Aviation Investigation Final Report

Location:	Provincetown, Massachusetts	**Accident Number:**	ERA21FA354
Date & Time:	September 9, 2021, 15:27 Local	**Registration:**	N88833
Aircraft:	Cessna 402C	**Aircraft Damage:**	Substantial
Defining Event:	Collision with terr/obj (non-CFIT)	**Injuries:**	7 Serious
Flight Conducted Under:	Part 135: Air taxi & commuter - Scheduled		

Analysis

The pilot was transporting six passengers on a scheduled revenue flight in instrument meteorological conditions. The pilot familiarized himself with the weather conditions before departure and surmised that he would be executing the instrument landing system (ILS) instrument approach for the landing runway at the destination airport. The operator prohibited approaches to runways less than 4,000 ft long if the tailwind component was 5 knots or more. The landing runway was 498 ft shorter than the operator-specified length.

The pilot said he obtained the automated weather observing system (AWOS) data at least twice during the flight since he was required to obtain it before starting the instrument approach and then once again before he crossed the approach's final-approach-fix (FAF). Though the pilot could not recall when he checked the AWOS, he said the conditions were within the airplane and company performance limits and he continued with the approach. A review of the wind data at the time he accepted the approach revealed the tailwind component was within limitations.

As the airplane approached the FAF, wind speed increased, and the tailwind component ranged between 1 and 7 knots. Since the exact time the pilot checked the AWOS is unknown, it is possible that he obtained an observation when the tailwind component was within operator limits; however, between the time that the airplane crossed over the FAF and the time it landed, the tailwind component increased above 5 knots.

The pilot said the approach was normal until he encountered a strong downdraft when the airplane was about 50 to 100 ft above the ground. He said that the approach became unstabilized and that he immediately executed a go-around; the airplane touched down briefly

before becoming airborne again. The pilot said he was unable to establish a positive rate of climb and the airplane impacted trees off the end of the runway.

The accident was captured on three airport surveillance cameras. A study of the video data revealed the airplane made a normal landing and touched down about 500 ft from the beginning of the runway. It was raining heavily at the time. The airplane rolled down the runway for about 21 seconds, and then took off again. The airplane entered a shallow climb, collided with trees, and caught on fire.

An airplane performance study was conducted using automatic dependent surveillance – broadcast (ADS-B) data, weather information, and aircraft performance data provided by the manufacturer. The study revealed that the approach became unstabilized when the airplane exceeded a sink rate of 1,000 ft/minute at 400 ft above mean sea level (msl). Per the operator's General Operations Manual (GOM), the pilot should have immediately executed a missed approach.

In addition, the wind speed and tailwind component increased as the airplane was on approach. Consequently, the airplane landed at a calibrated airspeed that was about 18 knots faster than the speed assumed in the pilot operating handbook (POH)/airplane flight manual (AFM) landing distance tables, with a tailwind component of about 11 knots.

Landing performance calculations indicated that even with the fast touchdown speed, the airplane had sufficient runway available to stop on a dry runway, including a 15% safety margin. However, the combination of the fast touchdown speed and reduced deceleration due to the wet runway significantly increased the distance that would have been required to stop the airplane. The video study revealed that if the pilot just continued to let the airplane decelerate on the runway, it would have stopped somewhere between 60 ft before the end of the runway to 88 ft beyond the end of the runway.

Due to the reduced deceleration, the pilot most likely thought the airplane was going to go off the end of the runway and he opted to go-around. After lifting off, the airplane continued to accelerate at 5.0 ft/s2. Climb performance calculations revealed that it was unlikely that the airplane could have simultaneously maintained this acceleration and climbed out of ground effect. The airplane could have achieved a higher climb angle and likely cleared the trees if it had maintained a constant airspeed after liftoff, instead of accelerating, even though the liftoff airspeed was below the airplane's best angle of climb speed. However, it is understandable that a pilot would want to accelerate to this speed before climbing to clear obstacles.

Given the outcome of the attempted go-around, the performance data determined that the better option for the pilot would have been to accept an overrun into the open area beyond the end of the runway.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be:

The pilot's delayed decision to perform an aborted landing late in the landing roll with insufficient runway remaining. Contributing to the accident was the pilot's failure to execute a go-around once the approach became unstabilized, per the operator's procedures.

