Aviation Investigation Final Report

Location:	Fort Thomas, Kentucky	**Accident Number:**	ERA12LA575
Date & Time:	September 22, 2012, 21:27 Local	**Registration:**	N735FJ
Aircraft:	Cessna 182Q	**Aircraft Damage:**	Substantial
Defining Event:	Loss of engine power (total)	**Injuries:**	2 Minor
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

According to the pilot, he performed preflight carburetor heat checks at the recently overhauled engine's run-up speed and at idle. He thought that the rpm drop was less than the drop before the engine was overhauled, yet he chose to make the flight. After takeoff, the pilot climbed the airplane to about 3,000 ft mean sea level, where he determined that the optional carburetor temperature gauge was inoperative. He subsequently applied carburetor heat in 5-minute intervals when he changed tanks, which he did twice at 20-minute intervals.

Noting precipitation in the area, the pilot decided to cut the flight short and return to the departure airport. He applied full carburetor heat before descending the airplane using the descent procedures checklist. About 9 nautical miles (nm) from the runway, with carburetor heat applied and the fuel tanks set to "both," he continued a slow descent with 10-degrees flaps. About 6 nm from the runway, the pilot felt a "power drop." The engine was still running, but the airplane was descending faster than anticipated. The pilot applied more throttle and felt a "slight boost," but the airplane continued to descend and subsequently impacted trees. During the descent, the pilot repeatedly checked the controls, "pulling them in and out to make sure they were not stuck," including the carburetor heat, throttle, prop pitch (fully in), and fuel mixture (full-rich).

No evidence of any preexisting mechanical anomalies that would have precluded normal operation was found. Although the pilot subsequently noted that he was concerned that a preexisting crimp in the scat tube leading from the heat manifold to the carburetor might have caused the engine to lose power, this scenario was unlikely due to the relative size of the crimp and the fact that the pilot did not note any engine anomalies when he applied carburetor heat during cruise flight with higher air flow requirements.

The temperature and dew point at the time of the accident were conducive to the accumulation of serious carburetor icing at glide power, and the make and model of airplane is known to be more susceptible than most airplanes to carburetor ice formation. In addition, although the pilot reported adding carburetor heat before initiating a long descent, he did not report adding engine power periodically to warm the engine during that descent; thus, it is likely that the carburetor heat manifold cooled to a point where the air being supplied to the carburetor was insufficiently heated to protect it from icing.

A review of Federal Aviation Administration, manufacturer, and advocacy group carburetor icing publications revealed disjointed and incomplete information. The lack of comprehensive, easily accessible carburetor icing information in a single location likely affects the overall pilot community's understanding of the subject and could have affected the pilot in particular.

Probable Cause and Findings

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

The pilot's failure to periodically add engine power during an extended descent in carburetor icing conditions, which resulted in insufficient carburetor heat, the gradual build-up of carburetor ice, and the subsequent loss of engine power.

Findings

Aircraft	Fuel control/carburetor - Related operating info
Aircraft	Intake anti-ice, deice - Incorrect use/operation
Personnel issues	Lack of action - Pilot
Personnel issues	Use of equip/system - Pilot
Environmental issues	Conducive to carburetor icing - Effect on equipment

Factual Information

History of Flight

Approach-VFR pattern final	Loss of engine power (total) (Defining event)
Emergency descent	Loss of engine power (total)
Emergency descent	Controlled flight into terr/obj (CFIT)

HISTORY OF FLIGHT

On September 22, 2012, at 2127 eastern daylight time, a Cessna 182Q, N735FJ, was substantially damaged when it impacted trees and terrain during a forced landing in Fort Thomas, Kentucky. The private pilot and the passenger sustained minor injuries. Night visual meteorological conditions prevailed, and a no flight plan had been filed for the local flight that originated at Cincinnati Municipal Airport-Lunken Field (LUK), Cincinnati, Ohio. The personal flight was conducted under the provisions of 14 Code of Federal Regulations Part 91.

According to the pilot, he arrived at LUK about 2000. "It was a beautiful ¼ moon-lit and starry evening…and although it had been windy mid-afternoon, it had calmed to 6-8 knots at 350 degrees and was to drop to calm winds later. It was the first really chilly evening since the installation of the overhauled engine, and it was also very humid."

The pilot performed a "complete" exterior and interior preflight inspection with a checklist, including oil, which was at 12 quarts, and 25 gallons of fuel in the left tank and 27 gallons in the right tank.

"Startup and pre-taxi procedures were followed exactly," and during subsequent engine checks (the engine had been overhauled about 3 hours earlier), the pilot confirmed proper operation of both magnetos, prop pitch (three times), and carburetor heat checks at both engine run-up speed and at idle.

