



Federal Aviation
Administration

Impossible Turn



FAASTeam

Turning back is the worst possible action when the powerplant fails during climbout in a single.

I watched the little Miles Sparrowhawk take off and cross the airfield boundary. I had been promised a ride in this beautiful little bird, the only remaining example of this beautiful, 1935 British racer. Then, without warning, the engine died.

Ahead were open farmlands. The pilot elected to turn back. He got halfway around the corner before the bank suddenly went past vertical, the nose went down and the Sparrowhawk was in a spin. At such a low height, there barely was room for a full turn before the airplane hit the ground and broke up beyond repair. Fortunately, there was no fire, but the pilot never was the same again.

Many years later, an almost-new, four-seat tourer took off from Biggin Hill, the famous Battle of Britain airfield not far from London. Biggin really is situated on a hill. The runway in use that day faces toward a wide, open valley which drops 200 feet or more from airfield level. At a height of about 250 feet, the tourer's engine abruptly died. In a wide arc ahead of the aircraft lay the valley, offering the luxury (in terms of gliding time) of another few hundred feet. The obvious decision was to land ahead.

Instead, the pilot turned back, entered a spin and crashed within yards of where the aircraft had been parked but a few moments previously. The pilot and one passenger died in that crash; the two other occupants were injured seriously.

A pair of all-too-factual stories: the first involves a very experienced professional test-pilot and the second an amateur who nevertheless had a reputation for reliability and a habit of doing things by the book. In each case, the pilot elected to turn back and attempt a hazardous downwind arrival when conditions were more or less ideal for a forced landing ahead.

Stories such as these are almost as old as flying itself. No doubt one could fill a large book with such factual examples. This is strange because there can be no secret about the dangers of turning back following an engine failure after takeoff; most textbooks, certainly those with reputable names on the covers, firmly advise against the practice. Yet, people continue to kill themselves when the situation could so easily result in only minor damage to the aircraft, little or none to the occupants and, later, drinks all 'round to celebrate an expertly conducted emergency procedure.

We live in permissive days. If one tells the aviating public that, if the donkey up front goes quiet during the early stages of climb-out, never to turn back, hackles rise and usually-reasonable folk accuse the speaker of being dogmatic. One or two almost invariably trot out some story in which the pilot turned back, got away with it and would have hit the headlines had he gone straight ahead.

No doubt there are a few, although very few, situations in which circumstances might dictate turning back. But, such decisions, demanding split second action and supreme skill, are beyond the capabilities of the average pilot. It's better by far to establish a well-rehearsed emergency drill and keep in practice, so that should the engine go on strike, there will be no "shall I/shan't I" nonsense while time runs out.

Why not turn back? Read on.

"Surely it is better to land back on the field rather than risk a touchdown in a plowed field and then face the cost of taking the bits apart and moving them back to the airfield." Brave words, those. But, they ignore the obvious risks of attempting a downwind landing against traffic taking off, assuming there is sufficient height to reach the airfield without spinning in. What is sufficient height? Take a look at the numbers.

Figure 1 illustrates the following situation. You have just completed one of your immaculate departures and climbed to 300 feet. Without prior warning, it all goes uncomfortably quiet up front. Some rather revealing experiments have been conducted concerning the average pilot's reaction time; from all accounts, the average pilot needs at least 4 seconds to react when faced with the unscheduled loud silence. Because the modern light plane climbs in a rather nose-high attitude, it is sitting nose-up with no power-the airspeed indicator winds down like a busted clock.

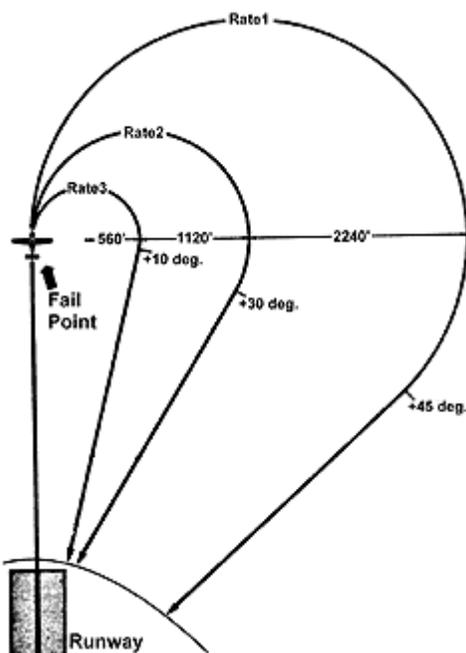


Figure 1- Although doubling turn rate halves turn radius when attempting to turn back to the runway, stalling speed increases dramatically.

