Aviation Investigation Final Report

Location:	Gary, Indiana	**Accident Number:**	CEN16LA076
Date & Time:	December 30, 2015, 09:00 Local	**Registration:**	N999VB
Aircraft:	Beech 200	**Aircraft Damage:**	Substantial
Defining Event:	Hard landing	**Injuries:**	9 None
Flight Conducted Under:	Part 135: Air taxi & commuter - Non-scheduled		

Analysis

The Part 135 passenger flight was cleared for an instrument landing system (ILS) approach to the destination airport in marginal VFR conditions. Radar data showed the airplane intercept the final approach course, cross over the course, then re-intercept it several times as the airplane approached the airport. Throughout the approach, the airplane flew level at an altitude about 2,300 ft above ground level (agl) until about 2 miles from the runway threshold, when it began to descend. The airplane crossed the runway threshold about 650 ft agl and subsequently landed hard on the runway, resulting in substantial damage. The pilot stated that the hard landing was the result of an aerodynamic stall at a higher airspeed than normal due to ice accumulation on the wings. Two line workers observed ice on the leading edges of both wings after the airplane landed.

The operator's training manual stated that an approach that becomes unstabilized below 1,000 ft above airport elevation in instrument meteorological conditions or 500 ft above airport elevation in visual conditions required an immediate missed approach or go-around.

Icing conditions were widespread along the airplane's route of flight. These conditions had been forecast, and numerous pilot reports confirmed the presence of icing in the area. The extent to which the pilot had familiarized himself with the current and forecast weather conditions before the flight could not be determined. Although the airplane was approved for flight in icing conditions and equipped with deicing boots, the investigation could not determine if or when the pilot cycled the boots. The manufacturer's flight manual warned that, even after cycling the boots, ice accumulation could remain on protected and unprotected surfaces, resulting in significant increases in stall speed. The manual also advised that ice could affect the aural stall warning system, and that pilots should maintain a "comfortable margin" of airspeed above normal stall speed. The aggressive flare that was likely required to arrest the airplane's high rate of descent on final approach, combined with the airplane's higher stall speed due to ice accumulation, likely resulted in an aerodynamic stall and subsequent hard landing.

Probable Cause and Findings

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

The pilot's failure to maintain the glidepath and appropriate airspeed during landing in icing conditions, which resulted in an aerodynamic stall and a hard landing.

Findings

Environmental issues	Conducive to structural icing - Effect on equipment
Personnel issues	Decision making/judgment - Pilot
Personnel issues	Use of equip/system - Pilot
Aircraft	Descent/approach/glide path - Not attained/maintained

Factual Information

History of Flight

Approach-IFR final approach	Structural icing
Approach-IFR final approach	Course deviation
Approach-IFR final approach	Altitude deviation
Landing	Hard landing (Defining event)

On December 30, 2015 about 0900, central standard time, a Beech 200, airplane, N999VB, had a hard landing at the Gary/Chicago International Airport (GYY), near Gary, Indiana. The pilot and eight passengers were uninjured. The airplane sustained substantial damage during the hard landing. The airplane was registered to and operated by Cobb Aviation Services Inc. as a 14 Code of Federal Regulations (CFR) Part 135 non-scheduled domestic passenger flight. Visual meteorological conditions prevailed about the time of the accident, and the flight was operating on an instrument flight rules (IFR) flight plan. The flight originated from the Abraham Lincoln Capital Airport (SPI), near Springfield, Illinois, about 0800, and was destined for GYY.

Witnesses at on the ramp at SPI did not see anything unusual in reference to the airplane and pilot when the passengers boarded the airplane.

The pilot indicated that the airplane encountered structural icing conditions while enroute to GYY. He reported that during the landing, the airplane stalled at a higher airspeed "due to ice accumulation" and that there was no mechanical malfunction. The airplane subsequently landed hard.

