide range of products and industries.

ASTM International formed a work group of industry stakeholders and regulators to undertake this effort, which is ongoing. In April 2013, the work group approved and released the first standard, ASTM F2993-13, “Standard Guide for Monitoring Weather Conditions for Safe Parasail Operation.”⁶ Other standards currently under development by the ASTM work group include guidelines for vessel operations, parasail gear and associated equipment, and emergency procedures, as well as training and competencies for crews on parasailing vessels. The standards are expected to be completed by the end of 2014.

In September 2011, the Coast Guard issued a safety alert directed at parasailing operators, titled “Know Your ROPES” (05-11). That safety alert highlighted the fact that most parasailing accidents stem from towline failures, and emphasized the need for operators to monitor weather conditions, prepare for emergencies, and ensure proper maintenance of parasailing equipment. In July 2013, the Coast Guard issued an updated “Know Your ROPES” safety alert (07-13), this time citing the April 2013 release of ASTM International’s weather standard F2993-13, to which parasailing operators can refer.

According to August 2013 parasailing guidance issued by Coast Guard headquarters to field units, the Coast Guard warned its marine safety personnel that “inspectors evaluating the adequacy or appropriateness of parasailing equipment place the Coast Guard at legal risk” (Coast Guard 2013). Although this recent guidance also prohibited Coast Guard personnel from “control[ing] parasailing activity or compel[ing] compliance with any parasailing standard in the absence of explicit regulations,” it did outline steps that the Coast Guard could take within its authority to improve parasailing safety. For example, during an SPV’s annual inspection, the Coast Guard can ask the operator to demonstrate “safe vessel operation under normal operating conditions.” This would entail operating with a deployed, unmanned parasail aloft to show the Coast Guard inspector the adequacy of primary, emergency, and backup steering gear during normal operational load. Also, during an emergency drill, the inspector is authorized to assess the operator’s navigation and vessel handling skills with the parasail aloft. The inspector can also verify whether the operator’s emergency instructions and compliance with emergency drill requirements (such as retrieving an overboard passenger) are adequate.

Further, although not specifically targeting parasailing operations, a Coast Guard district commander or captain of the port is authorized (per 33 CFR 160.111) to order a vessel to anchor if “justified in the interest of safety by reason of weather, visibility, sea conditions, temporary port congestion, other temporary hazardous circumstances, or the condition of the vessel.” In addition, although again not specifically targeting parasailing operations, Coast Guard district commanders have the authority to order the termination of a UPV voyage if the voyage is deemed “unsafe.” Title 33 CFR Part 177 defines an unsafe voyage as having inadequate lifesaving or firefighting equipment, being overloaded, failing to properly display navigation lights, being influenced by alcohol or dangerous drugs, leaking fuel or accumulating fuel in the vessel’s bilges, or not meeting ventilation or backfire flame control requirements. If the vessel is an SPV, a Coast Guard officer in charge [of] marine inspection (OCMI) may terminate the voyage for any of the conditions listed above. If a voyage is terminated under the provisions of

⁶ For details, see www.astm.org, and ASTM F2993-13, “Standard Guide for Monitoring Weather Conditions for Safe Parasail Operation.”

33 CFR Part 177, the 2013 parasailing guidance states that OCMI should consider suspending or revoking the operator's MMC.

Further, according to the 2013 parasailing guidance, although the Coast Guard cannot advocate, endorse, or distribute parasail inspections-related checklists, "best practices" guides, or other similar documentation developed by industry-specific organizations, Coast Guard units can perform outreach to parasailing operators, such as conducting educational meetings or having casual conversations on the dock during normal vessel inspections (or, for UPVs, during dock walks). This outreach includes informing vessel operators of the existence of ASTM International's voluntary standards and emphasizing their importance.

At present, no Coast Guard initiatives or rulemaking projects are under development that will promulgate, or lead to the promulgation of, enforceable regulations to address parasailing safety.

2.1.2 Federal Aviation Administration Action

The Federal Aviation Administration (FAA) became involved in parasailing safety following a March 18, 2004, midair collision between a banner-towing aircraft and a parasailing operation at Gulf Shores, Alabama. Although no one was injured in the collision, the FAA determined that an inherent risk of collision existed between parasails and aircraft, given that some parasails were being operated at altitudes exceeding 1,200 feet above the surface, and that regulations were needed.

On November 9, 2009, an FAA assistant chief counsel issued a memorandum stating that the parasail involved in the March 18, 2004, collision falls under the definition of a kite (and not an aircraft), as defined in 14 CFR Part 101 (FAA 2009). According to those regulations (Part 101, Subpart B, "Moored Balloons and Kites"), when a moored balloon or kite (parasail) is to be operated more than 150 feet above the surface, the parasailing operator must notify the nearest air traffic control facility 24 hours in advance and provide certain information. This information includes the names and addresses of the owners and operators, size and weight of the parasail, location of operation, height above surface at which the parasail is to be operated, and date, time, and duration of the operation.

In addition, Section 101.13, "Operating Limitations," states that no kite (parasail) operation may be conducted: within 5 miles of a boundary of any airport; less than 500 feet from the base of any cloud; more than 500 feet above the surface of the earth; or in any area where ground visibility is less than 3 miles. There are also marking requirements that mandate the parasailing towline to be lighted at night to provide a visual warning for all aircraft. During daylight hours, the towline is required to have colored pennants or streamers that are visible for at least 1 mile, beginning at 150 feet above the surface, and in intervals of not more than 50 feet.

If a parasailing operator wants to deviate from these parameters—for example, operate within 5 miles of an airport—the operator must request a waiver from the regulation from the FAA. On receipt of the request, the FAA will conduct an aeronautical study, and if appropriate, issue a Certificate of Waiver or Authorization (COA) for those operations that can be safely

integrated into the National Airspace System.⁷ The issued COA may contain terms and conditions specific to the operation and its location that will provide an equivalent level of safety. For example, if an operator wants to deviate from the towline lighting/marketing requirements, the FAA-issued COA may require the operator to assign an individual on the vessel to be a dedicated safety monitor or spotter to observe the parasail and surrounding airspace at all times while the canopy is aloft to ensure safety. Another common special provision stipulates that parasailing vessel operators yield the right-of-way to all aircraft in the vicinity. From 2011 through 2013, the FAA's Eastern Service Area (ESA) issued 84 COAs. The other two FAA service areas—Western (WSA) and Central (CSA)—combined issued 15 COAs during this same period.

The FAA does not have any authority to require training for parasailing operators nor to examine or inspect the parasailing vessel or equipment used for flight. However, the FAA's Southern Regional Office—colocated with the ESA in Atlanta, Georgia—has requested that all parasailing operators within the geographic area subject to the jurisdiction of the ESA attend an annual safety meeting, if one is available in their area of operation. If the parasailing operator is unable to attend this meeting, the operator is requested to contact the local Flight Standards District Office to coordinate an individual meeting. From January through April 2013, the FAA held four of these meetings, all within the ESA's jurisdiction (three in Florida; one in South Carolina).

The Coast Guard is authorized by 14 USC 141 to assist other agencies such as the FAA, states, territories, and political subdivisions with enforcement of laws and regulations if requested by proper authority. Likewise, in accordance with 49 USC 106(m), the FAA is authorized "to use or accept the services, equipment, personnel, and facilities of any other Federal agency." In 2012, the Coast Guard and the FAA conducted preliminary discussions regarding the Coast Guard enforcing FAA regulations applicable to parasailing. However, in correspondence with the NTSB in February 2014, the FAA stated that it has sole authority from Congress to regulate and manage the nation's air space, and that it would therefore be inappropriate to transfer enforcement authority of parasailing operations to another government agency.