Findings

Personnel issues	Aircraft control - Pilot
Personnel issues	Delayed action - Pilot
Environmental issues	Tailwind - Effect on operation
Environmental issues	Rain - Effect on operation

Factual Information

History of Flight

Landing-aborted after touchdown	Collision with terr/obj (non-CFIT) (Defining event)

HISTORY OF FLIGHT

On September 9, 2021, about 1527 eastern daylight time, a Cessna 402C, N88833, was substantially damaged when it was involved in an accident near Provincetown, Massachusetts. The pilot and the six passengers were seriously injured. The airplane was operated as a Title 14 *Code of Federal Regulations* (*CFR*) Part 135 flight.

The flight was being operated by Hyannis Air Service, Inc. d.b.a. Cape Air on an instrument flight rules flight plan from Boston-Logan International Airport (BOS), Boston, Massachusetts, to Provincetown Municipal Airport (PVC), Provincetown, Massachusetts.

In a postaccident interview, the pilot said he obtained weather information before the flight via a computer in the pilot crew room at BOS just before the passengers were boarded. The weather information included the graphic forecast for aviation; weather advisories including AIRMETs and SIGMETs, weather radar, METARs, and NOTAMs. The pilot reported that the radar was showing green bands of rain only between BOS and PVC. The pilot said that based on the weather conditions, he planned for the ILS RWY 7 approach into PVC. He then filed an IFR flight plan and began the boarding process.

According to Federal Aviation Administration (FAA) air traffic control (ATC) communications, the flight departed BOS about 1504. The pilot said it was a very quick flight and the AWOS frequency for PVC was already dialed into the No. 2 radio. He said he checked the AWOS “at least twice” during the flight but did not recall exactly when. He was required by the operator to check the AWOS before he started the approach and before he crossed the final approach fix (FAF) on the approach.

He recalled the weather being 200 ft overcast, visibility 3 to 4 miles in moderate rain, and the wind was 5 knots or below from the southwest. The pilot knew he would be landing with a quartering tailwind on runway 7 (a 3,502 ft-long runway) and that the wind conditions favored runway 25, but the ILS to runway 7 allowed for a lower ceiling minima than the RNAV approach to runway 25. So, runway 7 was preferable based on the existing weather conditions. The pilot also calculated that the tailwind component was within the performance limits for the airplane and the company requirements since Cape Air prohibited instrument approaches to short runways (4,000 ft or less) when the tailwind component was 5 knots or more.

At 1511, the pilot advised ATC that he had the weather at PVC and could accept the ILS RWY 7 approach. A controller instructed the pilot to proceed direct to WOMECK intersection, an intermediate fix for the approach. At 1513, a controller cleared him for the ILS RWY 7 approach, and the pilot acknowledged.

At 1521, a controller advised the pilot to cancel his flight plan once on the ground, and the pilot acknowledged. This was the last communication received by the pilot before the accident.

Review of FAA radar surveillance data revealed that the airplane crossed over the FAF at 1524, at an altitude of about 2,000 ft msl, and landed about 3 minutes later, at 1527.

According to the pilot, he said he flew the approach using the autopilot and extended the flaps to 15° a few miles outside the final-approach-fix (FAF). He stated that when the airplane crossed the FAF, the airplane's indicated airspeed was 120 knots, and he extended the landing gear. Once inside the FAF, he turned off the autopilot at 1,000 ft and extended the flaps to 20°-25° to compensate for the tailwind and wet runway. The pilot said the airplane slowed to about 90 knots and they broke out of the clouds at 500 ft, which gave him extra time to set up for the landing. The airport's runway landing lights were on, and it was raining.

The pilot stated that he extended the flaps to 45° when the airplane was about 300 ft above the ground. He said that when the airplane was about 50 to 100 ft above the ground, the airplane encountered "an aggressive sinking tendency" and "very heavy rain." The pilot believed he had encountered a downdraft and associated wind gust (which he estimated to be about 20 knots), which pushed the airplane down and to the left. The pilot added that the approach became unstable and that he immediately initiated a go-around before the airplane touched down. He brought both throttles full forward and retracted the flaps to 15°.

The airplane continued to descend and touched down on the runway for about 2 seconds before it became airborne again. The pilot said that he never applied the brakes because he was fully committed to going around. The pilot did not remember where on the runway the airplane touched down, but said it was beyond his intended landing point due to him initiating the go-around. The pilot said he was unable to establish a positive rate of climb and that he could feel the wings buffeting. The airplane impacted the trees off the end of the runway, then the ground, and caught on fire.

Another Cape Air pilot was holding short of runway 25 waiting to depart and witnessed the accident. He said that he first saw the accident airplane after it landed and was about halfway down the runway. As the accident airplane got closer to his position, he could tell that it was traveling "a little faster than it should be" and would not have room to stop on the remaining runway. The accident airplane then took off and entered a slow climb. The accident airplane cleared the localizer antennas at the far end of the runway, then the perimeter fence, before it collided with trees. The accident airplane disappeared into the trees and a ball of flames erupted shortly afterwards. The pilot told ATC that the accident airplane had gone off the runway and that he was returning to the terminal to contact his company about the accident.