Witnesses on the ramp at GYY observed that the airplane sustained a hard landing. One witness observed that fluid was leaking from the left side of the airplane near its wheels. Additionally, he noted that there was ice on the leading edge of both wings.

Pilot Information

Certificate:	Airline transport; Flight instructor	**Age:**	68,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:**	No
Medical Certification:	Class 2 With waivers/limitations	**Last FAA Medical Exam:**	June 26, 2015
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	November 23, 2015
Flight Time:	29388 hours (Total, all aircraft), 8759 hours (Total, this make and model), 28604 hours (Pilot In Command, all aircraft), 93 hours (Last 90 days, all aircraft)		

The pilot held a Federal Aviation Administration (FAA) airline transport pilot certificate with ratings for airplane single-engine and multiengine land, and instrument-airplane. The pilot also held a second-class medical certificate that was issued on June 26, 2015, with limitations that he must wear corrective lenses for near and distant vision. The pilot reported that he had accumulated 29,388 hours of total flight time of which 8,759 hours were in the same make and model as the accident airplane. He reported that his last flight review was conducted on November 23, 2015. The pilot reported that he attended a King Air recurrent training course. Additionally, the operator had a 14 CFR Part 135 Training Program. According to the operator's training material, pilots are taught stabilized approaches are to be flown prior to landing. The training material, in part, stated:

STABILIZED APPROACH
This training program uses the stabilized approach concept. All approach profiles (VMC/IMC) listed in this chapter are based upon achieving a stabilized approach, as depicted in the Flight Safety Foundation Approach-and-Landing Accident Reduction (ALAR) Tool Kit, Section 7.1. All flights must be stabilized by 1,000 [feet] above the airport elevation in instrument meteorological conditions (IMC) and by 500 [feet] above the airport elevation in visual meteorological conditions (VMC). An approach is stabilized when all of the following criteria are met:
1. The aircraft is on the correct flight path;
2. Only small changes in heading/pitch are required to maintain the correct flight path;
3. The aircraft speed is not more than V REF + 10 KT indicated airspeed and not less than V REF;
4. The aircraft is in the correct landing configuration;
5. Sink rate is no greater than 1,000 [feet] per minute; if an approach requires a sink rate greater than 1,000 [feet] per minute, a special briefing should be conducted;
6. Power setting is appropriate for the aircraft configuration and is not below the minimum power for approach as defined by the aircraft

operating manual;
7. All briefings and checklists have been conducted;
8. Specific types of approaches are stabilized if they also fulfill the following:
a. Instrument landing system (ILS) approaches must be flown within one dot of the glideslope and localizer
b. During a circling approach, wings should be level on final when the aircraft reaches 300 [feet] above airport elevation;
9. Unique approach procedures or abnormal conditions requiring a deviation from the above elements of a stabilized approach require a special briefing.

An approach that becomes unstabilized below 1,000 [feet] above airport elevation in IMC or 500 [feet] above airport elevation in VMC requires an immediate missed approach or go-around.

The operator had published a Winter Operations Manual. The manual, in part, stated:

WINTER WEATHER FACTORS
ICING
Icing is a major weather problem. It is difficult to forecast and its intensity can vary considerably. Rates of ice accumulation vary widely, from less than 1/2 [inch] per hour to as high as one inch per minute. Experiments have shown that ice accumulation of 1/2 inch on some airfoils will reduce lift by as much as 50 [percent], increase drag by an equal amount, and greatly increase stalling speed. There are only two requirements for ice formation on aircraft:
1. Temperature 0 Celsius or less
2. Visible moisture

Water droplets below 0 Celsius are called "supercooled" water droplets, and have been found as low as -19 Celsius. Supercooled water increases the rate of icing and is essential to rapid accretion. Supercooled water is in an unstable liquid state; when an aircraft strikes a supercooled drop, part of the drop freezes instantaneously. The latent heat of fusion released by the freezing portion raises the temperature of the remaining portion to the melting point. Aerodynamic effects may cause the remaining portion to freeze. The way in which the remaining portion freezes determines the type of icing. The types of structural icing are clear, rime, and a mixture of the two. Each type has its identifying features. The heaviest icing will occur between 0 and -10 Celsius. ...