After a second midair collision between an aircraft and a parasailing operation on August 6, 2011 (also at Gulf Shores, Alabama, with no injuries), the FAA inspector assigned to the case recommended, among other things, that the maximum altitude limit of 500 feet found in 14 CFR 101.13 and applied to parasailing operations be reduced to 400 feet to prevent conflict with aircraft. In July 2013, the FAA's ESA notified parasailing operators in its area of jurisdiction that future COAs would contain a special provision restricting the maximum altitude to 400 feet instead of 500 feet, with no exceptions. The ESA parasailing contact stated that the ESA imposed the altitude reduction to provide a 100-foot separation between any parasail aloft and banner-towing aircraft. According to 14 CFR 91.119, all aircraft are required to fly at a minimum above ground level (AGL) of 500 feet and cannot be operated closer than 500 feet to any person, vessel, vehicle, or structure.

⁷ FAA Form 7711-2, Application for Certificate of Waiver or Authorization, Revision 8-08.

In correspondence with the NTSB in February 2014, the FAA stated that the ESA-imposed altitude reduction reflected the ESA's position only and was not in response to any agency-wide policy or regulatory changes.

2.2 State Level

2.2.1 National Association of State Boating Law Administrators Action

The National Association of State Boating Law Administrators (NASBLA) is a nonprofit organization that represents the recreational boating authorities of all 50 states and US territories. NASBLA works to develop public policy to strengthen the ability of the states and US territories to reduce death, injury, and property damage associated with recreational boating. NASBLA reports that through its national network of professional educators, volunteers, and law enforcement officers, the organization affects more than 83 million US boaters. Of the many resources offered to its membership, NASBLA prepares model boating acts that contain standards and best practices to reduce risk on the water. These model acts promote consistency in the text and content of such legislation across all jurisdictions. Model acts developed and used successfully in the past have addressed charter boat safety, operator licensing, mandatory boating safety, safe operation of personal watercraft, and similar issues. One such act, titled "NASBLA Model Act for Safe Practices for Boat-Towed Watersports," did address some of the more common activities in which a device is towed behind a vessel and the rider has no inherent control over the device; however, this model act did not specifically address parasailing.

In January 2013, the NTSB requested that NASBLA query its membership to determine the number of states and US territories with parasailing operations on waterways not regulated by the Coast Guard, such as inland lakes, and the extent of existing state laws that governed parasailing operations in those locations. Of 41 responses, 18 members indicated that at least one known parasailing operation was active on that state's waterways, and outside of the Coast Guard's jurisdiction. The total number of parasailing operations was uncertain. Sixteen of the responders indicated that there was some form of state law in place that could be applied to parasailing. NTSB staff reviewed these statutes and determined that seven of them were specific to parasailing. The scope and depth of the regulations varied, with only two states, New Jersey and Virginia, having imposed some form of minimal standards for certain equipment such as the towline, and operational parameters such as acceptable wind and sea conditions.⁸

2.2.2 State of Florida Action

The FWC estimates that as of 2013, about 100 parasailing operators are actively working in Florida, most of them along the coastline. According to FWC statistics, in the 12-year span of 2001–2012, six people died and 18 were injured in 19 parasailing accidents in Florida. Contributing factors were reported as equipment failure, operator error, and high winds. To

⁸ Virginia Administrative Code 4VAC15-450 (2009); New Jersey Administrative Code NJAC 13:82-6.1–6.3 (2006).

manage this risk, lawmakers within the state have repeatedly attempted to introduce legislation to govern the activity.

Florida first attempted to regulate parasailing in October 2007, when Senate Bill (SB) 406 was introduced for consideration. SB 406 followed a parasailing accident off Pompano Beach earlier that year in which a 15-year-old girl died. A companion bill, House Bill (HB) 919, was filed in the Florida House of Representatives shortly thereafter.⁹ However, both SB 406 and HB 919 failed to pass during the 2008 legislative session.

The second attempt in Florida to institute parasailing legislation took place in response to the Clearwater, Florida, accident on September 5, 2010, in which a 27-year-old woman died after being dragged across the beach and colliding with the pole of a volleyball net (mentioned in Section 1.3; vessel *Sky Screamer*). SB 392 was introduced in January 2011; together with companion bill HB 451, the legislation became known as the “Alejandra White Act” and had similar provisions to the 2008 bills. Both SB 392 and HB 451 failed to pass during the 2011 legislative session.

After the fatal parasailing accident in Pompano Beach on August 16, 2012, in which a 28-year-old woman fell to her death after her harness failed (mentioned in Section 1.3; vessel *FL0238HY*), the elected representative from that district filed SB 64 for consideration by the Florida Senate during the 2013 legislative session. Companion bill HB 245 was filed in the Florida House of Representatives shortly thereafter. The legislation, referred to as the “White-Miskell Act” to recognize both victims from the 2007 and 2012 accidents, proposed changes to the Florida statutes that formally defined the term “commercial parasailing” as “providing or offering to provide, for consideration, any activity involving the towing of a person by a motorboat.” The Act also had provisions that required each vessel conducting commercial parasailing to obtain an annual license; required each vessel owner to carry liability insurance; addressed several operational measures regarding weather conditions, hours of operation, maximum towline length, vessel design, communications, equipment requirements, and minimum operator age; and prohibited operations in certain areas. However, the White-Miskell Act—which was the third attempt in the state of Florida to institute parasailing regulation—failed to pass in the Senate Commerce and Tourism committee on May 3, 2013.

Shortly after the July 1, 2013, accident in Panama City Beach, in which two 17-year-olds were seriously injured (mentioned in Section 1.3; vessel *Why Knot*), the same state senator who had sponsored SB 64 during the 2013 legislative session reintroduced a similar bill for consideration in the 2014 session.¹⁰ The new bill, SB 320, establishes requirements for liability insurance, requires parasailing operators to conduct safety briefings for all passengers, and includes operational requirements that address wind speeds, weather conditions, and certain locations where parasailing is prohibited. On May 1, 2014, both the Florida Senate and House of Representatives approved SB 320, and on June 13, 2014, the governor of Florida signed the bill into law. The provisions take effect October 1, 2014.

⁹ Florida has a bicameral state legislature with an upper house, the Senate, composed of 40 members, and a lower house, the House of Representatives, composed of 120 members. A companion bill is a bill introduced in one house that is identical or similar to a bill introduced in the other house. Use of companion bills permits their concurrent analysis and deliberation by both houses.

¹⁰ Florida SB 320, “White-Miskell Act”, filed October 25, 2013 by Senator Maria Sachs.

2.3 Parasailing Industry Associations

In the United States, several organizations promote safety in the parasailing industry and serve as focal points for parasailing operators. These organizations include WSIA (the Water Sports Industry Association, mentioned in Section 1.2) and the Parasail Safety Council (PSC).¹¹

Water Sports Industry Association. WSIA is a trade association that promotes various towed water sport activities. Membership includes manufacturers, importers, dealers, sales representatives, and other promoters of watersports. The association produces and distributes safety and educational materials for its members, and has recently produced a parasailing safety video for its membership. In the last 3 years, the association has been working with the Coast Guard, ASTM International, and parasailing operators in an effort to develop parasail safety standards.

Parasail Safety Council. The PSC is a nonprofit organization representing the parasailing public, with an emphasis on increasing parasailing safety. Representatives of the organization also serve as expert witnesses in parasailing-related litigation. On September 17, 2010, the PSC wrote to the Coast Guard Commandant stating that the industry had failed at self-regulation, and offered the PSC's assistance and expertise in addressing the situation. The Coast Guard considered the PSC letter a petition for rulemaking and opened a public docket in the matter.¹² The comment period on that docket closed, and two comments to the petition for rulemaking were received. Both were letters to PSC from offices within the Coast Guard headquarters organization, one of which indicated that the Coast Guard did not intend to take further regulatory action on the matter, and that its current position would be to support the development of voluntary best practices in this industry segment.¹³

There also used to be an organization called Professional Association of Parasail Operators (PAPO), which represented operators and promoted development of standards for public safety. Some states have used PAPO's standards as a model in developing the few laws that exist to govern parasailing. However, as of the date of this report, PAPO is no longer in operation.