The airplane subsequently took off from runway 3R about 2040, followed by a right turnout. At 500 feet above ground level, the pilot "pulled back the throttle until the manifold pressure was in the green," and continued the climb until 3,000 feet mean sea level, when he began cruise procedures via the checklist.

Shortly thereafter, as the pilot was scanning the instrument panel, he noticed that the "carburetor heat gauge" was not rising. He tapped the glass and it stayed to the left; then he noted that it as "NO OP" to tell his mechanic when he returned. He was concerned at that point since on mild days he had noticed that the carburetor heat needle would barely make it into the "green" when carburetor heat was applied, which he attributed to a difference in the old versus recently-overhauled engine. Nonetheless, after takeoff, he twice applied carburetor heat for 5-minute intervals whenever he changed tanks, which he was doing at 20-minute intervals.

The pilot also noticed on his onboard weather display that there was light rain falling to the northeast of LUK, so he cut the flight short. He asked the approach controller permission to descend from 3,000 feet to 2,500 feet in anticipation of returning to LUK on an extended right base to runway 3R. The approach controller advised him to descend at will, anticipate runway 3R, and to let the controller know when he had the airport in sight. The pilot acknowledged the instructions and applied full carburetor heat, descended using the descent procedures checklist, then started the pre-landing checklist. He informed the controller that he had the runway in sight and was handed off to the tower controller. About 9 nautical miles (nm) from the runway, with the carburetor heat applied, and the fuel tanks set to "Both," he began a slow descent at 10 degrees flaps.

About 6 nm from the runway, the pilot felt a "power drop." The engine was still running, but the airplane was descending faster than anticipated. The pilot applied more throttle and got a slight boost, but not enough, and the descent continued. The pilot called the tower and advised the controller that the engine was losing power. There were no suitable landing fields, only wooded hills. The airplane continued toward the runway, and the pilot "double and triple checked the controls, pulling them in and out to make sure they were not stuck, especially the carb heat, throttle, prop pitch (was full in) and mixture (also full in - rich)."

As the airplane descended toward trees, the pilot recalled the Hudson River tail-first landing, "which slowed the airplane and prevented diving in head first and flipping." He pulled back on the yoke and put the airplane "into a pronounced flair such that the stall warning came on, and still flared some more." The airplane then "hit the canopy more or less at a belly first attitude [about] 55 knots."

During a postflight interview with the NTSB phone duty investigator, the pilot confirmed that the carburetor temperature gauge indicator had been to the far left since the beginning of the flight, indicating severe carburetor icing, but that he thought there was a problem with the gauge and made a mental note to have his mechanic check it.

METEROLOGICAL INFORMATION

Weather, recorded at LUK at 2053, included calm winds, a temperature of 12 degrees C (54F), and a dew point of -1 degrees C (30F). Utilizing those ambient temperature/dew point conditions, the FAA chart titled "Conditions Favoring Carb Ice Formation" indicated the probability of serious carburetor icing at glide power. Temperature and dew point recorded at 2153 were the same as at 2053.

PERSONNEL INFORMATION

The pilot, age 67, held a private pilot certificate with a single engine land rating. He indicated 376 total flight hours with 116 hours in make and model. He also owned a Cessna 172.

AIRCRAFT INFORMATION

According to maintenance records, the airplane's Continental O-470-series engine was overhauled, then tested on July 25, 2012. It was subsequently installed on the airplane at a date not noted in the logbook, but at airplane total time 4,735.0 hours. A logbook entry, dated August 28, 2012, at airplane time 4736.0 hours, stated that the carburetor was removed, repaired, reinstalled, and "run up ok for return to service." When questioned about the need to repair the carburetor, the owner of the maintenance facility stated that anytime an engine was overhauled, the carburetor would be returned to the manufacturer for an overhaul as well.

The airplane was equipped with a carburetor temperature gauge. The gauge presentation arced into three sections: a black arc from -50 degrees C to -10 degrees C on the left side of the presentation, a yellow arc from -10 degrees C to +10 degrees C, and another black arc from +10 degrees C to +50 degrees C.

According to FAA-H-8083-25A, "Pilot's Handbook of Aeronautical Knowledge" (PHAK), "If the air temperature and moisture content of the air are such that carburetor icing is improbable, the engine can be operated with the indicator in the yellow range with no adverse effects. If the atmospheric conditions are conducive to carburetor icing, the indicator must be kept outside the yellow arc by application of carburetor heat."

There were no engine parameter recording devices onboard the airplane.