APPROACH AND LANDING
When there is risk of ice accretion, proper use of the anti-icing systems must be observed. If they are left OFF inadvertently or they malfunction,

the resultant accumulation of ice will increase stall speeds. Therefore, the safety margin between stalling speed and approach and landing reference speeds will be reduced. It should be remembered that speed adjustments made in recognition of this effect will correspondingly increase landing distance. ...

PERFORMANCE CALCULATIONS
It is imperative that each flight crewmember be completely familiar with all performance considerations for their specific aircraft type and weigh these carefully in their planning. All performance charts and calculations should be consulted and completed fully and accurately. They should then be applied to all applicable operations.

Aircraft and Owner/Operator Information

Aircraft Make:	Beech	**Registration:**	N999VB
Model/Series:	200 UNDESIGNAT	**Aircraft Category:**	Airplane
Year of Manufacture:	1980	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	BB-645
Landing Gear Type:	Retractable - Tricycle	**Seats:**	11
Date/Type of Last Inspection:	November 19, 2015 Annual	**Certified Max Gross Wt.:**	12500 lbs
Time Since Last Inspection:		**Engines:**	2 Turbo prop
Airframe Total Time:	6589 Hrs at time of accident	**Engine Manufacturer:**	P&W CANADA
ELT:	C126 installed, not activated	**Engine Model/Series:**	PT6A-42
Registered Owner:	COBB AVIATION SERVICES INC	**Rated Power:**	850 Horsepower
Operator:	COBB AVIATION SERVICES INCORPORATED	**Operating Certificate(s) Held:**	On-demand air taxi (135)
Operator Does Business As:		**Operator Designator Code:**	BOOA

N999VB was a 1980 model Beech Super King Air 200, all-metal, low-wing, twin-turboprop monoplane with serial number BB-645. The airplane's design incorporates fully cantilevered wings and a T-tail empennage. The airplane was approved for operations in known icing conditions. However, a warning in the airplane flight manual, in part, stated:

Due to distortion of the wing airfoil, ice accumulations on the leading edges can cause a significant loss in rate of climb and in speed performance, as well as increases in stall speed. Even after cycling deicing boots, the ice accumulation remaining on the boots and unprotected areas of the airplane can cause large performance losses. For the same reason, the aural stall warning system may not be accurate and should not be relied upon. Maintain a comfortable margin

of airspeed above the normal stall airspeed. In order to minimize ice accumulation on unprotected surfaces of the wing; maintain a minimum of 140 knots during operations in sustained icing conditions. In the event of windshield icing, reduce airspeed to 226 knots or below. Prior to a landing approach, cycle the deicing boots to shed any accumulated ice.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	KGYY,591 ft msl	**Distance from Accident Site:**	0 Nautical Miles
Observation Time:	08:45 Local	**Direction from Accident Site:**	263°
Lowest Cloud Condition:		**Visibility**	10 miles
Lowest Ceiling:	Overcast / 1300 ft AGL	**Visibility (RVR):**	
Wind Speed/Gusts:	7 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	250°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30.2 inches Hg	**Temperature/Dew Point:**	0°C / -4°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	SPRINGFIELD, IL (SPI)	**Type of Flight Plan Filed:**	IFR
Destination:	GARY, IN (GYY)	**Type of Clearance:**	IFR
Departure Time:	08:00 Local	**Type of Airspace:**	

A National Transportation Safety Board's (NTSB) meteorologist gathered weather data from multiple sources and produced a Group Chairman's Weather Study Report. His report, in part, stated that the National Weather Service (NWS) Surface Analysis Chart for 0900 depicted a cold front stretching from southern Minnesota eastward into central Michigan. A surface low-pressure center with a pressure of 1020-hectopascals (hPa) was located in northwestern Lower Michigan with a stationary front stretching eastward from the low pressure center into southern Canada. The station models around the accident site depicted air temperatures in the low 30's to mid 20's Fahrenheit (F), with temperature-dew point spreads of 5 degrees F or less, a west to southwest wind between 5 and 10 knots, cloudy skies, light snow reported to the west of the accident site, and freezing rain reported to the northeast of the accident site.