2.4 International Parasailing Safety

Parasailing is conducted throughout the world along coastlines and waterways with suitable conditions. Like in the United States, international parasailing is largely unregulated (with the exception of Queensland, Australia; more below). In certain locations in Europe and some of the desert regions, parasailing is also landbased, with heavy duty tow vehicles pulling the passengers. Europe has a parasailing association, the Professional Parasailing Association of Europe, which claims to be affiliated with the defunct American PAPO organization. The number of members in the European association is unknown.

¹¹ See www.wsia.net and www.parasail.org for more information about these organizations and their respective mission statements.

¹² US Department of Homeland Security/Coast Guard, docket ID USCG-1625-0932-001.

¹³ Coast Guard letters to PSC dated October 27, 2010, and November 25, 2010.

Investigators queried the United Kingdom's Maritime and Coast Guard Agency and found that although requirements such as basic lifesaving, firefighting, and safe operations are in place for small crafts, no codes, regulations, or other requirements specifically address parasailing.

According to the Australian Transportation Safety Board, 16 parasailing organizations operate 41 vessels in Australian waters. Since 1997, 9 accidents have occurred there. In 2000, the state of Queensland imposed mandatory standards to address the risk associated with parasailing. Those standards, revised in 2007, are comprehensive in nature and address equipment, personnel, weather, operations, passengers, and risk management.

According to Canadian authorities, Canada has instituted some minimal requirements for all towable water activities, although they are not specific to parasailing. The requirements include that an observer must be present, that the person being towed must wear a lifejacket or other personal flotation device, and that the activity must be performed during daylight hours. There is also a communication requirement; however, hand signals (such as "OK," "up," and "down") will suffice.

3. Postaccident Testing of Parasailing Equipment

The NTSB provided investigative and material evaluation support to the Coast Guard in six separate parasailing accidents, three of which involved the death of at least one passenger.¹⁴ Per the request of the Coast Guard investigators in these accidents, the NTSB performed material evaluation and testing of the parasailing equipment from each accident. The NTSB also conducted a field test of parasailing equipment in service to determine the forces that act on the equipment during operations. Because of those efforts, the NTSB identified safety concerns, including vessel masters who choose to operate in unfavorable wind conditions, inadequate winches used for towline manipulation, continued use of unserviceable gear, stressors affecting towline strength, and, in some cases, an overstatement of towline strength by the manufacturer.

3.1 Towline Strength Test

Towlines commonly used in parasailing include 12-strand polyester and double-braided polyester in 3/8- and 7/16-inch diameters with an advertised average tensile strength ranging from 4,800 to 10,000 pounds. Operators using vessels outfitted with small drums on their winches, or operators preferring smaller diameter line, use a 12-strand, 5/16-inch diameter Spectra® line made from ultra-high-molecular weight polyethylene, with an advertised average tensile strength of 9,500 pounds.

Vessel: FL0238HY. The operator in the Pompano Beach accident, in which a 28-year-old woman fell to her death after her harness failed, used the 5/16-inch Spectra® towline on his vessel, and it had been in service for about 7 months. Although the towline was not a factor in this accident, investigators removed about 149 feet of it for testing.

The riser end of the towline displayed stretching and a distinctive reduction in diameter when compared to the winch end. Further, investigators found three areas of localized compression within 30 inches of the riser end that were consistent with the towline having been knotted in those spots at some time. Generally, parasailing operators use a bowline knot (left, figure 3) to attach the towline to the riser, and this master had done so, too. However, he had also tied several hitch knots (center, figure 3) in the towline.

For the tensile testing, investigators divided the towline into 9 sections of equal length (about 16.5 feet each), and labeled them 1 through 9. Towline sections 1, 4, and 7 were tested with a bowline knot and hitches at one end and a spliced eye (right, figure 3) at the other.¹⁵ Sections 2, 5, and 8 were tested with a bowline knot at one end and a spliced eye at the other. Finally, sections 3, 6, and 9 were tested with a spliced eye at both ends.

¹⁴ For more information, see the following NTSB Materials Laboratory Factual Reports: (a) 10-040, accident no. DCA09SM020, vessel *Tied High*; (b) 11-018, accident no. DCA10SM019, vessel *Sky Viking*; (c) 11-036, accident no. DCA10SM027, vessel *Sky Screamer*; (d) 13-010, accident no. DCA12LM024, vessel *FL0238HY*; (e) 13-032, accident no. DCA13SM010, vessel *Ariel*; and (f) 13-064, accident no. DCA13SM028, vessel *Why Knot*.

¹⁵ Ropes can be purchased already spliced, or they can be spliced manually by persons with appropriate experience and tools.



Figure 3. The photos illustrate three ways to fasten a rope: A bowline knot (the most commonly used knot in parasailing operations); a hitch knot; and a spliced eye. (Bowline and hitch knot photos by James Aber; spliced eye photo by Grog, LLC.)

The testing revealed that the towline itself was stronger than advertised, but the introduction of a bowline knot drastically reduced the towline's strength, by more than half. Moreover, the addition of hitch knots further weakened the towline's strength, to less than 40 percent of the advertised strength. However, using only spliced eyes had no adverse effect on the towline's strength.

The tensile test results are presented below, showing the percentage reduction in strength compared to the advertised average strength (9,500 lbs), and the failure location on the towline.

Section number	Knot type	Load at failure (lbs)	Strength reduction (%)	Failure location
1	Bowline & hitch	3,500	63	knot
2	Bowline	4,400	53	knot
3	Spliced eye	12,000	none	towline
4	Bowline & hitch	3,600	62	knot
5	Bowline	3,800	60	knot
6	Spliced eye	12,000	none	towline
7	Bowline & hitch	3,600	62	knot
8	Bowline	4,500	52	knot
9	Spliced eye	11,800	none	towline

For three of the accidents (*Tied High*, *Sky Viking*, and *Sky Screamer*), the NTSB performed tensile tests both on the actual towline obtained from the vessels, and on new, unused towline of identical size, construction, and material. The original and new tows were tested with and without a bowline knot.

The following is a comparison between the tensile test results for the three accident tows:

Towline property	<i>Tied High</i>	<i>Sky Viking</i>	<i>Sky Screamer</i>
Construction and material	7/16"-diameter double-braid polyester	3/8"-diameter double-braid polyester	5/16"-diameter single-braid polyethylene
Advertised strength (lbs)	6,840	5,600	13,200
New rope strength (lbs)	6,390	4,620	13,435
Strength of new rope when knotted (lbs)	4,184	2,990	3,720
Strength reduction of new rope when knotted (%)	39	46	72
Accident towline time in service (months)	1	2	3
Accident towline strength (lbs)	4,829	2,620	9,850
Accident towline strength reduction from advertised strength (%)	29	53	25
Strength of accident towline when knotted (lbs)	3,415	2,446	3,200
Strength reduction of accident towline when knotted (%)	50	56	76

Investigators found that even the brand-new samples of the two double-braided polyester towlines failed below the manufacturer's stated strength, and all three of the new towlines—especially the single-braided line—lost significant strength when a bowline knot was introduced. Testing of the original towline from each accident indicated that the strength reduction caused by the knot worsened even further when the line was exposed to the environment of parasailing operations (sun, saltwater, etc.). In all three of the accidents, the parasailing operators used bowline knots in their towlines.

The NTSB and the Coast Guard also performed operational testing to measure tension force on a towline during flight off the Florida west coast at Bradenton. A canopy, yoke, flight bar, and towline similar to those involved in the *Tied High* accident were supplied by Custom Chutes, and a similar towing vessel and winch was supplied by YOLO Parasailing (both companies

based in Bradenton). For the test, a large plastic container was filled with water for a combined weight of 340 pounds, the approximate total body weight of the two accident passengers. The tension testing consisted of sailing into the wind and noting the tension force at various combined wind and vessel speeds experienced by the canopy. Wind speed was measured using a handheld anemometer. A 100-foot-long towline was connected between a Dillon® dynamometer attached to the vessel and the yoke on the riser. A second line to launch and recover the parasail was attached to the winch and the yoke.