According to the Cessna 182Q Pilot Operating Handbook (POH),

Under "Air Induction System," the POH states:

"In the event carburetor ice is encountered or the intake filter becomes blocked, alternate heated air can be obtained from a shroud around an exhaust riser through a duct to a valve, in the air box, operated by the carburetor heat control on the instrument panel. Heated air from the exhaust riser shroud is obtained from unfiltered air inside the cowling. Use of full carburetor heat at full throttle will result in a loss of approximately one to two inches of manifold pressure."

Under "Inadvertent Icing Encounter," the POH states:

"An unexplained loss in manifold pressure could be caused by carburetor ice or air intake filter ice. Lean the mixture if carburetor heat is used continuously."

Under "Normal Procedures, Operation," the POH states:

For optimum operation of the engine in cold weather, the appropriate use of carburetor heat is recommended. The following procedures are indicated as guidelines:

(1) Use carburetor heat during engine warm-up and ground check. Full carburetor heat may be required for temperatures below -12 degrees C whereas partial heat could be used in temperatures between -12 degrees C and 4 degrees C.
(2) Use the minimum carburetor heat required for smooth operation in take-off, climb, and cruise.

NOTE

Care should be exercised when using partial carburetor heat to avoid icing. Partial heat may raise the carburetor air temperature 0 degrees to 21 C range where icing is critical under certain atmospheric conditions.

(3) If the airplane is equipped with a carburetor air temperature gauge, it can be used as a reference in maintaining carburetor air temperature at or slightly above the top of the yellow arc by application of carburetor heat."

For "Rough Engine Operation or Loss of Power, Carburetor Icing," the POH states, "An unexplained drop in manifold pressure and eventual engine roughness may result from the formation of carburetor ice. To clear the ice, apply full throttle and pull the carburetor heat knob full out until the engine runs smoothly; then remove carburetor heat and readjust the throttle.

If conditions require the continued use of carburetor heat in cruise flight, use the minimum amount of heat necessary to prevent ice from forming and lean the mixture for smoothest engine operation."

WRECKAGE AND IMPACT INFORMATION

The responding Federal Aviation Administration (FAA) inspector did not note any preexisting mechanical anomalies with the airplane that would have precluded normal operation. Photographs he provided included the propeller, with no noticeable chordwise scratching, and one of the two blades bent aft.

Another photograph showed the carburetor heat control partially pulled out, the throttle full forward, the propeller pitch full forward, and the mixture pulled out; however, their positions in flight, before the crash sequence, could not be confirmed as the engine had pulled away from the firewall during impact.

The NTSB did not take control of or document the wreckage. Instead, it was removed in pieces from the woods and taken to an out-of-state recovery facility. It was subsequently sold to the maintenance facility where the engine was installed, and then to a nearby engine facility. According to the owner of the maintenance facility, he and engine facility personnel discussed what may have occurred; but with the impact damage done to the engine could find no mechanical source of failure.

The pilot provided two photographs: one of the engine compartment before the airplane flew after engine replacement, and one after the accident, and was concerned that a crimp in the scat tube from the heat manifold to the carburetor may have led to the engine shutting down. The pilot did not note any engine anomalies when carburetor heat was applied during cruise flight with higher air flow requirements.

The pilot also noted that when he performed the carburetor heat check during engine run-up, the rpm drop was less than what he had come to expect from the engine before it was overhauled.

RESEARCH

FAA Publications:

The Pilot Handbook of Aeronautical Knowledge states:

"One disadvantage of the float-type carburetor is its icing tendency. Carburetor ice occurs due to the effect of fuel vaporization and the decrease in air pressure in the venturi, which causes a sharp temperature drop in the carburetor. If water vapor in the air condenses when the carburetor temperature is at or below freezing, ice may form on internal surfaces of the carburetor, including the throttle valve.

When conditions are conducive to carburetor icing during flight, periodic checks should be made to detect its presence. If detected, full carburetor heat should be applied immediately, and it should be left in the ON position until the pilot is certain all the ice has been removed. If ice is present, applying partial heat or leaving heat on for an insufficient time might aggravate the situation. In extreme cases of carburetor icing, even after the ice has been removed, full carburetor heat should be used to prevent further ice formation. If installed, a carburetor temperature gauge is useful in determining when to use carburetor heat.