The NWS Storm Prediction Center Constant Pressure Charts for 0600, in part, depicted low-level troughs to the west-southwest of the accident site around the accident time with temperatures below freezing. It showed that the entire atmosphere from the surface through about 30,000 feet above mean sea level (msl) was below freezing indicating that any precipitation that would fall would likely be in the form of snow.

At 0845, the recorded weather at GYY was: Wind 250 degrees at 7 knots, visibility 10 miles, overcast clouds at 1,300 feet, temperature 0 degrees C, dew point -4 degrees C, and altimeter setting 30.20 inches of mercury. Additionally, observations from GYY and from an airport near GYY indicated that marginal VFR conditions, which are ceilings between 1,000 and 3,000 feet above ground level (agl) and visibility between 3 to 5 miles, were present around accident airport subsequent to the accident flight.

The 0600 sounding taken at Lincoln, Illinois, indicated a moist vertical environment from the surface through 5,500 feet msl, then a dry layer between 5,500 and 7,000 feet, then relatively moist conditions again from 7,000 feet through 14,000 feet. The sounding indicated icing (clear, rime, and mixed) between 2,000 and 4,000 feet msl and between 8,000 feet and 12,000 feet msl. The sounding was also close to saturation between -4° C and -11° C (between 2,000 and 5,500 feet msl and between 8,000 and 12,000 feet msl) which is considered a temperature range supportive of the growth of super cooled liquid water droplets.

The Geostationary Operational Environmental Satellite-13 visible imagery from 0830 and 0845 indicated a general west to east movement of the clouds over the accident site at the accident time with cloud cover between SPI and the accident site. The imagery indicated a general uniform cloud top height near the accident site at the accident time, with the highest cloud tops located across Wisconsin. At 0845, the approximate cloud-top heights over the accident site were 14,000 feet.

Weather surveillance radar charts depicted that the accident flight flew through base reflectivity values correspond to very light to light precipitation returns. There were no recorded lightning strikes near the accident site at the accident time.

Dual-Polarization weather radar data depicted conditions consistent with the accident airplane encountering hydrometeors (precipitation) having a larger surface area in the horizontal dimension rather than the vertical dimension. The hydrometeors were shaped more like pancakes, rather than spherical or tear dropped shaped as the hydrometeors fell. The hydrometeors had characteristics are similar to the freezing drizzle and supercooled liquid water. The data depicted that accident airplane encounter icing conditions on descent into the destination airport and the worst of the icing conditions were likely between 4,590 feet and 7,550 feet msl.

There was a record of multiple pilot reports (PIREPs) before and after the accident that indicated the presence of icing in clouds. However, there is no record of a report from the pilot of the accident airplane indicating the ice that the airplane had accumulated during accident flight.

No Significant Meteorological Information advisory was valid for the accident site at the accident time. No Center Weather Service Unit Advisory or Meteorological Impact Statement were valid for the accident site at the accident time.

Airmen's Meteorological Information (AIRMET) Zulu, Tango, and Sierra, issued at 0245 and valid at the accident time, were the AIRMETs valid for the accident site at the accident time. In addition, these AIRMETs were valid for the entire accident flight track. AIRMET Zulu forecasted moderate icing conditions below 16,000 feet, AIRMET Tango forecasted moderate turbulence between 15,000 feet and Flight Level 350, and AIRMET Sierra forecasted IFR conditions for ceilings below 1,000 feet and/or visibilities below 3 miles due to precipitation and mist

The Area Forecast, issued at 0445 and valid at the accident time, forecasted an overcast ceiling at 2,500 feet msl with tops to 12,000 feet. Scattered light snow showers were not forecast until 1000.