The operational test results are presented below in the order they were recorded:

Combined vessel and wind speed (mph)	Tension force on the line (lbs)
16.5	830
18.0	1,000
17.0	1,000
20.0	1,210
22.0	1,210
23.0	1,290
22.0	1,290
23.0	1,290
24.0	1,560
24.5	1,630
26.0	1,860
28.0	2,110
29.0	2,110
30.0	2,110
28.0	2,430
26.0	2,430

To visualize the results, the operational test data were plotted and a curve was produced using a least squares curve fit.¹⁶

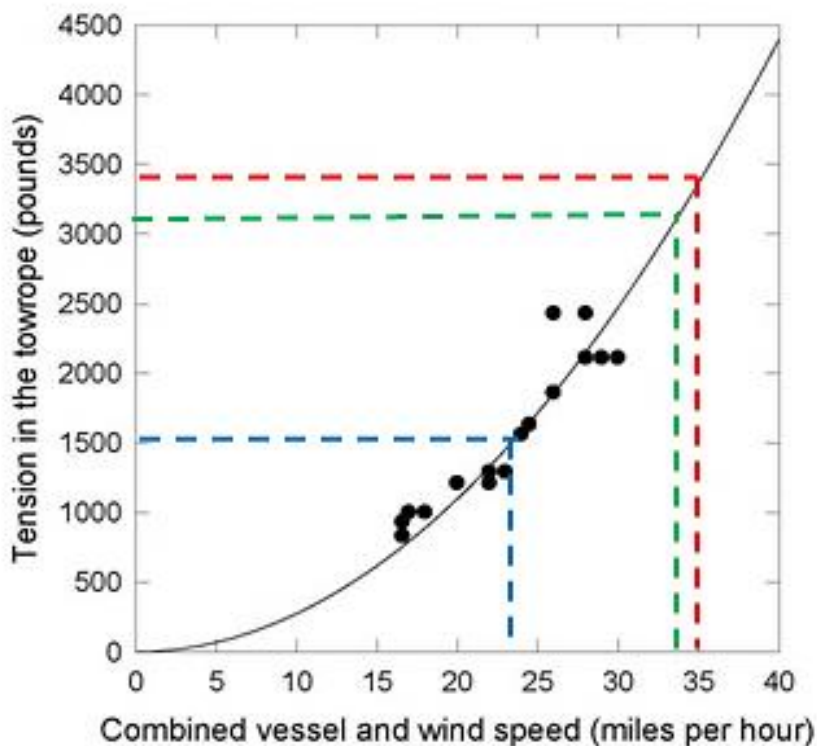


Figure 4. Towline tension force at combined vessel and wind speeds.

As illustrated in the above figure 4, the data points and the curve axes start at zero and extend beyond the data points. The horizontal red dashed line represents the accident towline average failure load of 3,415 pounds (from the laboratory testing of the towline from the *Tied High*), and crosses the curve in the vicinity of a combined vessel and wind speed of 35 mph, as indicated by the vertical red dashed line. Similarly, the horizontal blue dashed line represents the working load of 1,520 pounds specified in the manufacturer’s literature for that towline, and indicates that a combined vessel and wind speed of about 23 mph could exceed that working load. (See section “3.2 Winch Testing and Examination; Vessel: *Tied High*” for details on the green dashed line).

During the offshore testing, investigators steered the winch boat cross wind on three separate trial runs and recorded the variation in tension force during each run to determine the effect that would have on the tension in the towline. The variations were as follows:

¹⁶ The least squares curve fitting process fits curve equations to the raw data, producing a curve with a minimal deviation from all the data points.

Trial run	Combined vessel and wind speed (mph)	Variation in tension force (lbs)
1	23.0	200–600
2	23.0	400–600
3	24.5	600–1,100

When compared with the field test results at similar combined wind speeds, investigators noted that the variation exceeded the 10 percent change specified in the manufacturer's literature and would constitute a hazardous shock load that would void the normal working load recommendation. In summary, investigators concluded that because of cyclic loading, exposure to environmental elements, the presence of knots, overloading, or a combination of these factors, towlines have repeatedly failed at levels significantly below their rated strength. (See page 34 for a safety alert about this issue.)

3.2 Winch Testing and Examination

Vessel: *Tied High*. Investigators used the same parasailing vessel involved in the field test of the towline to determine the tension force capacity of the hydraulic winch. As previously noted, the towing vessel and the winch were similar to those of the *Tied High*, with the exceptions that the hydraulic motor driving the reel on the *Tied High* winch was shaped differently than the motor in the testing vessel. The *Tied High*'s winch reel was supported in pillow block bearings and the reel in the test vessel was supported in bearings located in side plates. Both winches were equipped with similar fleeting mechanisms that automatically change direction at the end of travel.

Investigators secured the vessel alongside the dock and affixed the towline between the dynamometer and the dock structure. The winch was operated until the tension on the dynamometer display stopped increasing, thereby indicating that the capacity of the winch had been exceeded and the pressure relief valve had operated.¹⁷ The dynamometer displayed a maximum tension of 3,125 pounds. The green dashed line in figure 4 indicates that the maximum tension of 3,125 pounds could occur at a combined vessel and wind speed of about 33 mph, relatively close to the 35 mph required to fail the knotted accident towline. The testing suggests that the winch in the test vessel would be incapable of reeling in aloft passengers in conditions where the combined vessel and wind speed was near or above 33 mph. This would likely be the result for other hydraulically powered winches as well.

Vessel: *Sky Screamer*. Investigators also performed a forensic examination of the hydraulic motor, its bearing housing, the brake and the winch drum from the *Sky Screamer*. This vessel was involved in the September 5, 2010, accident in Clearwater Beach, Florida, where a 27-year-old woman died after being dragged across the beach. The *Sky Screamer*'s winch was driven by the hydraulic motor powered by a hydraulic pump on the engine (a pressure relief valve is normally installed between the pump and the motor but is not visible in figure 5). The

¹⁷ It was reported that the pressure relief valve is set at 3,000 pounds per square inch by the manufacturer.

hydraulic motor drives a splined drive shaft, which drives an output shaft inside the bearing housing. The output shaft drives the brake, which drives the winch drum. The brake is released when hydraulic pressure is applied to the hydraulic motor and is activated when the hydraulic pressure is removed. The drum onto which the towline is reeled is identified and the chain drive from the drum to the fleeting mechanism is indicated by the blue arrow (lower left). The fleeting mechanism consists of the screw indicated by the yellow arrow (center), which drives the identified guide block from one side of the drum to the other to lay the towline sequentially on the drum. The towline passes between rollers indicated by the green arrow (upper left) on the guide block and onto the drum. To reel in the towline, the hydraulic motor rotates clockwise when viewed from its rear.