By the end of those 4 seconds, the message should have gotten through to the pilot: "Lower the nose and safeguard the airspeed." At that stage, all the good advice of your flight instructor and those marvelous textbooks is thrown away and you roll into a bank to get back to the airport. Not wishing to risk a spin, you limit yourself to a standard-rate turn. How long does it take to do a 180 at standard rate? 60 whole seconds!

In addition, it is often forgotten that turns require room and the faster you fly the bigger the turn will be. Even at the modest, 70-knot gliding speed of a little tiddler, radius of a standard-rate turn is an astonishing 2240 feet. By the time direction has been reversed, you and your favorite wonderplane are 4480 feet to one

side of the runway-that makes a nasty hole in a mile! The drawing shows that the turn must be continued for another 45 degrees before the aircraft is pointing in the general direction of the airfield, so total turning entails changing direction through 180 degrees plus 45 degrees for a total of 225 degrees.

When the engine fails, time is of the essence. As my old flying instructor liked to say, "Gravity never lets up." Because time can be related to height loss, let us take a look at what happens during the time that passes after your engine goes on strike at 300 feet AGL. First, there is 4 seconds reaction time. Then you use up 60 seconds to turn through 180 degrees at standard rate and 15 seconds more for the extra 45 degrees necessary to point you at the airfield; total time since power failure so far is 79 seconds. An average lightplane in a turn will descend at, say, 1000 fpm: at that rate, 79 seconds translates into a height loss of 1316 feet. Having started the emergency procedure only 300 feet above the ground, you and your wonderplane now would be 1016 feet BGL (below ground level)!

Supporters of turning back no doubt will counter this argument with the suggestion that a standard-rate turn is not the way to handle the emergency. "Hawk it 'round the corner and head back to the field," they will tell you, conveniently ignoring the many problems that will occur.

It is common knowledge that, because of loading, stalling speeds increase with angle of bank. Take a look at the figures which relate to a typical four-seat tourer in world wide use (see Table 1).

Bank Angle	Stall Speed	Increase (%)
0 deg.	49 knots	0%
35 deg.	53 knots	8%
45 deg.	59 knots	20%
60 deg.	71 knots	43%
75 deg.	97 knots	97%

Table 1-Typical chart for a four-seat single shows relation of stall speed to bank angle.

The obvious message conveyed by Table 1 is that, if you stand the bird on one wingtip and pull back the pole, stalling speed can almost double. It seems clear that when an engine failure occurs at a safe height for turning back (to be discussed later), 45 degrees of bank should be regarded as the absolute maximum.

Another factor often overlooked by supporters of tight-turning back to the field is the need to increase gliding speed as bank is added beyond, say, 20 degrees, and the increase in descent rate that is bound to result. Taking our lightplane with its 70-knot gliding speed as an example, if you roll on 45 degrees of bank, common prudence demands that you increase the airspeed to 80 knots-any steeper and up go the G-forces, inflating both stalling speed and descent rate.

If you stand the bird on one wingtip and pull back the pole, stalling speed can almost double.

At 80 knots, a 45 degree bank would approximate to a four-times standard-rate turn, meaning 15 seconds

will be necessary to change direction 180 degrees. Take another look at Figure 1: Although for a 70-knot turn it shows a radius of 560 feet and adding 10 knots will not make a lot of difference, to point back at the airfield it is necessary to fly through another 10 degrees. In terms of time, we have 4 seconds in which to react, 15 for the turn through 180 degrees and another 1 second for the extra 10 degrees needed to head for the airfield, for a total of 20 seconds.

Even if the rate of descent remains unchanged (although you know, and I know, that it is bound to increase while banked at 45 degrees) a third of a minute while descending at 1000 fpm means you will have lost 333 feet at the end of the turn, which we started from 300 feet AGL.

Study the data in Table 2. They show how much time is required to head back to the field at different rates of turn. Of course, one must add the 4-second reaction time to the figures quoted in the last column because the table is confined to turning time. As with Figure 1, the table assumes a gliding speed of 70 knots and, although speed will have to be increased for a twice- or a four-times standard-rate turn, the larger radius will be balanced by the higher speed.