The GYY terminal forecast expected a wind from 250 degrees at 4 knots, 3 miles visibility, light snow,

and an overcast ceiling at 1,200 feet agl around the time of the accident.

The investigation could not verify a preflight briefing for the accident flight. The accident pilot could have reviewed weather information via a kiosk without the weather information reviewed being archived.

Current Icing Potential (CIP) and Forecast Icing Potential (FIP) advisories indicated that the Supercooled Large Droplet (SLD) values were either zero or very low at both 0800 and 0900, at all flight levels below 10,000 feet msl near the accident site. FIP indicated a greater than 50 percent probability of icing at 2,000 feet at 0900 at the accident site with decreasing probabilities by 4,000 feet msl to 40 percent and below. Probabilities remained below 40 percent between 4,000 and 8,000 feet msl and this was likely due to the drier air there as indicated by the Lincoln, Illinois, sounding. Probabilities increase back up to near 40 percent and above for the accident site area by 8,000 feet msl. The most severe icing conditions of moderate were located in the accident site area at and below 2,000 feet msl and above 8,000 feet msl according to the 2-hour FIP forecast for 0900. Similar values are seen in the 1-hour FIP forecast for both 0800 and 0900. The CIP icing probabilities and icing severity values are very similar to the 1 and 2-hour FIP values for both 0800 and 0900 at all altitudes from the surface to 10,000 feet msl. However, CIP values of ice severity do remain a little higher at 4,000 feet msl and are the FIP values for the accident area. The weather radar information from a site near Romeoville, Illinois, does indicate moisture between 4,000 and 8,000 feet unlike the Lincoln, Illinois, sounding. Therefore, the icing conditions were likely worse than indicated by FIP and CIP along the accident flight track between 4,000 and 8,000 feet msl and the accident aircraft likely encountered areas of moderate or greater icing while in descent to the destination airport. The Group Chairman's Weather Study Report is appended to the docket associated with this investigation.

Airport Information

Airport:	GARY/CHICAGO INTL GYY	**Runway Surface Type:**	Asphalt
Airport Elevation:	596 ft msl	**Runway Surface Condition:**	Dry
Runway Used:	30	**IFR Approach:**	ILS
Runway Length/Width:	8859 ft / 150 ft	**VFR Approach/Landing:**	Full stop

GYY, located approximately three miles northwest of downtown Gary, Indiana, was a certificated airport under 14 CFR Part 139. The Gary/Chicago Airport Authority was listed as its owner. GYY's field elevation was 596 feet above mean sea level. The airport had air traffic control tower services between 0500 and 2200. The airport supported aircraft rescue and firefighting index B requirements and index C with four hours prior notice.

GYY had 2 runways: runway 12/30 - 8,859 feet by 150 feet, asphalt/grooved and runway 2/20 - 3,604 feet by 100 feet, asphalt.

Runway 30 was marked as a precision approach runway and had high intensity runway edge lights. It was serviced by a four-light precision approach path indicator installed on the left side of the runway. The runway's threshold was displaced 900 feet. It had MALSR (medium intensity approach lighting system with runway alignment indicator lights) approach lighting and centerline lighting.

Wreckage and Impact Information

Crew Injuries:	1 None	**Aircraft Damage:**	Substantial
Passenger Injuries:	8 None	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	9 None	**Latitude, Longitude:**	41.617221,-87.414443(est)

FAA inspectors examined the airplane and documented its damage. Review of images of the damage revealed wrinkles in the wing and fuselage skin. Damage included separated brake components that were recovered from the runway. Images of the airplane revealed that ice was present on the leading edges of the elevator and the left wing.

Communications

A transcript of GYY's radio communications in reference to N999VB, in part, stated:

N999VB PILOT: And, Gary Tower, 999VB is with the (inaudible).