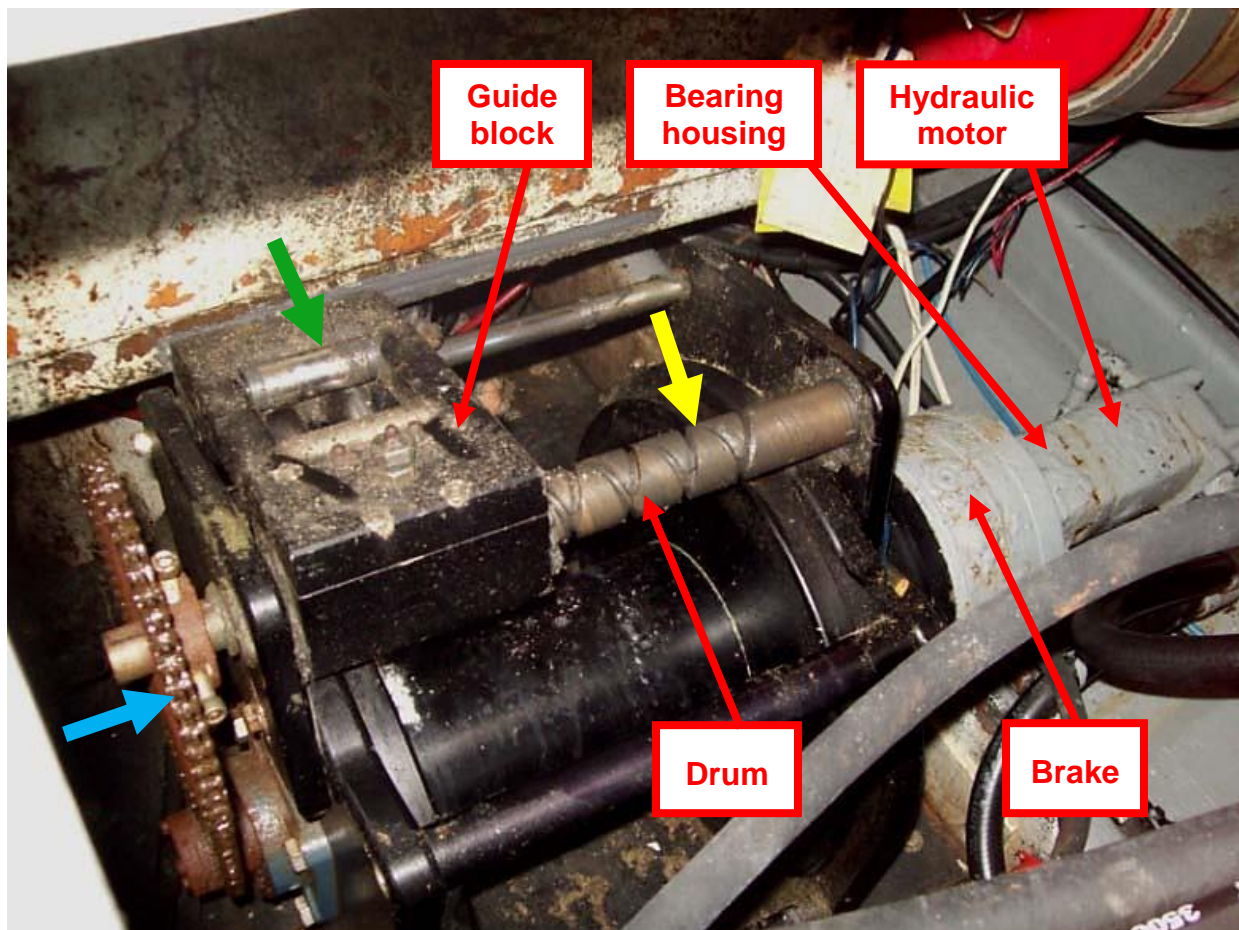


Figure 5. The winch used on board the *Sky Screamer*.

The Coast Guard reported that the two *Sky Screamer* passengers were being reeled in and were about 100 feet from the vessel when the towline suddenly reeled out uncontrollably, despite attempted use of the winch (which prevented the brake from activating), until the drum was empty and only the end of the towline was attached to the drum. At that moment, the vessel reportedly heeled over on its starboard side and the towline parted at the bowline knot where it attached to the parasail's yoke. A subsequent Coast Guard examination and disassembly revealed that the splined drive connecting the hydraulic motor to its bearing housing had failed. The two major pieces of the splined drive are illustrated in figure 6 below, along with the bearing housing, the output shaft, and the recovered spline pieces.

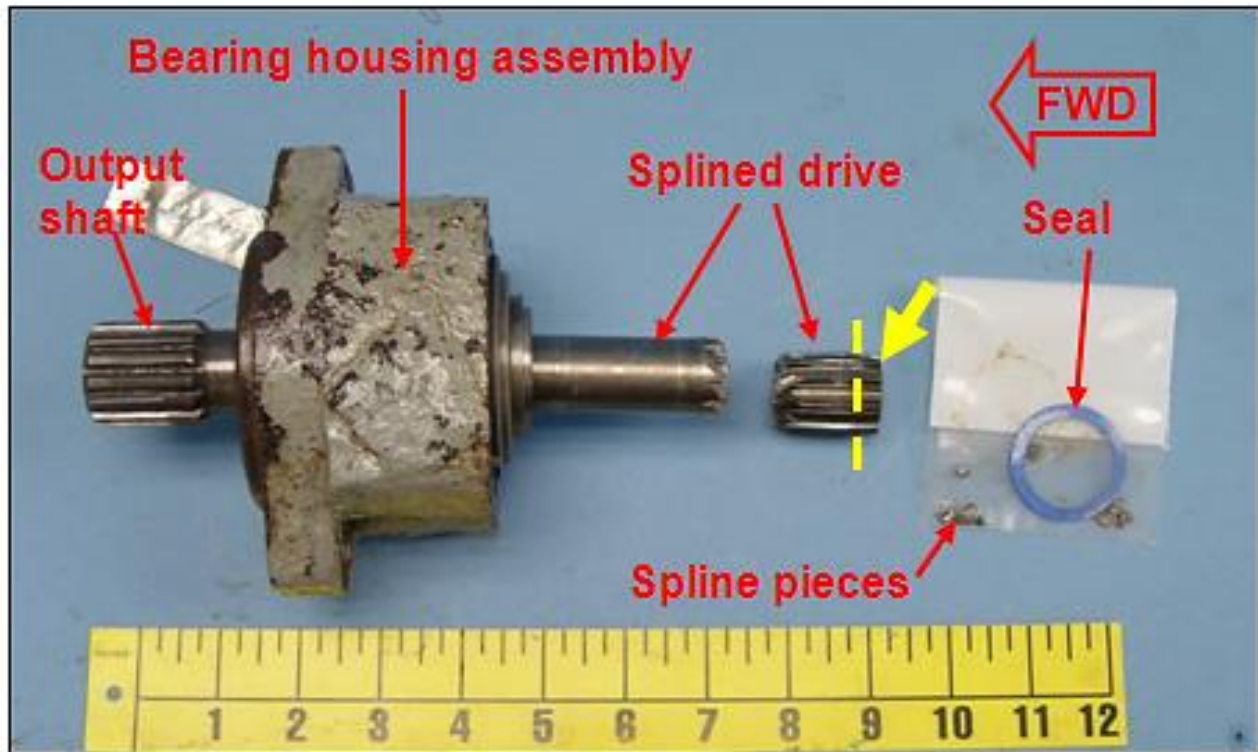


Figure 6. The splined drive pieces with the bearing housing assembly.

Because a torsional fracture is a type of shearing action, investigators made calculations to relate the shear capacity of the splined shaft to the shear applied to it by parasailing operations. The calculations indicate that the shaft will fail when a shear stress in the vicinity of 78,000 lb/in² is applied to it, and that a parasail in high winds can develop a shaft shear stress in the vicinity of 326,000 lb/in². The results, although approximate, indicate that parasailing in high winds can produce shear stress on the shaft that far exceeds its capacity.

Vessel: *Why Knot*. The winch on board the *Why Knot* was also examined during a field test, with which the NTSB assisted the Coast Guard and the FWC. Two female passengers had been seriously injured in the July 1, 2013, accident off Panama City Beach, Florida, when the *Why Knot*'s winch could not recover them after the wind increased, and the towline parted. The field test revealed that the winch system on the *Why Knot* could generate a nominal tension force of 1,280 pounds, with a maximum recorded peak of 1,350 pounds. Based on earlier underway field testing that used the same size parasail canopy as the *Why Knot*'s, investigators determined that a combined vessel and wind speed of as low as 22 mph could generate 1,290 pounds of tension on a parasail towline. In this case, with the *Why Knot* being anchored, winds at or above 22 mph would have generated more tension on the parasail towline than the vessel's winch could withstand. According to the Coast Guard's accident report, the winds at the time had rapidly increased to 14 mph, with gusts in excess of 20 mph, due to a passing storm front.