The accident was recorded on three airport surveillance cameras, which showed a different series of events versus what the pilot recalled. The videos revealed the airplane actually made a normal landing and touched down about 500 ft from the end of the runway's threshold. It was raining heavily at the time and a splash of water was observed when the main landing gear contacted the ground. The airplane rolled down the runway before it became airborne near the end of the runway. The airplane entered a shallow climb, collided with trees, and caught on fire. The airport's windsock was observed in the video and was consistent with the airplane landing with a tailwind.

The passengers reported that they perceived the airplane was moving too fast to land and stop safely on the runway. One passenger said that after the airplane landed, the pilot tried to stop, and she felt the sensation of decelerating in her seat as the brakes were applied. But the airplane did not slow down. The pilot brought power up on both engines as they neared the end of the runway and attempted to take off. 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.

PERSONNEL INFORMATION

The pilot held an airline transport pilot certificate with a rating for airplane multiengine land. He also held a commercial pilot certificate with ratings for single and multiengine land airplanes, and instrument airplane. In addition, the pilot was a certified flight instructor with ratings for single and multiengine airplanes, and instrument airplane. His last FAA first-class medical certificate was issued on April 2, 2021. The pilot had been employed by Cape Air for about 9 years and reported a total of 17,617 flight hours, of which, 10,000 hours were in the Cessna 402C. He was also type rated in Boeing 727 and Beech 1900 airplanes.

AIRCRAFT INFORMATION

The Cessna 402C is a light twin, piston engine aircraft and certificated for single-pilot operations. The airplane is powered by two 325 hp turbocharged Continental engines with three-bladed, constant-speed, fully feathering propellers. The airplane was maintained via an FAA-approved inspection program (AAIP). The last inspection was completed on August 26, 2021. At the time of the accident, the airplane had accrued a total of 36,722 hours.

The airplane was not equipped, and was not required to be equipped, with a flight data recorder (FDR) or cockpit voice recorder (CVR). There were no other sources of nonvolatile memory devices installed onboard the airplane.

METEOROLOGICAL INFORMATION

A review of the weather conditions at the time of the accident indicated a low-pressure system and associated cold front was moving across Massachusetts with moderate to heavy rain and thunderstorms across the region. A convective SIGMET was current during the period over the route of flight and destination airport. IFR conditions were reported approximately 40 minutes

before departure with LIFR conditions at the time of the accident due to moderate to heavy rain and low ceilings at 200 ft above ground level.