Turn Rate	Time to Turn 180 deg.	Additional Turn Req'd	Total Time
standard (3 deg./second)	60 seconds	45 deg.	75 seconds
twice standard (6 deg./second)	30 seconds	30 deg.	35 seconds
4 times standard (12 deg./second)	15 seconds	10 deg.	15.8 seconds

Table 2-Turning back to the runway requires more than 180 degrees of turn, consumes extra time and altitude.

So far we have considered only the numbers. On that count alone, turning back at low level is a nonsolution. However, there are other reasons why that turn should not be attempted unless circumstances offer a sporting chance. First, there is the obvious hazard of landing against oncoming traffic. But, even if the airfield is quiet and you have the place to yourself, there still is a downwind landing to contend with. At worst, final approach may be downwind and crosswind, a situation that could result in more damage than a well-executed arrival in a plowed field. The crosswind further complicates the problem because it extends or reduces your turn radius according to whether you bank left or right on the way back. At low level, with all the pressures and anxieties of an engine failure, do you feel confident enough to make the right decision?

If you are confronted with nothing but buildings or trees in all directions, and provided you have gained at least 600 feet prior to engine failure, there is a reasonable chance of regaining the airfield provided a 9 degree-per-second, gliding turn is started without delay and speed is increased by about 10 knots above that for a straight glide. But, at the end of the turn, you will face a difficult landing ahead.

Obvious factors affecting the outcome of turning back are glide performance of the aircraft and, most

importantly, the pilot's skill. By now I hope the seeds of doubt have been sown in the minds of those who feel capable of turning back, because below 600 feet AGL, the numbers spell disaster.

At low level, with all the pressures and anxieties of an engine failure, do you feel confident enough to make the right decision?

One of the reasons why some folks get uptight when they are told to land ahead if the engine quits after takeoff is because they feel denied the right to exercise their judgment. I would be the first to agree. To demand that the landing must be straight ahead would be pointless and potentially dangerous. Ahead may lie the biggest and densest housing development of all time. 10 degrees to one side could be an open field the size of JFK. Figure 2 illustrates the options available if you scan the relatively wide area contained within a 60 degree arc left and right of the takeoff path. There is no reason why the aircraft should not be maneuvered within those relatively far-ranging limits.

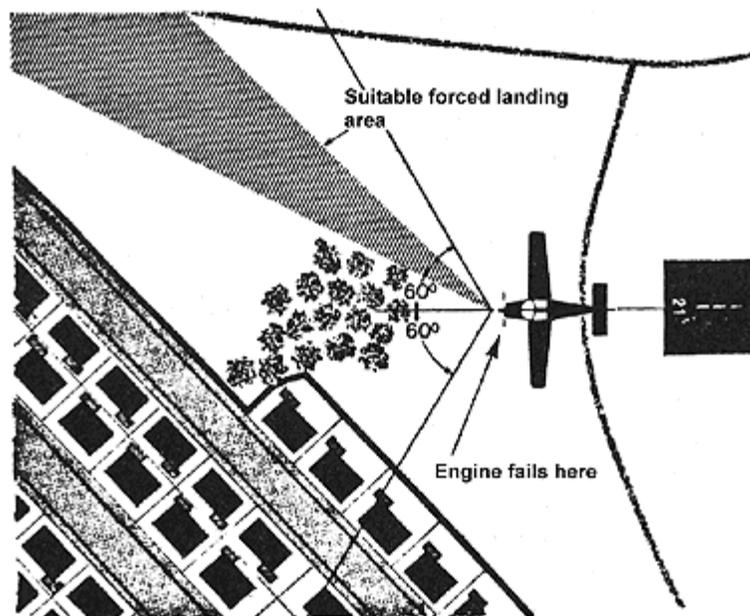


Figure 2-If engine fails at low altitude, it's reasonable to search for a suitable landing site up to 60 degrees either side of aircraft heading.

Even assuming that no obstacle-free landing area can be found within this 120 degree scanning area (60 degree left and right of climb-out heading) most light singles have relatively slow gliding speeds, and when a wind is blowing, groundspeed at point of contact can be modest. Following are the drills. They should be practiced at least once every six months, and preferably in the company of a good instructor.

Engine Failure During Takeoff-You are belting along the runway, building up speed and minding your own business when a cessation of activity up front announces there has been an engine failure:

1. Close the throttle;

2. Brake firmly;
3. Maintain runway heading;
4. While the aircraft slows down, turn off the fuel, switch off the mags and pull the mixture into idle-cutoff to minimize fire risk;
5. When there is a risk of passing the end of the runway, or even of running off the airfield entirely, swing onto the grass. Take firm avoidance action when obstacles are present.