3.3 Examination of Fractured Harness

Following the August 16, 2012, Pompano Beach accident in which a 28-year-old woman fell to her death while being towed by the state-registered vessel *FL0238HY*, NTSB investigators

examined the fractured harness that she had been wearing (figure 7). The fractured ends of the red hangers displayed raveled filaments adjacent to the fractures. The tips of the filaments were relatively flat and oriented on a slant plane, or were split and showing white discoloration, all features consistent with overload separation. In addition, much of the blue covering on the seat pad was worn out from extended use and revealed the underlying white padding. Worn areas on the waist pad also exposed white padding. Investigators removed the red waist belt for tensile testing (see section “3.4 Tensile Testing of Harness Waist Belts”).



Figure 7. Fractured harness, worn by the victim. The black arrows illustrate the fractured ends of the hangers.

Investigators learned that the parasailing operator had purchased a bag of harnesses from another operator who was going out of business. The history of the harnesses (frequency of use, extent of exposure to saltwater and sun, etc.) was unknown. Investigators could not determine the precise age of the accident harness, but by researching and analyzing images of the hanger webbing and stitching, they concluded that the harness had likely been made in England in the late 1990s or early 2000s.

Investigators also examined the flight bar from which the harness detached (figure 8). Torn portions of the harness’s left and right hangers were still attached to the flight bar.

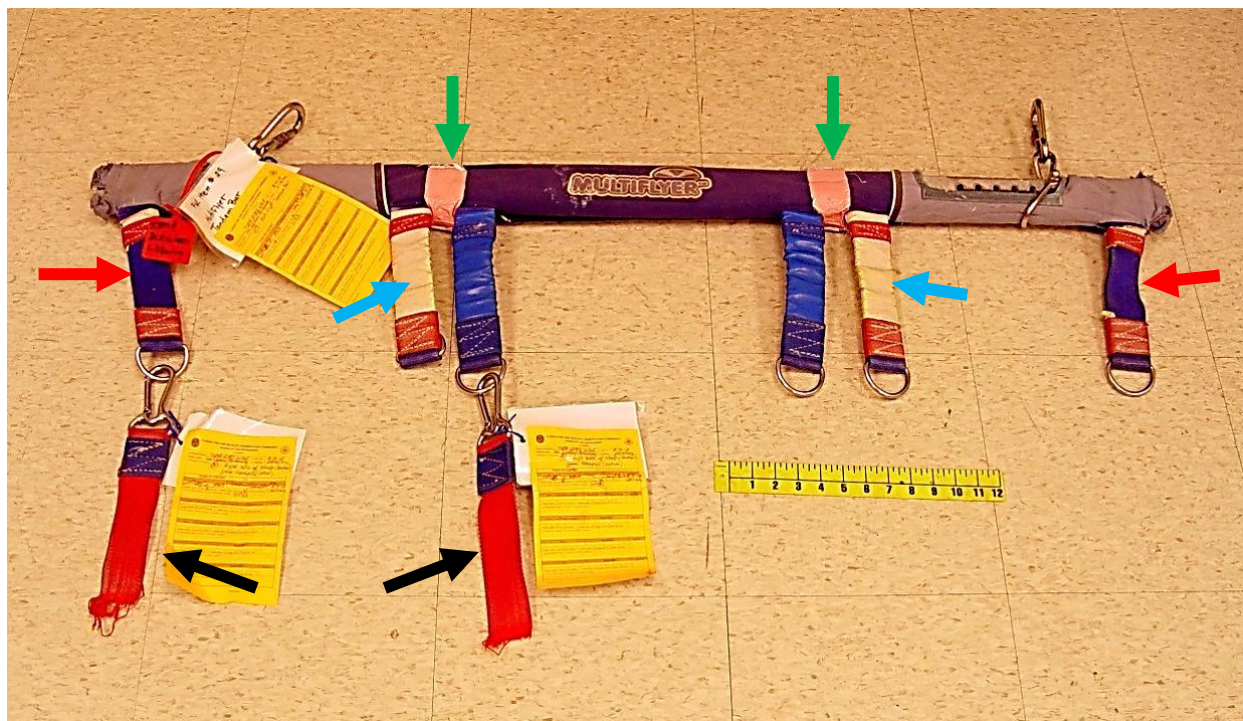


Figure 8. Accident flight bar.

Examination of the flight bar revealed torn and missing padding at the outer ends, and most of a protective cover missing from the outer straps (indicated by red arrows). What remained on the outer straps was the same cream color as the cover on the next inboard strap, indicated by the blue arrows. When investigators turned the edges of these covers, it was revealed that the inboard straps were originally red but had faded due to extended use and sun exposure. The green arrows indicate a portion of pink-colored duct tape that had originally obscured most of a warning label on the opposite side of the flight bar, but now only the adhesive remained.¹⁸ On the warning label's lower edge, "www.customchutes.com" was displayed.

The victim's husband had been parasailing next to her in a tandem arrangement and was not injured. Investigators also examined his harness (figure 9).

¹⁸ The warning label stated "we are compelled to warn all who use this product that by so doing life and limb are endangered and that the manufacturers and agents of this product do not hold themselves responsible in any way whatsoever for any accident or incident resulting in death or injury. This product is used entirely at the users' own risk."



Figure 9. Intact harness, worn by the victim's husband.

The husband's harness, like the flight bar, was manufactured by Custom Chutes. This harness had only a small worn area where the white padding was exposed, indicated by the yellow arrow in the image. The waist belt from this harness was also removed for tensile testing (see section "3.4 Tensile Testing of Harness Waist Belts").

Comparison of the two harnesses revealed that the hangers on the fractured harness consisted of a single piece of webbing that extended from the flight bar attachment to the seat/waist webbing junction. The hangers on the intact harness consisted of two pieces of webbing that were sewn together and extended from the flight bar attachment through the seat/waist webbing junction, under the seat, through the other seat/waist webbing junction and to the other flight bar attachment. The intact harness that the victim's husband had been wearing had a more robust original design and was also less degraded from extended use.

3.4 Tensile Testing of Harness Waist Belts

The waist belts from the fractured harness and the intact harness were the only portions of the harnesses long enough for a tensile test. As noted previously, no red webbing was available to compare with the red webbing from the fractured harness so it is added for comparison. The webbing supplier for the intact harness was identified as Tapecraft by the harness manufacturer, Custom Chutes, which also provided a data sheet for the webbing. The

data sheet listed the tensile strength of the webbing as “4,718-lbs average.” Tapecraft supplied a sample length sufficient for five test specimens. The tensile test results for each specimen are presented below, showing the reduction in strength compared to the average strength from the datasheet.

Specimen description	Load at failure (lbs)	Strength reduction (%)
Red waist belt	906	81
Black waist belt	3,100	34
Webbing sample	4,000	15
Webbing sample	3,970	16
Webbing sample	3,980	16
Webbing sample	3,970	16
Webbing sample	3,970	16

Examination of the fractured ends of the black waist belt and the black webbing samples from the intact harness revealed raveling and filaments displaying globular tips consistent with a high energy overload separation. The significant strength reduction of the red waist belt from the fractured harness explains the separation features noted earlier. The red waist belt was also subjected to testing that revealed that the polypropylene in the belt was degraded from sun exposure.

4. Analysis

4.1 Coast Guard Effort

The mission of the Coast Guard merchant mariner credentialing program is to promote a safe and secure marine transportation system operated by mariners who meet established standards of experience, professionalism, and competency. The Coast Guard has a minimum sea service requirement for mariners who intend to propel UPVs and SPVs by sail, or who intend to use a sail as an alternative means of propulsion. The Coast Guard also requires those mariners to complete either an approved classroom course or the Coast Guard's written examination before the agency will issue a sail endorsement. The Coast Guard imposes similar requirements for mariners who intend to conduct commercial assistance towing. However, these requirements are not applied to parasailing.

Many of the parasailing accidents noted in this report have resulted from the operators' failure to monitor developing weather conditions, using worn or poorly maintained flight gear, lack of knowledge about towline strength loss from knots, and/or overloading equipment such as toelines and winches. No evidence suggests that these acts or omissions were intentional. Rather, they are attributed to the operators' failure to take prudent action or to exercise reasonable care due to poor judgment, lack of sufficient experience, improper training, or a combination of these and other factors. The NTSB concludes that although establishing a specialized license endorsement would not eliminate all shortcomings attributed to human error, it would set a minimum level of experience and professional competence for those who operate parasailing vessels. The NTSB therefore recommends that the Coast Guard implement a specialized license endorsement that all holders of a valid Coast Guard merchant mariner credential would be required to obtain before conducting parasailing operations.

