



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

April 28, 2022

Specialist's Report

SURVIVAL FACTORS

ERA21FA354

A. ACCIDENT

Location: Provincetown, MA
Date: September 9, 2021
Time: 1527 Eastern daylight time (EDT)
1927 Coordinated universal time (UTC)
Airplane: Cessna 402C, N88833, Cape Air

B. SURVIVAL FACTORS SPECIALIST

Specialist Amanda Taylor
National Transportation Safety Board
Washington, DC

C. DETAILS OF THE INVESTIGATION

On April 21, 2022, the survival factors specialist, the investigator in charge, representatives from the Federal Aviation Administration, and a representative from Cape Air convened at Colonial Air in New Bedford, MA to conduct a wreckage examination of seats, restraints, and the airplane. Prior to that Interviews with passengers and witnesses were conducted by the IIC.

D. FACTUAL INFORMATION

1.0 Airplane Configuration

The airplane was a Cessna 402c non-pressurized twin engine piston airplane. It was configured with a pilot seat (1A), a copilot seat (1B), and eight passenger seats (see figure 1). The airplane was equipped with an escape hatch adjacent to the pilot seat (1A); an emergency escape hatch adjacent to seats 2B; and a two-section clamshell-style outward opening airstair door (main cabin door) adjacent to seats 4A, the lower portion of which was equipped with stairs. The pilot and copilot seats were equipped with lift latch lap belts and single-strap shoulder harnesses, and the passenger seats were equipped with lift latch lap belts. Seven occupants were on board the flight, the pilot and six passengers. Passengers were seated in seats 1B, 2A, 2B, 3A, 3B and 4A.

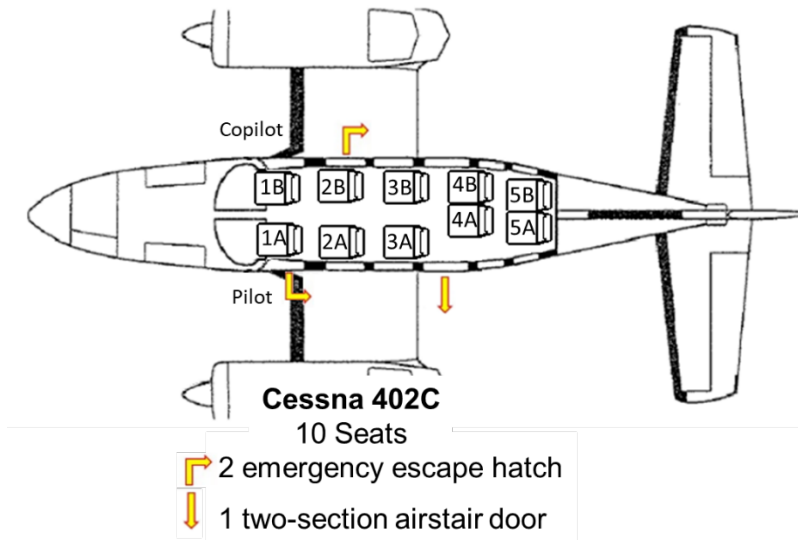


Figure 1. Cabin configuration of N88833 with occupant and exit locations.

2.0 Airplane documentation

2.1 Overall airplane exterior

The airplane had a post-crash fire with charring noted along the exterior left side from just aft of the nose section to the main cabin door, as well as on the right side just in front of the wing. There was crumpling from the nose aft to just in front of the wing on both sides of the airplane (see figure 2).



Figure 2. N88833 post-crash after the fire was extinguished.

2.2 Cabin Interior

The cabin was mostly intact (see figure 3) with downward overhead cabin deformation noted to the front right structure around copilot seat (1B) near an area where a tree found inside of the windshield (see figure 4). There was fire damage to the interior of the cabin on the left side just aft of the pilot seat (see figure 5).



Figure 3. Aft-facing photograph taken from the pilot escape hatch.



Figure 4. Photograph of structure around copilot seat (1B).