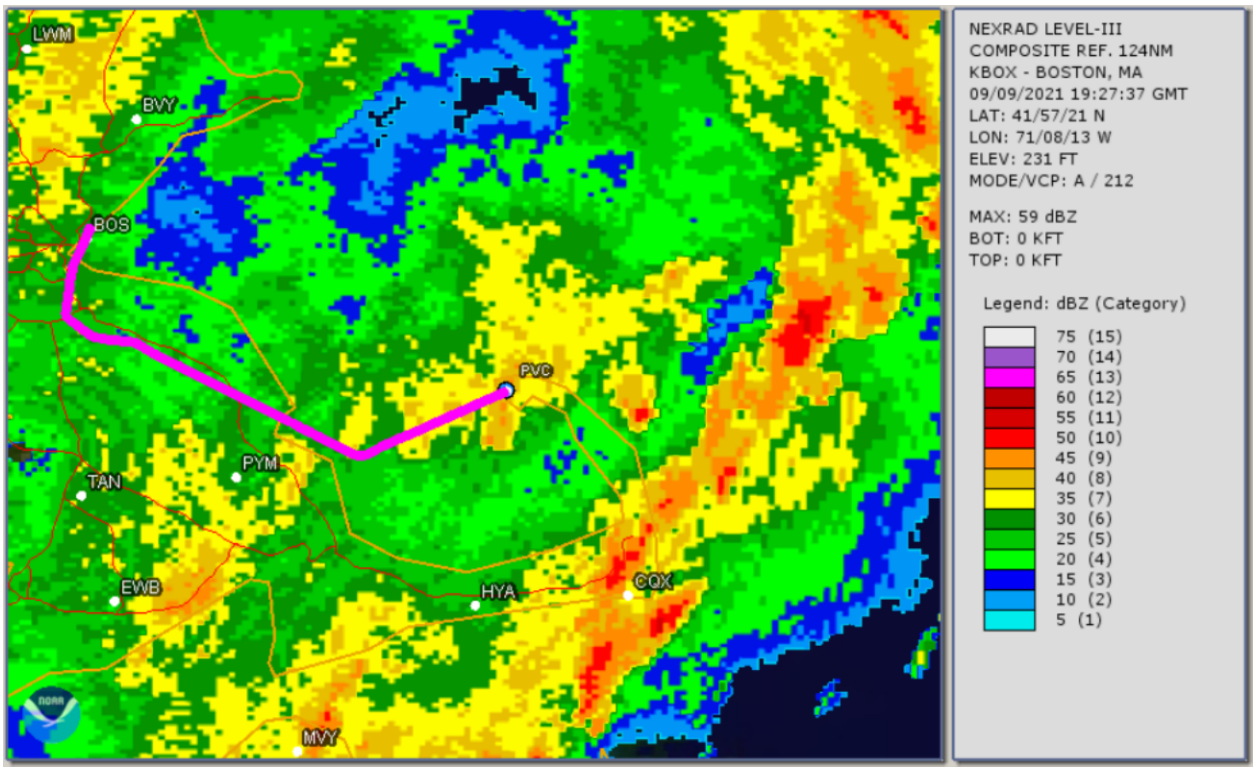

Figure 1 – Boston WSR-88D Composite reflectivity image and flight track at 1527 EDT

The High Resolution Rapid-Refresh (HRRR) sounding indicated an unstable atmosphere favorable for convection, with a low potential for any non-convective low-level wind shear at the time of the accident. The sounding (and satellite imagery) did not indicate any microburst potential over the accident site at the time of the accident. Furthermore, WSR-88D weather radar imagery did not detect any outflow boundaries or microburst at the time of the accident.

PVC was equipped with an AWOS. The AWOS disseminated weather in two formats: hourly and continuous. The hourly reports (which also included any special observations) were in the form of an official meteorological aerodrome report (METAR). At the time of the accident, the hourly issued METAR observations at PVC were:

At 1456, wind was 200° at 5 knots, visibility 4 miles, moderate rain, mist, ceiling broken clouds at 200 ft, overcast clouds at 600 ft, temperature 21° C, dewpoint 21° C, and an altimeter setting of 29.79 in Hg. The hourly precipitation at that time was reported as 0.27 inches.

At 1537, a special observation was issued and reported wind from 210° at 10 knots, visibility 3 miles, heavy rain, mist, few clouds at 200 ft, ceiling broken at 3,400 ft, overcast clouds at 5,000 ft, temperature 21° C, dewpoint 21° C, and an altimeter setting of 29.79 in Hg.

The continuous AWOS information, updated once a minute, which included wind speed and direction, cloud cover, temperature, precipitation, and visibility, could only be accessed by a pilot via VHF radio. An FAA technician was able to retrieve some of the AWOS data immediately after the accident, including wind speed and direction.

Cape Air requires pilots to check the arrival airport's weather/AWOS twice before starting an instrument approach per their Cessna 402 Normal Procedures Handbook, Section 3.11 – Instrument Approach. The procedure was to check weather (AWOS) once before setting up for the approach and then "recheck it again prior to crossing the FAF to assure regulatory compliance." The pilot said he checked the weather "at least twice" but did not recall when he checked it. Since the pilot was monitoring the AWOS via VHF radio, there was no way to determine which observation he obtained.

However, a review of the wind data between 1504 and 1511, the time the airplane departed and when the pilot informed ATC that he had the weather at PVC, revealed the tailwind components ranged between 1 and 4 knots respectively.

Between 1513 and 1524, the times the airplane was cleared for the approach and reached the FAF, the tailwind components ranged between 1 and 7 knots respectively.

Between 1524 through 1527, when the airplane was crossing over the FAF and landed, the wind speeds increased, and the tailwind component ranged from 6 to 11 knots in heavy rain.

AIRPORT INFORMATION

PVC is a noncontrolled, publicly owned commercial service airport with an elevation of about 8 ft above sea level. PVC has a single runway, 7/25, which is 3,502 ft long by 100 ft wide and is constructed of asphalt.

Runway 7 was equipped with high-intensity runway lights along the edges, a medium intensity approach lighting system with sequenced flashers, and a 4-light precision approach path indicator (PAPI) system.

Scheduled passenger operations at PVC include airplanes that do not exceed nine passenger seats. Therefore, the airport was not required to provide aircraft rescue and firefighting services as outlined in 14 *CFR* Part 139.