Engine Failure After Takeoff-At a height of 400 feet expensive noises from the sharp end let it be known that there has been a power failure:

1. Immediately depress the nose and trim into the glide at optimum speed;
2. Look through an arc of about 60 degrees left and right of aircraft heading and select the best available landing area (see Figure 2);
3. Turn off the fuel and mags. Pull the mixture to idle-cutoff to minimize fire risk;
4. If yours is a tailwheel aircraft, avoid risk of turning over during the landing by retracting the gear (if applicable). It is better to leave the nose gear extended on tri-gear aircraft to absorb the first shock of arrival;
5. Make gentle turns to avoid obstacles;
6. When you are sure of reaching the chosen landing area, lower the flaps, in stages if necessary, but aim to have full flaps before touchdown. Do not allow the airspeed to increase;
7. On short final, turn off the master switch and unlatch the cabin doors (to guard against risk of being trapped in the cabin through the doors jamming);
8. *Resist the temptation to turn back to the field!*

When engine failure takes the form of a noiselessly windmilling propeller, without obvious signs of mechanical damage, the cause could be fuel starvation. In such cases you would change to another fuel tank (if there is one) after selecting your best landing field. Continue through the list if the engine will not restart.

Few experienced pilots would disagree that an engine failure after takeoff, particularly in a single, is one of aviation's most challenging situations. Certainly it is calculated to sort the nobs from the peasants, as they say in the classics. If this article does no more than convince the convincible that, in all but ideal circumstances, turning back is not an option for the thinking pilot with ambitions to age gracefully, then it will have served a valuable purpose. Fortunately, engine failure is rare these days but it nevertheless remains a fact of aviation life.

The engine that for one reason or another comes apart (connecting rod through the crankcase, rocker arm broken, etc.) may be outside the pilot's control. So often, however, an engine failure could have been prevented through sensible preflight action. Following are some hints for happy piloting:

Preflight Checks-These should not be treated as a ritual to be dealt with parrot-fashion and under sufferance.

1. It is vital to check for water in the fuel tanks. There is little point in letting the fuel strainer spray onto the ground-that will tell you nothing. Use a small jar and keep running the strainer until fuel (not water) comes out. I know of two pilots who were killed last year because they did not check

for water in an aircraft that had been standing outside for weeks. Having used the fuel strainers, make absolutely certain they are shut correctly. Otherwise your tanks will run dry in no time at all.

2. Yesterday's honest fuel gauges could be liars today. Look into the tanks, make a visual check of fuel level and compare it with fuel indications when you enter the cabin.
3. Check the oil and replace the filler cap correctly. I once saw a light plane make a high-speed landing trailing black smoke fit to turn day into night. The oil cap had not been replaced properly and the results, while more frightening than dangerous, had all the appearance of a serious engine fire. In fact, one may well have developed.

Engine Checks and Vital Actions-

1. On reaching the holding point, change tanks prior to the run-up. This way you will check the fuel system. On no account change tanks after the power checks and just before taxiing onto the runway. If anything is amiss, you can put money on it that the motor will throw in the towel at the worst possible moment.
2. Check the magnetos, hot air (or alternate air) and, when fitted, the propeller pitch change.
3. It is vital to check the fuel pressure without the electric pump working because only then can you be sure the mechanical pump is functioning. This is the time to check all engine temperatures and pressures as well as vacuum and electric charge but do it with the power on, not at idling rpm.
4. During the early part of the takeoff run, be alert for any unusual roughness, vibration or unfamiliar noises. Even when it all sounds good, take a quick look at the engine instruments as soon as direction is assured and satisfy yourself that everything is in the green.

If there is the slightest hint of abnormality, close the throttle, abandon the takeoff and stop playing the hero.

A test pilot mate of mine once told me, "The difference between the true professional and other pilots is that during takeoff many amateurs are surprised when something doesn't work; the pro is equally surprised when it does?" The truth of this little quotation is that too many pilots have a blind faith in things mechanical. There is the illogical habit of turning off the electric fuel pump as soon as the aircraft has departed the airfield. It only needs the mechanical pump to play up and we have an engine failure on our hands. At that stage the pilot elects to turn back and-but we all know the outcome of that!

**Flying is a discipline...
safety is an attitude.**

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