Figure 5. Photograph of charring aft of the pilot seat after the pilot seat was removed.

2.3 Seats

2.3.1 Pilot and copilot seats

The pilot and copilot seats (1A and 1B) were composed of a metallic frame with an adjustable seatback. They were able to be adjusted forward or aft on the seat rails to accommodate the occupant (see figure 6). Both seats remained attached to the seat rails which were fastened to a boxed structure which then attached to the floor. The seats were found with the seatback in an upright position with no damage noted to the seat cushions or structure. There was no seat manufacturer information or data plate located on the seats.

The seats were equipped with a 3-point restraint with a lift latch buckle manufactured by AmSafe. The lap belt was anchored on the floor, with the upper torso restraint anchored slightly aft and above the occupant on the sidewall. The seat belts did not become detached from their anchor points and were unbuckled when investigators arrived. The buckle could be latched and released normally. The webbing for the upper torso section and right lap belt were in good condition but the left, outboard lap belt was melted.



Figure 6. Pilot and copilot seat as found in airplane when investigators arrived on scene at the accident site.

The pilot seat (1A) upper torso restraint measured 34 inches from the attachment hardware to the button on the insert tang. The left lap belt, outboard, was melted and could not be measured. The right lap belt, inboard, was 26.25 inches long, which was fully extended.

The copilot seat (1B) upper torso restraint measured 36 inches from the attachment hardware to the button on the insert tang. The left lap belt, inboard, length measured 19.6 inches and the right lap belt, outboard, was 35 inches long.

2.3.2 Passenger seats

There were three different passenger seat types on the accident airplane. All three types had a pedestal which then connected the seat to the seat rails which were fastened to the floor. The first seat type was a "fold-over" seatback which had hinges between the seatpan and seatback that allowed it to be folded over (seats 2B and 3A) (see figure 7). The second type was a single solid seat bucket seat with no motion built in for the seatback (seats 2A and 3B) (see figure 8). The third type was a rigid double seat bucket attached to pedestals which were connected to each other with frame, which then attached to the seat rails (rows 4 and 5) (see figure 9).



Figure 7. Fold-over style passenger seat.



Figure 8. Solid seat bucket passenger seat with no motion built in for the seatback.



Figure 9. Two rigid seat buckets attached to pedestals which are connected to each other with frame.

All the passenger seats remained attached to the seat rails which were fastened to the floor, and all restraints were still attached to their seats. The seat pitch¹ for passengers, according to Cape Air's website, was 27 inches and seat width was 17 inches with no seat recline. The passenger seatpans and seatbacks were composed of an aluminum honeycomb sandwiched between two layers of composite. They then had foam glued to the composite which was all enclosed by a leather dress cover glued directly to the seat.

Seat 2B left lap belt was adjusted to a length of 10 inches, and the right had a length of 22.6 inches. Seat 3A left lap belt was adjusted to a length of 16.5 inches, and the right had a length of 21 inches. Seat 3B left lap belt was adjusted to a length of 14.5 inches, and the right had a length of 20.75 inches. Seat 4A left lap belt was adjusted to a length of 17.5 inches, and the right had a length of 19 inches.

2.3.3 Seat 2A

Seat 2A was found with the seatback rotated forward and had visible damage along the back seatpan/seatback junction (see figure 10). There were no data labels found on the seat or pedestal. The seat rail locking plunger functioned properly, and there was no damage noted to the attachment points or the seat rails.

¹ Seat pitch is the distance between a fixed point on an airplane seat to the same fixed point on the seat directly in front of or behind that seat.



Figure 10. Seat 2A as found in the airplane.

Seat 2A was equipped with a 2-point restraint with a lift latch buckle manufactured by AmSafe. The lap belt routed around the base of the seatback. The seat belts did not become detached and were found unbuckled when investigators arrived. The buckle could be latched and released normally. The webbing was undamaged with no fraying or UV damage noted. The left lap belt was adjusted to a length of 14.75 inches, and the right had a length of 20.6 inches.