WRECKAGE AND IMPACT INFORMATION

An on-scene examination of the wreckage revealed the airplane collided with a cluster of about 20-foot-tall pine trees that bordered the airport's perimeter fence, about 660 ft from the end of the runway. The airplane traveled through this cluster of trees, crossed a two-lane road, impacted the ground and more trees on an approximate heading of 068°, before coming to rest upright in a nose low/tail high attitude on an approximate heading of 300°. All major components of the airplane were accounted for at the accident site. A postimpact fire consumed most of the left wing and a portion of the right wing.

From the point of initial impact with trees to where the airplane came to rest was about 200 ft. Numerous broken tree limbs were found along the wreckage path. Several of these limbs exhibited flat angular cuts, with black paint transfer marks, consistent with contact with a moving propeller blade. Also found along the wreckage path were portions of left- and right-wing structure and a landing gear door panel.

The airplane fuselage and the leading edges of the tail flight control surfaces sustained impact damage. The instrument panel and window on the co-pilot's side was pushed aft into the cockpit area due to impact with a tree, which was still partially embedded in the impact area. A concentrated area of fire damage was observed to the external fuselage below the co-pilot's side window.

Examination of the airframe revealed flight control continuity to all major flight control surfaces. The flap indicator in the cockpit indicated 0°, and the flap handle was displaced toward the 15° down position. Examination and measurement of the chains that move the flaps up and down revealed that the right flap was in the fully retracted position. The chain for the left flap was impact damaged and could not be measured.

The landing gear were down at the time of impact. The left main gear remained attached to its respective wing and sustained extensive fire damage; however, the brake did not appear to be worn. The right main gear separated from the airframe and was found under the right wing and protected from the fire. The brake did not appear to be worn. Examination of the right main landing gear tire revealed two oval-shaped areas of melted rubber. The tread depth was measured, and photos were sent to the National Transportation Safety Board's (NTSB) Materials Laboratory for analysis. Examination of the tire marks were consistent with multiple skid events.

The left and right engines were located with the main wreckage and sustained impact and fire damage.

Examination of both engines and the airplane revealed no mechanical deficiencies that would have precluded normal operation at the time of impact.

SURVIVAL ASPECTS

The pilot and all six passengers sustained extensive burns, and some had soft tissue damage and bone fractures. All seven exited the airplane from the top opening of the main cabin (clamshell-style) door, located in the rear cabin area on the left side of the passenger compartment adjacent to row 4. After the pilot and passengers exited, they each had to jump/fall about 9.5 ft to the ground due to the nose down/high-tail position of the airplane.

All six passengers reported that the pilot did not provide "any" safety briefing before takeoff and were confused after the accident on how to exit the burning airplane. The passenger seated in 2B, where the emergency exit window was located, said she punched the window to try and open it. She then read the passenger briefing card and learned how to open the

window. Another passenger said he tried to open the main cabin door, but it would not open. He then kicked the door and the top half of the door opened. A third passenger said her seat broke during the impact with trees, and she was unable to unclasp her lap belt, which delayed her exiting the airplane.

The pilot stated that he gave a passenger safety briefing. The briefing included making sure the passengers knew they were going to Provincetown; what the weather was going to be, and to expect a smooth flight. He stated he also instructed the passengers on how to use the seatbelts, directed them to where the emergency exits were located, how to find the passenger life vests and to review the passenger briefing card.

An NTSB Survival Factors Specialist examined the airplane, along with the seats and restraints. The examination revealed that the airplane was equipped with two doors and an emergency exit window. The pilot's door (crew door) located in the cockpit on the left side of the airplane, was found partially separated from the airframe and remained attached via the upper forward hinge. The window sustained extensive heat damage and was breeched and curled inward. The pilot said the door broke from impact and fire was coming in through the door. He tried to block the fire by holding the door up, but it was too intense, and his hands got badly burned along with the left side of his arms and face. This forced him to exit through the main cabin door. The crew door could not be tested due to impact and fire damage.

The emergency exit (passenger window) located in the forward cabin area on the right side of the passenger compartment (seat 2B) was found open. The passenger, who was seated in 2B, said that she was able to open the window, but when she put her hands on the frame of the window to get out, her fingers were immediately burned. She turned around and exited out the main door.

The main door was a two-section, outward opening, airstair door. The lower section folded down when open to provide two steps for ease in boarding and deplaning passengers, while the top portion folded up when open. The top portion of the door was found open at the accident site. The lower portion was found up and latched at the accident site. The door handle was manually tested by investigators, and the lower portion of the door folded out normally. An approximate 5-inch diameter tree limb was observed laying diagonally adjacent to the bottom hinge area of the door. If the lower door had been opened, the tree limb would have prevented the door from being able to fold down to its completely open position.