Whenever the throttle is closed during flight, the engine cools rapidly and vaporization of the fuel is less complete than if the engine is warm. Also, in this condition, the engine is more susceptible to carburetor icing. If carburetor icing conditions are suspected and closed-throttle operation anticipated, adjust the carburetor heat to the full ON position before closing the throttle and leave it on during the closed-throttle operation. The heat will aid in vaporizing the fuel and help prevent the formation of carburetor ice. Periodically, open the throttle smoothly for a few seconds to keep the engine warm; otherwise, the carburetor heater may not provide enough heat to prevent icing."

FAA Special Airworthiness Information Bulletin (SAIB) CE-09-35, "Carburetor Icing Prevention" states:

"The FAA and the Aircraft Owners and Pilots Association (AOPA) have addressed the subject of carburetor icing several times in various forms. Despite the certification requirements, and the information provided by FAA and AOPA, the accident trend has remained fairly steady throughout the years."

It further notes,

"To prevent carburetor icing, the pilot should:

• Assure the proper functionality of the carburetor heat during the ground (Before Takeoff) check.
• Use carburetor heat on approach and descent when operating at low power settings, or in conditions where carburetor icing is probable.

To recognize carburetor icing, the warning signs are:

• A drop in rpm in fixed pitch propeller airplanes.
• A drop in manifold pressure in constant speed propeller airplanes.
• In both types, usually there will be a roughness in engine operation. The pilot should respond to carburetor icing by applying full carburetor heat immediately. The engine may run rough initially for short time while ice melts.

The above recommendations are general suggestions. The pilot should consult the AFM or the pilot's operating handbook for the proper use of carburetor heat."

The SAIB also contains a carburetor icing probability chart that is consistent with charts found elsewhere.

Additional FAA references include:

Advisory Circular (AC) FAA - P - 8740-24 "Tips on Winter Flying," which states in part:

"Fuel Ice - Forms at and downstream of the point where fuel is introduced, and occurs when the moisture content of the air freezes as a result of the cooling caused by vaporization. It generally occurs between 40 and 80 degrees F, but may occur at even higher temperatures.

It also notes: "In general, carburetor ice will form in temperatures between 32 and 50 degrees F when the relative humidity is 50 percent or more. If visible moisture is present, it will form at temperatures between 15 and 32 degrees F. A carburetor air temperature (CAT) gauge is extremely helpful to keep the temperatures within the carburetor in the proper range. Partial carburetor heat is not recommended if a CAT gauge is not installed. Partial throttle (cruise or letdown) is the most critical time for carburetor ice. The recommended practice is to apply carburetor heat before reducing power and to use partial power during letdown to prevent icing and overcooling the engine."

The AC also contains a carburetor icing probability chart, but it is not consistent with charts found elsewhere.

Anecdotal Research

In an AOPA Flight Training "Learning Experiences" article dated March 2000, titled "When Carb Ice Won't Melt," a certificated flight instructor (CFI) on an instructional flight related his near off-field landing experience in a fixed-pitch Cessna 172.

The CFI noted that about 10-12 minutes after leveling off, as he was demonstrating a transition to cruise flight, he increased throttle but noticed no significant increase in rpm. He verified that the carburetor heat was on full, the mixture was rich, and the gauges were "in the green." He varied the throttle setting from low to high, and it felt as if the cable was slipping after the first inch of travel. In a subsequent slow descent, he turned off the carburetor heat, which, as normal, increased the rpm by about 100. He reapplied carburetor heat and saw a slight decrease in rpm followed by an increase. Power came back to normal, and he concluded that he had experienced a severe carburetor ice condition.

When safely back on the ground, the CFI asked instructors and mechanics about the incident, but none had heard of a low-power, high-moisture condition where carburetor heat was ineffective. The CFI finally spoke to a pilot who had been instructing in Cessna 172s for many years:

"After hearing my story, his face broke into a smile. He explained the aircraft's carburetor heat design and discussed how the small carburetor baffle (actually a small box around the exhaust manifold) will not always heat the air sufficiently to melt ice under very low power settings. Higher power settings produce higher exhaust temperatures and thus hotter carb heat. He explained that, with the carb heat on at low power settings, it is possible to develop carburetor ice under certain atmospheric conditions. As we were flying, we were building carburetor ice with no indication because the ice did not restrict airflow at the low power setting. As I increased the throttle, the carb ice limited the airflow, thus limiting the power. Since the power was extremely limited, so was the exhaust temperature; thus only an increase in power would create the heat necessary to melt the accumulated ice. When I turned off the carb heat, the denser air increased the amount of power being developed and slightly increased the exhaust temperature. When I turned the carb heat back on, the now-hotter manifold conducted enough heat into the carburetor to melt the ice. This severe icing condition can turn into a catch-22. You need to develop heat to melt the ice, but you must melt the ice to develop heat. I was told that an increase in rpm caused by reducing the pitch attitude might have increased the heat enough to melt the ice, though this did not seem like a wise option at low altitude with an ailing engine."