The seat covering was a single sewn piece that went over the seat and was glued to the bottom of the pedestal. When the broken seat back was lifted, the cover for the seat bottom was no longer attached and there was tearing of the foam along the seat bottom (see figure 11). A small amount of fire damage was noted on the front right portion of the exposed foam.



Figure 11. Seat 2A viewed from the rear with broken section lifted away revealing damage to the seat bottom cushion.

After removing the seatback portion, the remaining cushion material was removed to examine the seat bottom. Damage along the rear right side of the seat pan was found, as well as downward deformation along the forward right edge of the seat (see figure 12). There were also loose fibers along the sides of the seat pan from where the cushion material was pulled away from the pan.



Figure 12. View of seat pan from the front showing damage to the forward right portion of the pan.

After the seatpan was documented, the seatback foam was removed to expose the structure beneath. Crumpling was found on the left side of the seatback structure (see figure 13 and 14).



Figure 13. Seat 2A seatback with covering and foam removed to show crumpling on the bottom left section of the structure.



Figure 14. Seat 2A with covering and foam removed from seatpan and the lower portion of the seatback.

2.4 Rudder pedals

The rudder pedals were examined, and the captain's rudder pedals appeared undamaged. The area around the captain seat was free of any damage or debris. The area around copilot seat (1B) had some deformation to the surrounding structure (see figure 15) with damage to the right rudder pedal.

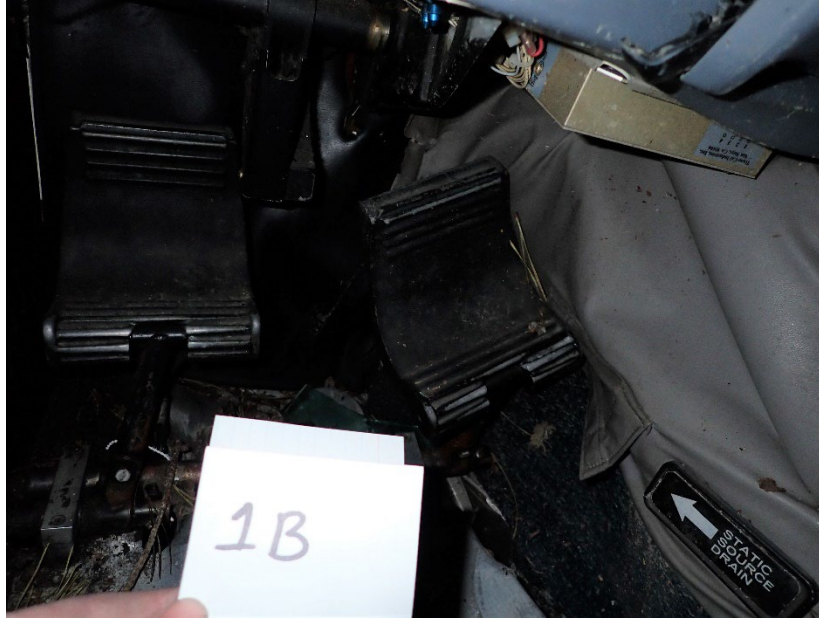


Figure 15. Copilot seat (1B) rudder pedal area.

2.5 Main cabin door and escape hatches

2.5.1 Left escape hatch

The left window escape hatch was located adjacent to the pilot and found partially attached to the airplane; however, it was no longer secured and had damage to the window (see figure 16). The opening measured 18 inches wide at the top and 27 inches wide at the bottom, with a height of 21 inches (see Figure 17).



Figure 16. Left escape hatch located adjacent to the pilot, as found after the fire was extinguished.