All the passenger seats remained attached to their respective seat rails which were fastened to the floor. The only seat that exhibited any structural damage was seat 2A, which the passenger in that seat said had "twisted" when the airplane impacted the trees. The seatback was rotated forward and had visible damage along the back seat pan/seatback junction. The seat covering was a single sewn piece that went over the seat and was glued to the bottom of the pedestal base, which was anchored to the floor. 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. The seat's lap belt wrapped around the back of the seat back, so the passenger would have been held to the broken seat by the lap belt.

The passenger said the lap belt's clasp was "jammed" and she tried to lay down to see if she could get out of the belt. She screamed for help, and the pilot, who was just about to exit, went back and released the lap belt. He then assisted her out of the airplane via the main door before he exited. The lap belt was found unclasped at the accident site but functioned normally when manually tested. All the other seat restraints were still attached to their seats/structure. Each of the restraints were manually tested and all functioned normally.

Passenger safety briefing cards were found in some of the seat back pockets and throughout the cabin area. The cards contained instructions in graphical form on both sides and included information on how to use both exit doors and the emergency exit.

Examination of the emergency exit (passenger window), main cabin door, seats and restraints revealed no mechanical deficiencies that would have precluded normal function/operation at the time of the accident.

TESTS AND RESEARCH

An NTSB airplane performance engineer conducted a performance study which examined the performance of the airplane on final approach, through its landing and deceleration on runway 7, and its attempted takeoff/go-around. Since the airplane was not equipped with a CVR or FDR, the control inputs, engine power, speed, and acceleration of the airplane throughout the entire approach, landing, and go-around could not be determined with precision. In addition, the lack of FDR data, and the unknown lift characteristics of the airplane at flaps 45° in ground effect, precluded a computation of the wheel braking friction coefficient achieved on the wet runway during the landing, and a comparison of the friction achieved with the friction levels achieved in other wet-runway landing accidents investigated by the NTSB.

However, the airplane's altitude, position, and speed during the approach to runway 7 could be computed from ADS-B data. Furthermore, the NTSB conducted a video study utilizing the images recorded on the three airport surveillance cameras, which captured the airplane's landing, landing roll, and go-around. Data from the videos was used to determine the airplane's position and speed on portions of the runway, as well as the time elapsed between the touchdown and the impact with the trees. This information, together with airplane performance data published in the Cessna 402C Pilot's Operating Handbook & Airplane Flight Manual (POH/AFM) and additional performance information provided by the airplane manufacturer was used to evaluate the distance required to stop on the runway and the climb capability of the airplane during the go-around. The study also referenced Cape Air's General Operations Manual (GOM).

The performance study revealed that at 1525:40, the airplane was centered on the localizer for the ILS approach as it descended through 1,100 ft msl. The airplane was slightly above the ILS glideslope centerline, at an airspeed of 129 knots calibrated airspeed (KCAS) descending at

about 760 ft/min and decelerating at about 1 knot every 10 seconds. At 1526:15, at about 660 ft msl, the deceleration increased to about 6 knots every 10 seconds. At about the same time, the airplane started to deviate further above the ILS glideslope centerline and at 600 ft msl exceeded the ILS glideslope 1-dot “fly down” beam.

At 1526:38, the sink rate briefly exceeded 1,000 ft/min as the airplane descended through 400 ft msl. The pilot stated he did not break out of the clouds until 500 ft msl, but the operator stated that the glideslope exceedance at 1526:15 might have been the result of the “ballooning” effect of extending the flaps to 45° after breaking out of the clouds closer to 600 ft msl (the pilot reported extending the flaps to 20°-25° at 1,000 ft msl, and then to 45° when the airplane was 300 ft msl). If the cloud base was at 500 ft msl (as reported by the pilot), then the airplane was below 1,000 ft msl and still in instrument meteorological conditions (IMC) when the glideslope exceedance occurred. Per the GOM, this should have triggered “an immediate go-around” due to the approach not being stabilized. If the cloud base was closer to 600 ft msl, the airplane could have been below the cloud base and in visual meteorological conditions (VMC) when the exceedance occurred, in which case a go-around would not have been required per the GOM. However, the GOM would still have required a go-around when the sink rate exceeded 1,000 ft/min at 400 ft msl.

At 1527:00, the airplane was 50 ft above the runway surface. At that time, the airplane’s calibrated airspeed (with an 11-knot tailwind component) was 107 KCAS. Per the POH/AFM, at the airplane’s planned landing weight of 6,215 lbs., the airplane’s calibrated airspeed at 50 ft above the runway should have been 89 knots. Hence, the airspeed was about 18 knots higher than that assumed in the landing distance tables in the POH/AFM.