The existing SPV safety and inspection regulations were developed for surface craft of conventional design and operational characteristics. In instances where the application of these rules and regulations has been applied to nonconventional SPVs with unique characteristics, such as those vessels capable of total submersion, the Coast Guard has taken a systems approach. In the case of submersibles, factors such as vessel design, operation, dive site, and operator qualifications are all examined from the planning stage through initial phase of operations. The Coast Guard Commandant provided specific guidance to Coast Guard field personnel addressing areas exclusively associated with this type of vessel, including buoyancy control, emergency ballast systems, oxygen and CO₂ removal systems, and the training and qualifications of personnel serving on these submersibles. The Coast Guard has not taken this type of action regarding parasailing vessels.

Parasailing passengers are exposed to a significantly greater safety risk than passengers on vessels that engage in more benign activity such as sightseeing or fishing. A parasailing passenger is attached to the vessel by a towline and subject at all times to the judgment, skill, and control exercised by the master. In addition, all gear that is needed to participate in the activity itself and not rigidly attached to the vessel, such as a properly sized flight harness and a personal flotation device, is provided to each passenger by either the vessel crew or shoreside staff. The

safety of each parasailing passenger remains exclusively dependent on the skills and expertise of the master, as well as the overall serviceability of the parasailing equipment.

With regard to UPVs, the vessels are not subject to SPV regulations in part because UPVs are limited to carrying six or fewer passengers, as compared to SPVs, which are allowed to carry seven or more passengers. Simply put, the greater the number of passengers carried, the greater the risk. Although UPVs are not subject to inspection, they still operate on waters subject to Coast Guard jurisdiction and are therefore required to adhere to a limited set of regulations. Those existing regulations address personnel licensing, crew watchstanding, lifesaving equipment, firefighting equipment, engineering safety equipment, special operation conditions, environmental regulations, and termination authority for unsafe or particularly hazardous conditions. Some of the regulations address in detail the acceptable cooking, heating, cabin lighting, and toilets that can be used on a UPV, but to date, no requirements apply specifically to parasailing or associated equipment.

Whether parasailing is conducted from an SPV or a UPV, the risks are identical across both vessel types because the number of passengers that may be aloft at any one time is the same (three or less, per current equipment designs). Therefore, any risk mitigation procedures—such as development of equipment requirements and operational standards—should be identical and applied to both SPVs and UPVs.

Although the Coast Guard has statutory authority to regulate parasailing operations on both SPVs and UPVs, the agency has to date chosen not to do so. The NTSB recognizes that the Coast Guard remains concerned about parasailing safety, and applauds the Coast Guard's 2011 request that ASTM International develop a safe practices guide and standards for parasailing operators and equipment. These standards and guide will certainly serve to establish a minimum baseline for the equipment and activity itself. However, because this approach relies on voluntary compliance, it may not be as effective as a regulatory requirement would be. The NTSB concludes that for ASTM International's standards to be the most effective in reducing the number of parasailing deaths and injuries, they should have the same force and effect as a regulation and be actively enforced both on SPVs and UPVs. The NTSB therefore recommends that the Coast Guard incorporate by reference ASTM International's parasailing standards to govern all parasailing operations.

4.2 FAA Regulations

The Coast Guard has authority to enforce federal regulations applicable to US waters. The agency's marine safety program is charged with minimizing the risk associated with commercial and recreational vessel operation. This effort is accomplished through the agency's existing statutory authority to develop maritime personnel standards, issue merchant mariner certificates and licenses, perform vessel inspections, and conduct maritime casualty investigations. This existing authority, and the Coast Guard's assets—including waterborne craft from which to perform enforcement boardings, and trained vessel inspectors and marine casualty investigators—make the Coast Guard the best suited agency to enforce all federal regulations applicable to vessel operations.

Although the FAA regulations applicable to parasailing (14 CFR Part 101) are limited in scope, they are the only existing federal regulations affecting parasailing. The FAA does not

have the maritime background or personnel, the waterborne assets, or the statutory authority to enforce these regulations where they would be most effective—in a preventive manner, rather than postaccident. However, the Coast Guard—if given enforcement authority—has the capability and local resources to enforce the FAA regulations with regard to parasailing operations. Not only can the Coast Guard place operational restrictions on any certificate of inspection issued to an inspected SPV, but also—as outlined in the Coast Guard’s 2012 parasailing guidance—it can stop negligent operation of a vessel, including terminating the vessel’s voyage for unsafe or especially hazardous conditions. The Coast Guard could also take suspension or revocation action against the operator’s credential. The NTSB concludes that a logical course of action to improve parasailing safety would be for the FAA to request assistance from the Coast Guard to enforce existing FAA regulations. The NTSB therefore recommends that the FAA, in accordance with 14 USC 141 and 49 USC 106(m), request assistance from the Coast Guard to enforce existing FAA regulations applicable to parasailing operations.

Parasailing operations are conducted world-wide and, in warm climates, year-round. In the United States and its territories, most of the parasailing activity occurs along the congested coastline areas and locations with warmer climates, but it also occurs on many inland lakes and river systems with seasonal leisure and tourism interest. In each of these areas, banner tow airplanes or other aircraft operate in the same airspace as the parasailing operators. Despite this fact, in 2013, only the FAA’s Southern Regional Office (the FAA office that has made the most effort on parasailing safety to date) held parasailing and banner tow operator safety meetings, and only a total of 4 meetings were held. Additionally, from 2011 to the date of this report, the FAA’s ESA issued 84 percent of the total COAs nationwide, as compared to the other two FAA service areas. Because most, if not all, of the parasailing vessels in service today cannot comply with the towline marking provisions of the FAA regulations, these data suggest that many parasailing operations within geographic responsibility of the FAA’s CSA and WSA are not aware of the need to request and obtain a waiver to deviate from those regulatory requirements.

The NTSB is concerned that the FAA’s approach to enforcement of its parasailing regulations is inconsistent among the various regions, and that some special provisions in the COAs are inconsistent with other federal regulations. Although the only two recorded parasail and aircraft midair collisions did occur within the geographical boundaries of the FAA’s ESA and Southern Regional Office, the potential for a midair collision between a parasail and an aircraft exists anywhere the two activities take place. Neither the 400-foot AGL limit that the ESA imposes on parasailing operations—nor the existing regulatory 500-foot AGL limit published in 14 CFR Part 101 that the other two FAA regions impose on parasailing operations—accounts for the vertical distance in which the banner may be suspended below and behind the tow aircraft. In addition, neither of these two AGL limits enforced for parasailing operations aligns with the long-existing regulatory requirements, found in 14 CFR Part 91, that all aircraft maintain at least 500 feet of separation from any person, structure, or object such as a parasail aloft. Given this fact, the two different AGL limits applied to parasailing operations—that is, the ESA’s currently imposed special provision limit of 400-feet AGL, and the existing regulatory 500-foot AGL limit enforced by the other two FAA service areas—need to be clarified to prevent confusion and be consistently applied both for pilots and parasailing operators from a national perspective.

Further, the special provision found in COAs that requires a parasailing vessel to yield the right-of-way to all aircraft is inconsistent with the hierarchy found in the international and

inland navigation rules enforced by the Coast Guard. By definition, these collision prevention regulations consider the parasailing vessel with a canopy aloft to be restricted in its ability to maneuver, and require all other power-driven, fishing, and even sailing vessels to keep out of the way. It is unclear how a vessel restricted in its ability to maneuver can reasonably be expected to steer clear of an aircraft at flight speed.