GARY TOWER: Yes, 999VB, good morning, Gary Tower. The wind is 250 at 7 and the altimeter now 3020. Runway 30 clear to land. Bases reported at 2,000 MFL on a three-mile final by a cereus (phonetic) 15 minutes, go.

N999VB PILOT: 999VB, thank you. (Inaudible) localized air, we're going to come back on.

GARY TOWER: Yes, I noticed that. 999VB, will you be able to rejoin?

N999VB PILOT: Yes, I think so.

GARY TOWER: Roger, keep me advised.

CHICAGO APPROACH CONTROLLER: Gary, Approach.

GARY TOWER: Yes, the King Air says he's able to turn back to it.

CHICAGO APPROACH CONTROLLER: Okay, so he's got a base report and lights are on high.

GARY TOWER: Wind 240 at 7, King Air 999VB, advise when rejoining.

N999VB PILOT: We're rejoining right now, sir.

GARY TOWER: Roger. Lights are on high for you. King Air 999VB, I show you right of -- or left of course now.

N999VB PILOT: We're coming back.

GARY TOWER: Roger. Advise field in sight.

N999VB PILOT: 999VB, I have the field in sight.

GARY TOWER: King Air 999VB, roger. Clear to land, runway 30.

N999VB PILOT: Thank you.

GARY TOWER: King Air 999VB, if able, right turn off at Charlie followed by a right turn onto taxiway Alpha where you parked.

N999VB PILOT: Charlie, Alpha then (inaudible), where should we go?

GARY TOWER: I'm sorry, say again?

N999VB PILOT: CA parking, where should we go?

GARY TOWER: For general aviation, we've got two FPOs. The first will be off your left at Alpha 5 with the canopy that's B Coleman. Further down Alpha is the Gary Jet Center.

N999VB PILOT: Okay, we'll go to Gary Jet.

GARY TOWER: Roger. Taxi by Alpha down to Alpha 6 and the Jet Center, stay with me.

Tests and Research

An NTSB air traffic control specialist gathered radar data associated the accident flight and produced a graphic depiction. The graphic showed the airplane flew northwest bound through the localizer at 2,300 feet about 6.6 miles from the landing runway's threshold. The airplane was north and abeam of WASTU at 2,300 feet. The graphic showed that the airplane flew

westbound through the localizer and was at 2,300 feet about 2.03 miles from the runway threshold. The graphic showed that the airplane flew northwest bound through the localizer again and descended to 1,400 feet about .9 miles from the runway threshold. The graphic showed that the airplane was at 700 feet at the runway threshold. The air traffic control specialist's graphic depiction is appended to the docket associated with this investigation.

Additional Information

The FAA Instrument Procedures Handbook, in part, stated:

Many reasons exist for executing a missed approach. The primary reasons, of course, are that the required flight visibility prescribed in the IAP [instrument approach procedure] being used does not exist when natural vision is used under 14 CFR Part 91, section 91.175(c), the required enhanced flight visibility is less than that prescribed in the IAP when an EFVS [enhanced flight vision systems] is used under 14 CFR Part 91, section 91.175 (l), or the required visual references for the runway cannot be seen upon arrival at the DA [decision altitude], DH [decision height], or MAP [missed approach point]. In addition, according to 14 CFR Part 91, the aircraft must continuously be in a position from which a descent to a landing on the intended runway can be made at a normal rate of descent using normal maneuvers, and for operations conducted under Part 121 or 135, unless that descent rate allows touchdown to occur within the TDZ [touchdown zone] of the runway of intended landing.

Administrative Information

Investigator In Charge (IIC):	Malinowski, Edward
Additional Participating Persons:	Adama Allmond; Federal Aviation Administration; Springfield, IL Ernest Hall; Textron Aviation; Wichita, KS
Original Publish Date:	December 12, 2016
Last Revision Date:	
Investigation Class:	Class
Note:	The NTSB did not travel to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=92519