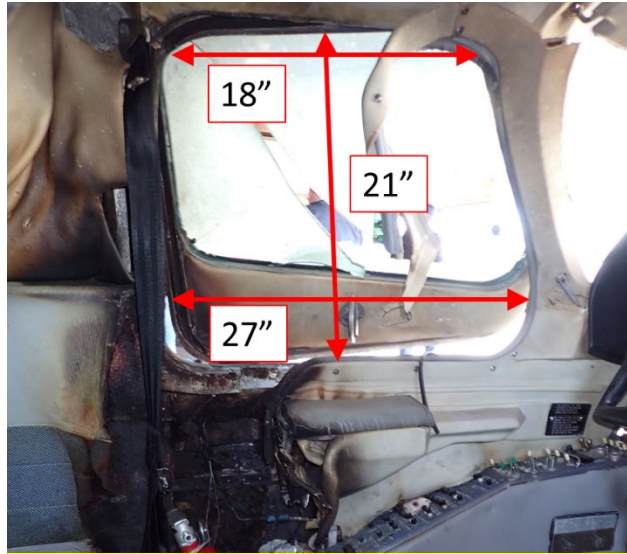


Figure 17. Left escape hatch by pilot with measurements, looking from the interior of the airplane outward.

2.5.2 Right escape hatch

The right escape hatch was located by seat 2B and was found open (see figure 18). According to passenger statements it was opened by the female passenger in 2B following the directions on the safety briefing card located in the seatback pocket. It measured 25.5 inches wide with a height of 16 inches (see figure 19). The handle functioned when turned and the hatch opened without impingement.



Figure 18. Right escape hatch located adjacent to seat 2B, as found after the fire was extinguished.

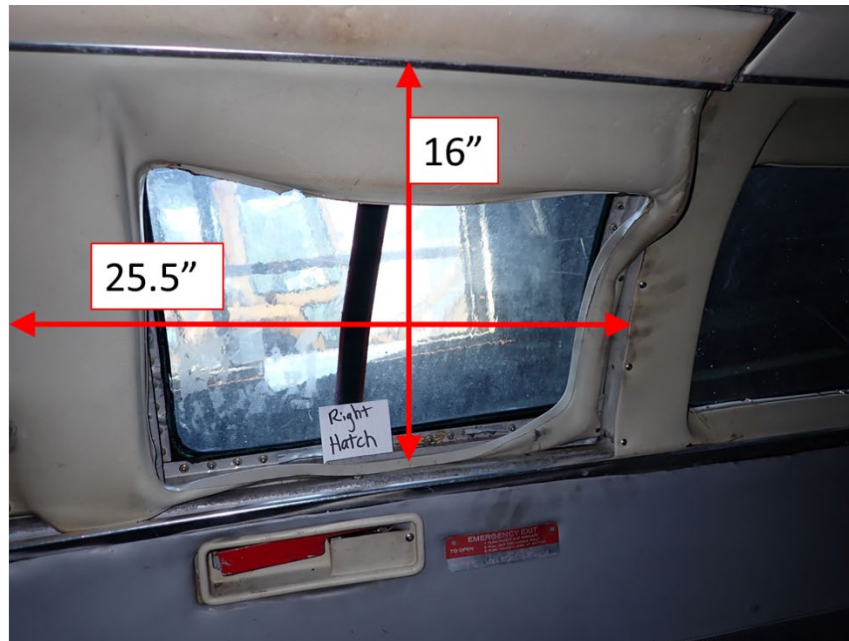


Figure 19. Right escape hatch with measurements, as viewed from the interior.

2.5.3 Main cabin door

The main cabin door was a clam shell type two-piece door located adjacent to seat 4A. The door is opened from the interior by first by rotating a lever counterclockwise, which releases the top portion, then pushing it outwards. The top portion has pneumatic assists on the forward side to help open it and hold it open during normal operation. The bottom portion is then opened by pulling up on a lever located on the top of the structure.



Figure 20. Directions for opening the main cabin door from the Cape Air briefing card.

The door was found partially open at the scene. The top portion of the two-piece clamshell type door was open however the bottom section was still closed and secured (see figure 21). According to interviews passenger 4A stated he was unable to open the main cabin door and turned in his seat and started kicking it. He kicked the upper window latch and the top portion of the door opened. All passengers described evacuating out the top half of the door and jumping or falling to the ground below. This height was estimated from photos of the airplane at the accident

scene as about 9.5 feet. The opening measured 22 inches wide and 19 inches high (see figure 22). The lever for the top portion and latch for the bottom both functioned normally.