To heighten the awareness of risk of midair collisions in shared airspace, and to promote the consistent and clear application of current FAA regulations regarding altitude limitations designed to separate the airspace of each interest, key stakeholders should be identified in each FAA region. These stakeholders should be given uniform application of regulations and the opportunity to attend annual parasail and banner tow operator safety meetings in locations throughout the United States and its territories. The NTSB concludes that the different maximum AGL limits applied to parasailing operations, and the hierarchy of aircraft in flight over parasailing vessels operating on the surface, are confusing and conflict with existing regulations. The NTSB recommends that the FAA review all existing regulations and special provisions that are intended to separate parasailing and aircraft operations, and take appropriate action to ensure that these directives are in harmony and consistently applied nationwide to reduce the risk of midair collisions. The NTSB further recommends that the FAA work with the Coast Guard to resolve conflicts between (a) the existing FAA special provision that gives aircraft right-of-way over parasailing vessels, and (b) the existing international and inland navigation rules that imply that parasailing vessels are restricted in their ability to maneuver and, therefore, should have the right-of-way.

4.3 State Level Effort

As evident by the multiple unsuccessful attempts by Florida lawmakers to pass parasailing legislation in that state, the development, promotion, and acceptance of such measures is challenging. The legislative process in any governmental body is often a lengthy and tedious one. The inability to pass this legislation can be attributed to many factors, including adverse input from industry stakeholders or special interest groups, concerns over the potential added economic burdens that may be involved, and inability of lawmakers to agree on the draft legislation itself because of issues with its content. However, by using a NASBLA model act, these factors may be more easily resolved. NASBLA model boating safety acts have in the past successfully served as a framework that states and US territories consulted while drafting new legislation or amending existing law associated with recreational boating and waterways safety. The NTSB concludes that the development and promotion of a model act focused on the unique training, operational safety, and equipment associated with parasailing would not only call attention to the significant risk associated with the activity, but would also provide those governmental bodies seeking to develop standards and regulations with a solid foundation on which to begin the process. The NTSB therefore recommends that NASBLA draft a model act that may be used by its membership as a framework for state legislation to reduce the risk associated with parasailing.

5. Conclusions

5.1 Findings

1. Although establishing a specialized license endorsement would not eliminate all shortcomings attributed to human error, it would set a minimum level of experience and professional competence for those who operate parasailing vessels.
2. For ASTM International's standards to be the most effective in reducing the number of parasailing deaths and injuries, they should have the same force and effect as a regulation and be actively enforced both on small passenger vessels and uninspected passenger vessels.
3. A logical course of action to improve parasailing safety would be for the Federal Aviation Administration to request assistance from the Coast Guard to enforce existing Federal Aviation Administration regulations.
4. The different maximum above ground level limits applied to parasailing operations, and the hierarchy of aircraft in flight over parasailing vessels operating on the surface, are confusing and conflict with existing regulations.
5. The development and promotion of a model act focused on the unique training, operational safety, and equipment associated with parasailing would not only call attention to the significant risk associated with the activity, but would also provide those governmental bodies seeking to develop standards and regulations with a solid foundation on which to begin the process.

5.2 Recommendations

To the United States Coast Guard:

1. Implement a specialized license endorsement that all holders of a valid Coast Guard merchant mariner credential would be required to obtain before conducting parasailing operations. (M-14-11)
2. Incorporate by reference ASTM International's parasailing standards to govern all parasailing operations. (M-14-12)

To the Federal Aviation Administration:

3. In accordance with 14 *United States Code* 141 and 49 *United States Code* 106(m), request assistance from the Coast Guard to enforce existing Federal Aviation Administration regulations applicable to parasailing operations. (M-14-13)
4. Review all existing regulations and special provisions that are intended to separate parasailing and aircraft operations, and take appropriate action to ensure

that these directives are in harmony and consistently applied nationwide to reduce the risk of midair collisions. (M-14-14)

5. Work with the Coast Guard to resolve conflicts between (a) the existing Federal Aviation Administration special provision that gives aircraft right-of-way over parasailing vessels, and (b) the existing international and inland navigation rules that imply that parasailing vessels are restricted in their ability to maneuver and, therefore, should have the right-of-way. (M-14-15)

To the National Association of State Boating Law Administrators:

6. Draft a model act that may be used by your membership as a framework for state legislation to reduce the risk associated with parasailing. (M-14-16)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

CHRISTOPHER A. HART
Acting Chairman

ROBERT L. SUMWALT
Member

MARK R. ROSEKIND
Member

EARL F. WEENER
Member

Adopted: June 18, 2014



NTSB ***SAFETY ALERT***

National Transportation Safety Board

★ **Towline Failure is the Leading Cause of Injury and Death in Parasailing Accidents** ★

Tying knots in the towline may significantly weaken it

The problem

Towline failure is the leading cause of injury and death in parasailing accidents.¹ The NTSB recently studied several parasailing accidents and verified that the knot most commonly used by parasailing operators to fasten their towlines is a bowline knot. In subsequent laboratory testing, the NTSB confirmed that this knot (and any knot in general) can reduce towline strength by as much as 70 percent, even on brand-new, otherwise-strong ropes.²

When the testing also factored in sun and saltwater exposure, sudden “shocks” by wind gusts or other overloads, and general wear-and-tear, the ropes weakened further.

Although most parasailing operators may be aware that tying knots in the towline reduces rope strength, they may have no idea just how drastic the weakening really can be. This lack of awareness can potentially be deadly.



A bowline knot, the knot most commonly used by parasailing operators in their towlines. This type of knot can weaken a brand-new rope by as much as 70 percent.

¹ Coast Guard safety alerts “Know Your ROPES,” 2011 and 2013.

² The NTSB tested three types of rope commonly used by parasailing operators: 3/8”- and 7/16”-diameter double-braid polyester, and 5/16”-diameter single-braid polyethylene.

What can parasailing operators do?

- Recognize that although a particular rope may be rated at 10,000 pounds, the moment you tie a knot in it, the rope strength can drop by half or more. This is *before* factoring in the rope's age, use, etc.
- Frequently and carefully inspect your ropes to ensure that they are in good overall condition with no sign of external abrasion or other damage, and that they are suitable for the intended operation.
- At the parasailing location, use an anemometer or other device to measure wind speeds to ensure that those speeds fall within the parasail canopy manufacturer's recommendations.
- Use steady and consistent speed and force on the winch when deploying and recovering the canopy towline.
- Maintain logs about rope usage and examinations. These should include information on the type of ropes you're using, their time in service, and details of every examination. A usage log is a great way to determine if excessive tension or shock-loading has occurred and weakened the ropes.
- Store your ropes in a clean and dry location out of direct sunlight.
- Trim back the working ends of the ropes as needed, and replace your ropes frequently. For more specifics, consult a recognized source of information such as the Cordage Institute on the selection, care, and disposition of ropes. In addition, refer to the standards for parasailing equipment, currently being developed by ASTM International.

References

- Coast Guard. (Undated.) *Analysis of Parasailing Vessel Casualties – A Review of Casualties Aboard Inspected and Uninspected U.S. Flagged Vessel Engaged in Parasailing for Hire*. Coast Guard Office of Investigations and Analysis (CG-INV), CY 1992–2001.
- . 2007. “Promoting Parasail Safety.” *The Coast Guard Journal of Safety & Security at Sea; Proceedings of the Marine Safety & Security Council*. Vol. 64, no. 1, pp. 25–28 (Spring).
- . 2004. *Voluntary Commercial Parasailing Vessel Safety Examination Booklet*. Coast Guard Sector St. Petersburg, Florida.
- . 2009. *Parasailing Casualties*. Coast Guard Office of Investigations and Analysis; Compliance Analysis Division CG-5452. (Updated 2010)
- . 2013. *Commercial Parasailing Vessel Safety Guidance*. Coast Guard Office of Commercial Vessel Compliance (CG-CVC-1).
- FAA. 2009. *Applicability of 14 CFR Part 101 (Moored Balloons, Kites, Unmanned Rockets and Unmanned Free Balloons) to Parasails and Parasail Operations*. (AGC-200/240)