The CFI further stated that he learned from the experience to clear the engine with a throttle increase whenever the power setting is low for more than a few minutes.

In another AOPA Flight Training "Learning Experiences" article, undated but titled: "Carburetor Icing, There's a Quick Fix for this Unexpected Visitor," the author states,

"In most cases, pilots can get rid of accumulations of carburetor ice by using carb heat. Nothing more is necessary. This proves that the system works as designed—warming the carburetor venturi and body—especially if we are conscientious in applying carb heat before reducing power.

Rarely do engines quit when you apply carburetor heat, so pilots have trouble accepting that it can happen. I was an unbelieving pilot until the engines in two different airplanes stopped on me in the same week. I was able to get the engines running again because I remembered to pull the mixture almost to idle cut-off in both cases. The engines generated enough heat to melt the ice.

Having adequate heat to melt ice becomes a real problem during prolonged low-power operations because the engine just isn't generating enough heat in the system. There are several partial solutions to this problem.

First, apply carb heat well before you reduce power. This preheats the carburetor and keeps ice from forming in the first place. If you do this when descending from altitude and in the landing pattern, you can push carb heat off on short final, so you won't have to worry about it in the event of a go-around.

Second, if you need to make a prolonged, low-power descent, "clear" the engine periodically by applying power, heating up the carb heat system, and burning out any ice that may have accumulated.

Finally, if applying carb heat results in loss of power, or even in significant "roughening" of the engine, you must immediately open the throttle and pull the mixture control out far enough to smooth out the engine. As the ice melts, restore the mixture gradually to the original position."

Pilot Information

Certificate:	Private	**Age:**	67
Airplane Rating(s):	Single-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	Unknown
Instrument Rating(s):	None	**Second Pilot Present:**	No
Instructor Rating(s):	None	**Toxicology Performed:**	No
Medical Certification:	Class 3 With waivers/limitations	**Last FAA Medical Exam:**	September 1, 2011
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	
Flight Time:	376 hours (Total, all aircraft), 116 hours (Total, this make and model), 249 hours (Pilot In Command, all aircraft), 5 hours (Last 90 days, all aircraft), 5 hours (Last 30 days, all aircraft), 1 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Cessna	**Registration:**	N735FJ
Model/Series:	182Q	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	
Airworthiness Certificate:	Normal; Utility	**Serial Number:**	18265387
Landing Gear Type:	Tricycle	**Seats:**	4
Date/Type of Last Inspection:	August 17, 2012 Annual	**Certified Max Gross Wt.:**	2931 lbs
Time Since Last Inspection:	4 Hrs	**Engines:**	1 Reciprocating
Airframe Total Time:	2553 Hrs at time of accident	**Engine Manufacturer:**	CONT MOTOR
ELT:	C91 installed	**Engine Model/Series:**	O-470 SERIES
Registered Owner:	On file	**Rated Power:**	230 Horsepower
Operator:	On file	**Operating Certificate(s) Held:**	None

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Night
Observation Facility, Elevation:	LUK,480 ft msl	**Distance from Accident Site:**	2 Nautical Miles
Observation Time:	00:53 Local	**Direction from Accident Site:**	30°
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	/	**Turbulence Type Forecast/Actual:**	/ None
Wind Direction:		**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30.14 inches Hg	**Temperature/Dew Point:**	12°C / -1°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Cincinnati, OH (LUK)	**Type of Flight Plan Filed:**	None
Destination:	Cincinnati, OH (LUK)	**Type of Clearance:**	VFR
Departure Time:	20:40 Local	**Type of Airspace:**	Class B

Airport Information

Airport:	Cincinnati Muni-Lunken Field LUK	**Runway Surface Type:**	Asphalt
Airport Elevation:	483 ft msl	**Runway Surface Condition:**	Dry
Runway Used:	03R	**IFR Approach:**	None
Runway Length/Width:	6101 ft / 150 ft	**VFR Approach/Landing:**	Forced landing;Traffic pattern

Wreckage and Impact Information

Crew Injuries:	1 Minor	**Aircraft Damage:**	Substantial
Passenger Injuries:	1 Minor	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	2 Minor	**Latitude, Longitude:**	39.075021,-84.446395(est)

Administrative Information

Investigator In Charge (IIC):	Cox, Paul
Additional Participating Persons:	Joseph Bohnert; FAA/FSDO; Cincinnati, OH
Original Publish Date:	March 17, 2015
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=85119