Per the landing performance charts in the airplane’s POH/AFM, the required landing distance at the 5-knot tailwind component limit allowed by Cape Air (and at the nominal airspeed at 50 ft assumed in the POH/AFM) would have been about 2,628 ft. With an 11-knot tailwind, the required landing distance, without any adjustment for wet runway conditions, would have been about 3,015 ft. However, the reduction in braking friction resulting from a wet runway increased the required landing distance significantly. According to the video study, the estimated deceleration rate of the airplane as it was moving past the midpoint of the runway was constant at 0.16 g. The video study estimated that if the airplane continued decelerating along the runway at a rate of 0.16 g, it would have stopped somewhere between 66 ft before the end of the runway and 88 ft past the end of the runway (in an open field).

The airplane was on the runway for about 21 seconds before it became airborne and began to climb/accelerate at 5.0 ft/s2. The airplane’s calculated climb performance with this rate of acceleration revealed that it was unlikely that it could have simultaneously climbed out of ground effect and accelerated continuously at this rate. The airplane could have achieved a higher climb angle and likely cleared the trees if it had maintained a constant airspeed after liftoff, instead of accelerating, even though the liftoff airspeed was below the airplane’s best angle of climb speed (Vx). However, it is understandable that a pilot would first want to

accelerate to Vx before climbing to clear obstacles. Unfortunately, in this case there was insufficient space to clear the trees by first accelerating to Vx before climbing.

Given the outcome of the attempted takeoff, the performance data determined that the better option for the pilot would have been to accept an overrun into the open area beyond the end of runway 7.

ADDITIONAL DATA

The accident flight was conducted under the provisions of Part 135. However, since the Cessna 402C is a small, normal category airplane with reciprocating engines and fewer than 10 passenger seats, the corresponding regulation regarding the runway lengths required at a destination airport was §91.103, "Preflight Action". The rule states that, "Each pilot in command shall, before beginning a flight, become familiar with all available information concerning that flight. This information must include:

(a) …

(b) For any flight, runway lengths at airports of intended use, and the following takeoff and landing distance information:

(1) For civil aircraft for which an approved Airplane or Rotorcraft Flight Manual containing takeoff and landing distance data is required, the takeoff and landing distance data contained therein; …

The regulation only specifies that the pilot in command shall "become familiar" with the available runway lengths and AFM takeoff and landing distances requirements, but no safety factor on the available length is specified.

Section 2.14.2 of Cape Air's GOM ("Preparation and Planning") states that, "Before each flight, the pilot shall become familiar with all available information concerning that flight. For all flights, this includes, but is not limited to: Runway lengths, and takeoff and landing distances.

This content reflects the same language of 14 *CFR* §91.103. The GOM does not provide any additional guidance or instructions for adjusting the POH/AFM landing distances to account for non-dry runway conditions. To address non-dry runway conditions, Cape Air provides pilots with training regarding "Adverse Weather Practices", which includes a module on "Operations from Contaminated Runways." This module notes that:

• Normal landing distance calculations for the Cessna 402C are predicated on Level, Hard Surface Runway and do not account for contamination.

• The FAA recommends pilots follow the recommendations of Safety Alert for Operators (SAFO) 19001, Landing Performance Assessments at Time of Arrival, for operating on wet or contaminated runways.

• The SAFO recommends adding a safety margin of at least 15% be added to the actual airplane landing distance.

Although the SAFO intends that the 15% safety margin be added to the required landing distance computed considering the actual arrival conditions (including the friction reduction associated with a wet runway), Cape Air reported that a 15% safety margin applied to the dry-runway landing distances to account for reduced performance on wet runways has been sufficient for their operations.

Based on the POH/AFM dry runway landing performance data previously discussed, with the 15% safety margin added to account for a wet runway, the runway required landing distance would have been about 3,022 ft with a 5 kt tailwind, and about 3,467 ft with the 11 kt tailwind.

A passenger provided two photos that he took when the airplane was on final approach. Both photos were taken near the back of the airplane looking forward and the runway is clearly visible through the windshield. In the first photo, the runway's precision approach path indicator (PAPI) system is visible on the right side of the runway. The PAPI shows four white lights, indicating the aircraft was above the glidepath for the runway.