Figure 21. Main cabin door adjacent to seat 4A, as found after the fire was extinguished.

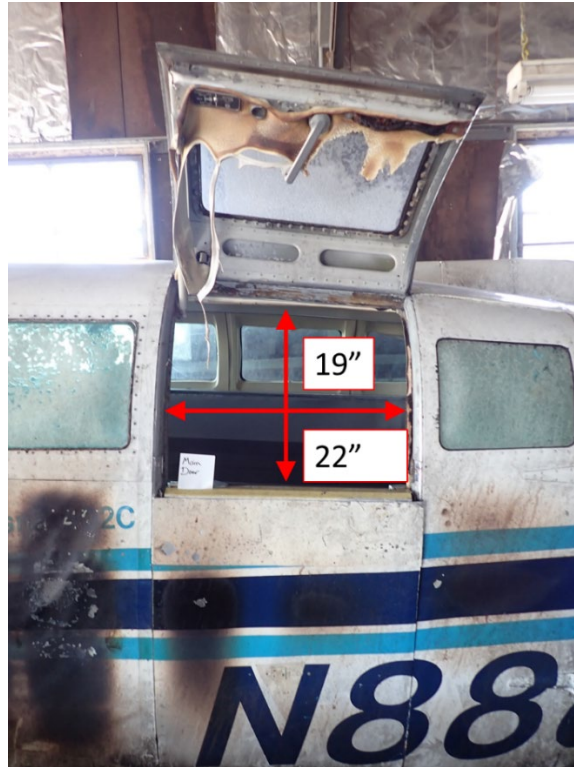


Figure 22. Main cabin door opening as the passengers exited with measurements.

3.0 Emergency equipment

3.1 Life vests

The passenger seats had a life vest pouch secured beneath the seat during operation, and life vests were found still attached to seat 2A, 2B, 3B, and 5A. The other four life vests were found throughout the cabin. The pilot and copilot seats had life vests stowed between the seat and sidewall during operation. After the accident, the pilot seat life vest was found in its normal location, but the copilot life vest was located near the rudder pedals in front of the seat.

3.2 Fire extinguisher

A single halon fire extinguisher was found lying on the floor just forward of the copilot seat (see figure 23). It is normally secured to the front of the copilot seat.



Figure 23. Figure extinguisher as found by investigators in the airplane.

3.3 Emergency briefing card

Emergency briefing cards were found in multiple seatback stowage pockets, and others were found throughout the cabin. They were six panel cards containing instructions in graphical form on both sides (see figure 24 and 25). The cards included information about:

- Approved electronic devices, no smoking, and remaining buckled while seated.
- How to buckle and unbuckle seat belts.
- Location and operation of the escape hatches and main cabin door.
- Location and how to don life vests.
- Location and operation of the fire extinguisher located by the copilot seat (1B).
- Brace for impact positions.



Figure 24. Side 1 of an instructional briefing card found in seatback pocket.



Figure 25. Side 2 of an instructional briefing card found in seatback pocket.

4.0 Airport information

Provincetown Municipal Airport (PVC) located 2 miles northwest of Provincetown Massachusetts at an elevation of 7.8 feet. The airport was served by

one runway (7/25). PVC was a publicly owned commercial service airport. Scheduled passenger operations at PVC used airplanes that did not exceed 9 passenger seats and therefore the airport was not required to hold an operating certificate issued by the FAA as outlined in 14 CFR Part 139.

4.1 Runway 7 information

The accident flight attempted to land on runway 7. Runway 7 was 3502 feet long and 100 ft wide. It had an asphalt surface in good condition with an elevation of 7.8 feet. The runway had high intensity edge lighting, a medium-intensity approach lighting system with sequenced flashers (MALSF), a 4-light precision approach path indicator on the right side with a glideslope of 3.00 degrees, and precision instrument markings in good condition. At the end of the runway there were 12-foot trees 610 feet off the end of the runway to the airport fence line, and 125 feet from the centerline.