The Performance Study indicates that between approximately 600 and 300 ft msl, the airplane was above the ILS 1-dot "fly down" glideslope deviation beam. This beam is approximately 0.33° above the glideslope centerline. The PAPI will present four white lights when the airplane is about 0.5° above the (PAPI) glideslope centerline; consequently, the photograph depicting four white lights (and VMC conditions) must have been taken when the airplane's altitude was below 600 ft msl and above 300 ft msl.

In the second photo, the PAPI shows two white lights, and the other two lights are obscured by the center of the windscreen. It could not be determined if the airplane was either at or above the glidepath for the runway. A review of the metadata in the phone revealed that it was not set up to capture altitude and the time setting was not accurate, so it was not possible to determine at what time or what altitude the photos were taken. Both photos also revealed manifold pressure for both engines indicated around 17 inHg, and the rpm for both propellers indicated around 2,400 rpm. Visible engine instruments appeared to have nominal values. The resolution of the image did not provide enough clarity to resolve the settings on the Garmin GPS navigation device.

Pilot Information

Certificate:	Airline transport; Commercial	**Age:**	51,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	3-point
Instrument Rating(s):	Airplane	**Second Pilot Present:**	No
Instructor Rating(s):	Airplane multi-engine; Airplane single-engine; Instrument airplane	**Toxicology Performed:**	Yes
Medical Certification:	Class 1 With waivers/limitations	**Last FAA Medical Exam:**	April 2, 2021
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	June 10, 2021
Flight Time:	17617 hours (Total, all aircraft), 10000 hours (Total, this make and model), 12000 hours (Pilot In Command, all aircraft), 294 hours (Last 90 days, all aircraft), 124 hours (Last 30 days, all aircraft), 4 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Cessna	**Registration:**	N88833
Model/Series:	402C	**Aircraft Category:**	Airplane
Year of Manufacture:	1980	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	402C0265
Landing Gear Type:	Retractable - Tricycle	**Seats:**	10
Date/Type of Last Inspection:	August 26, 2021 Continuous airworthiness	**Certified Max Gross Wt.:**	7210 lbs
Time Since Last Inspection:		**Engines:**	2 Reciprocating
Airframe Total Time:	36722 Hrs as of last inspection	**Engine Manufacturer:**	Continental
ELT:	C126 installed, not activated	**Engine Model/Series:**	IO-520-VB
Registered Owner:	HYANNIS AIR SERVICE INC	**Rated Power:**	325
Operator:	Cape Air	**Operating Certificate(s) Held:**	On-demand air taxi (135), Fractional ownership
Operator Does Business As:		**Operator Designator Code:**	HYIA

Meteorological Information and Flight Plan

Conditions at Accident Site:	Instrument (IMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	PVC,8 ft msl	**Distance from Accident Site:**	0 Nautical Miles
Observation Time:	15:37 Local	**Direction from Accident Site:**	240°
Lowest Cloud Condition:	200 ft AGL	**Visibility**	4 miles
Lowest Ceiling:	Broken	**Visibility (RVR):**	
Wind Speed/Gusts:	5 knots / None	**Turbulence Type Forecast/Actual:**	None / None
Wind Direction:	200°	**Turbulence Severity Forecast/Actual:**	N/A / N/A
Altimeter Setting:	29.79 inches Hg	**Temperature/Dew Point:**	21°C / 21°C
Precipitation and Obscuration:	In the vicinity - None - Mist		
Departure Point:	Boston, MA (BOS)	**Type of Flight Plan Filed:**	IFR
Destination:	Provincetown, MA	**Type of Clearance:**	IFR
Departure Time:	15:04 Local	**Type of Airspace:**	Class G

Airport Information

Airport:	PROVINCETOWN MUNI PVC	**Runway Surface Type:**	Asphalt
Airport Elevation:	7 ft msl	**Runway Surface Condition:**	Wet
Runway Used:	07/25	**IFR Approach:**	ILS
Runway Length/Width:	3502 ft / 100 ft	**VFR Approach/Landing:**	Full stop

Wreckage and Impact Information

Crew Injuries:	1 Serious	**Aircraft Damage:**	Substantial
Passenger Injuries:	6 Serious	**Aircraft Fire:**	On-ground
Ground Injuries:	N/A	**Aircraft Explosion:**	On-ground
Total Injuries:	7 Serious	**Latitude, Longitude:**	42.075993,-70.211744

Administrative Information

Investigator In Charge (IIC):	Read, Leah
Additional Participating Persons:	David Cardullo; FAA/FSDO; Boston , MA Ricard Arsensio; Textron Aviation ; Wichita Nick Keopple; CapeAir; Hyannis, MA
Original Publish Date:	August 15, 2023
Last Revision Date:	
Investigation Class:	Class 3
Note:	
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=103831