5.0 Accident summary²

The passengers arrived at Logan International Airport in Boston Massachusetts the day of the flight and were aware of flight delays out of Boston due to rainy weather. When it was time to board, they were escorted outside by a Cape Air ramp agent and instructed to put their luggage on the ground by the plane to be loaded. When asked if anyone wanted to sit up front a male passenger volunteered immediately. He then boarded through the main boarding door located adjacent to seats in row 4 and sat in the copilot seat (1B) next to the captain who was seated in the pilot seat (1A). The rest of the passengers loaded in rows 2 through 4 with row 5 left empty.

Once on board the captain stated he gave the passengers a safety briefing and information on the approximate length of the flight, however passengers stated they but did not get a safety briefing on restraints or emergency procedures³. Passengers felt that the boarding process and initial taxi were normal based on their previous experiences. Passenger 1B noted how busy the captain was during the flight, actively using charts and writing things down on a note pad.

As the airplane turned over the bay to start the landing approach, it entered clouds and raindrops began to hit the windshield. The passengers felt the airplane was moving too fast to land or stop on the runway. Passenger 1B estimated they

² The pilot, all passengers and a witness were interviewed by the IIC. Summaries produced from the interviews are included in attachment 1. The information obtained was used to create this narrative.

³ 14 CFR § 135.117 "Briefing of passengers before flight," details what must be orally briefed to all passengers by the pilot in command. The briefing had to consist of: smoking, the use of safety belts, seat back position, location and means for opening the passenger entry door and emergency exits, location of survival equipment, ditching procedures for flights over water, use of oxygen equipment, and location and operation of fire extinguishers.

touched down about halfway down the runway. He described the motion during landing as shifting left and right and felt "wobbly and squiggly" during the landing roll out. The captain then brought the power back up on both engines and attempted to take off. There were no audible alarms from the cockpit during this time, nor did the passengers remember the pilot saying anything.

The passengers could see the trees located off the end of the runway and did not believe the airplane would get high enough to clear them. The airplane impacted the trees, yawed left and then impacted the ground with the nose lower than the tail section.

A tree came through the windshield in front of 1B, who stated he felt pain in his face, right foot, and arm. He immediately saw flames and remembers hearing the pilot yelling "Get out! Get Out!" Initially he did not evacuate immediately until the pilot yelled a second time "Get Out! Get Out!" Multiple passengers described the air inside the cabin as hot and hard to breathe. Passenger 1B unbuckled his seat belt and moved toward the back. He tripped and fell on female passenger 2A who was lying face down in the aisle.

Passenger 2B "punched the emergency exit" window to try and open it. It did not open, she then read the instructions and opened the window, but the flames were "too much." She grabbed the window frame, and her fingers that were in contact with the outside skin of the airplane were instantly burned. She then unbuckled her seat belt and exited out the top half of the main cabin door headfirst. After exiting she ran to a nearby road with "great back pain."

Passenger 3B hit his head on the side of the cabin during the crash which "dazed" him. He was disoriented to the point that he could not unbuckle his seat belt. Passenger 3A unbuckled 3B's seat belt for him before they both headed to the main cabin door behind them.

Passenger 4A stated he was unable to open the main cabin door and turned in his seat and started kicking it. He kicked the upper window latch and the top portion of the door opened. He then pushed a female passenger 2B out of the window before he jumped out and ran to Race Point Road, approximately 35 feet away (see figure 26). Passengers 3A and 3B exited after them.

Passenger 2A reported her seatback had "twisted" when they struck the trees, and she was thrown forward and to the right, hitting her head on 2B's jaw. Passenger 2A was unable to unbuckle her seat belt and get free from her seat. She felt like the seat belt was tangled and it was a struggle. After yelling for help the captain came from the back to help her. He was unable to open the lift latch buckle stating it was "jammed" and instead loosened it to pull her through the fastened belt. After he

freed her, she exited out the main cabin door followed by the pilot last. The pilot was badly burned.

When grabbing the door frame of the main cabin door to get out passengers describe it being so hot it burned their hands. After getting through the open top half of the main cabin door passengers described jumping down a large distance. All occupants sustained serious burn injuries during the evacuation. Passengers could hear sirens in the distance and were loaded into ambulances for transport to Cape Cod General Hospital.

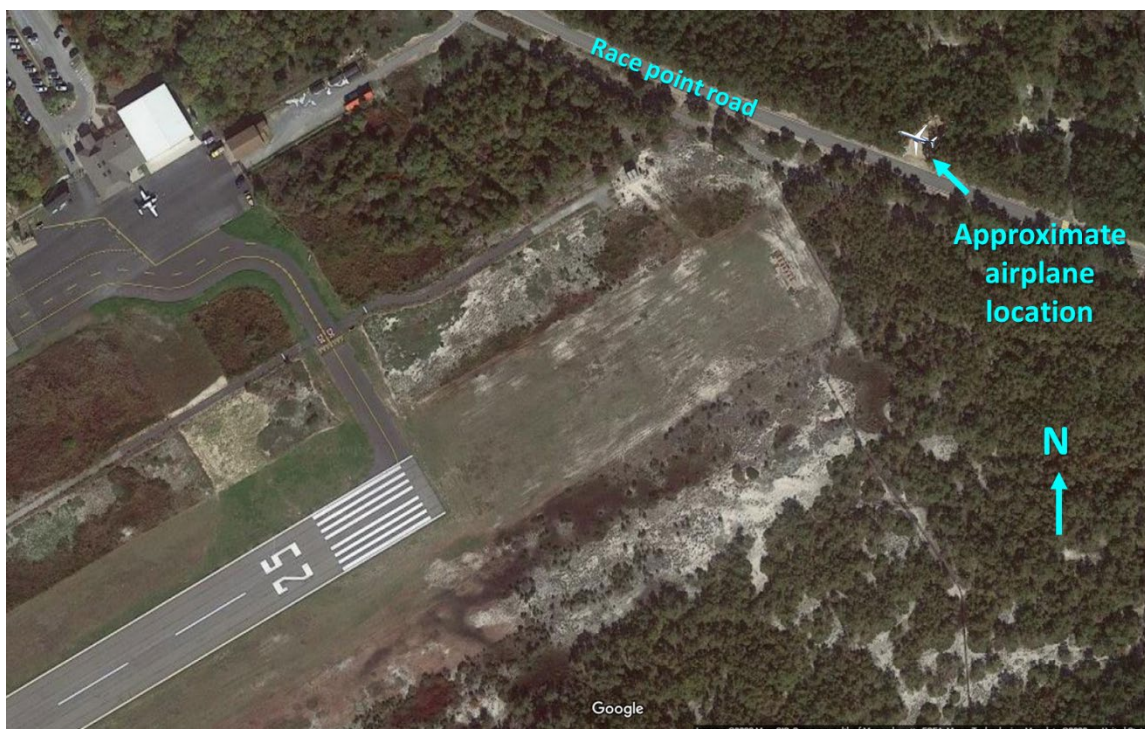


Figure 26 Google Earth view of the end of the runway and approximate airplane location.

6.0 Injury Information

According to interviews all occupants were transported via ambulance to Cape Cod General hospital with serious injuries. These consisted of second- and third-degree burns, with some occupants sustaining fractures. Two passengers were later transferred to Brigham and Women's Hospital in Boston, Massachusetts for additional treatment. Details of the injuries are in attachment 2 of this report.

6.1 Injury table

Type of injury	Crew	Passengers	Total
Fatal	0	0	0
Serious	1	6	7
Minor	0	0	0

None	0	0	0
TOTAL	1	6	7

E. LIST OF ATTACHMENTS

Attachment 1: Passenger record of conversations

Attachment 2: Injury chart

Submitted by:

Amanda M Taylor

Survival Factors Investigator