CRASH LANDINGS

The power is gone, the only choice is down, and the terrain is hostile, but survival is possible.

BY BARRY SCHIFF

One of aviation's popular adages defines a good landing as one from which a pilot can walk away. This simplistic attitude originated when engines were no more reliable than a politician's promise and emergency landings occurred with predictable regularity. Today, however, engines usually drone on without interruption, and the adage has become anachronistic. More often than not, it is used to console someone who has made an embarrassing landing.

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Unfortunately, emergency landings still occur for mechanical or pilot-induced reasons. According to the National Transportation Safety Board, one of every four general aviation accidents is associated with an emergency landing.

Emergency landings fall into two basic categories. One is the precautionary landing. It is considered less hazardous because a pilot has *elected* to land (on or off an airport) instead of continuing into what he thinks may be worsening conditions. Power is available, and this allows some choice of landing sites.

The other is the forced landing—more ominous because a pilot is compelled to land (usually without power), and the

Author Barry Schiff had the opportunity to test his theories when the engine quit. He walked away.

available landing sites are more limited.

When engine power no longer is available, a pilot will attempt to glide to a dirt road, a farmer's field or even an airport. But because of fate or poor planning, the landing often must be made on more hostile terrain. A pilot then is faced with an emergency landing of the worst kind. Airframe damage is probable and the threat to life, substantial.

Crash landing is a grim prospect, but pilots should take some comfort in knowing that such an emergency usually is survivable. By being forearmed with the proper attitude and the understanding of some of the basic principles involved, a pilot usually can expect to make a landing from which he and his passengers can walk away.

When any in-flight emergency occurs, one of a pilot's most immediate obligations is to attend to the cause. If the problem cannot be corrected and the emergency dictates an untimely descent, he immediately must shift mental gears and deal with the crisis. Although this *sounds* logical, it is not unusual for a pilot confronted with a genuine emergency to reject reality initially; he is reluctant to accept the emergency. He becomes mentally paralyzed and subconsciously desires to alter the facts. This interferes with his ability to adapt to the circumstances and leads to wasted time and possibly to errors that further compound the emergency.

Consider the pilot of a powerless craft who, in his zeal to protect the aluminum, turns back to the departure runway from too low an altitude or attempts illogically to stretch a glide, so as to avoid landing on rugged terrain. Such maneuvering often leads to graver consequences, a stall/spin accident.

It has been demonstrated that a pilot who accepts an emergency and takes command of both the airplane and his emotions has a much-improved prospect for survival, no matter how dire the circumstances appear. This admittedly is easier said than done.

Anyone who drives an automobile is reminded frequently that speed kills. In reality, speed alone does not kill: It is the extremely rapid dissipation of speed that does, especially when one is driving or flying headlong into an immovable object. In other words, the potentially destructive forces present during a crash landing are determined by the groundspeed at touchdown *and* the distance used while coming to a halt.

The extent to which excessive speed contributes to injury often is not appreciated fully. This is because the potential for disaster increases with the square of the impact speed. A crash at 71 knots, for example, is twice as dangerous as one at 50 knots; it is three times safer to crash at 50 than at 87 knots.

This indicates that touchdown should be made into the wind (if possible) and at as slow an airspeed as will still allow adequate control of the airplane.

The second factor in the emergency landing equation—stopping distance—also plays a key role. Survival depends on the obvious need to use as much distance as possible for deceleration. Although a few thousand feet of tarmac would satisfy this requirement nicely, such a luxury may not be available. Nor is it a necessity. In theory, very little stopping distance is required if groundspeed can be dissipated uniformly. This is because general aviation cockpit frames are designed to withstand up to 9 Gs of forward deceleration.

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The table shows the absolute minimum distances required to halt an airplane touching down at various groundspeeds and decelerating uniformly at 9 Gs. At 50 knots, for example, the required stopping distance is a remarkable 12.3 feet. Doubling groundspeed to 100 knots, however, quadruples the distance to 49.2 feet. These distances, however, have little practical value, because it is virtually impossible for a pilot to control deceleration so precisely. There simply are too many variables that influence stopping distance. And, although the cockpit structure might be able to withstand such a shock, those rattling around inside probably cannot.

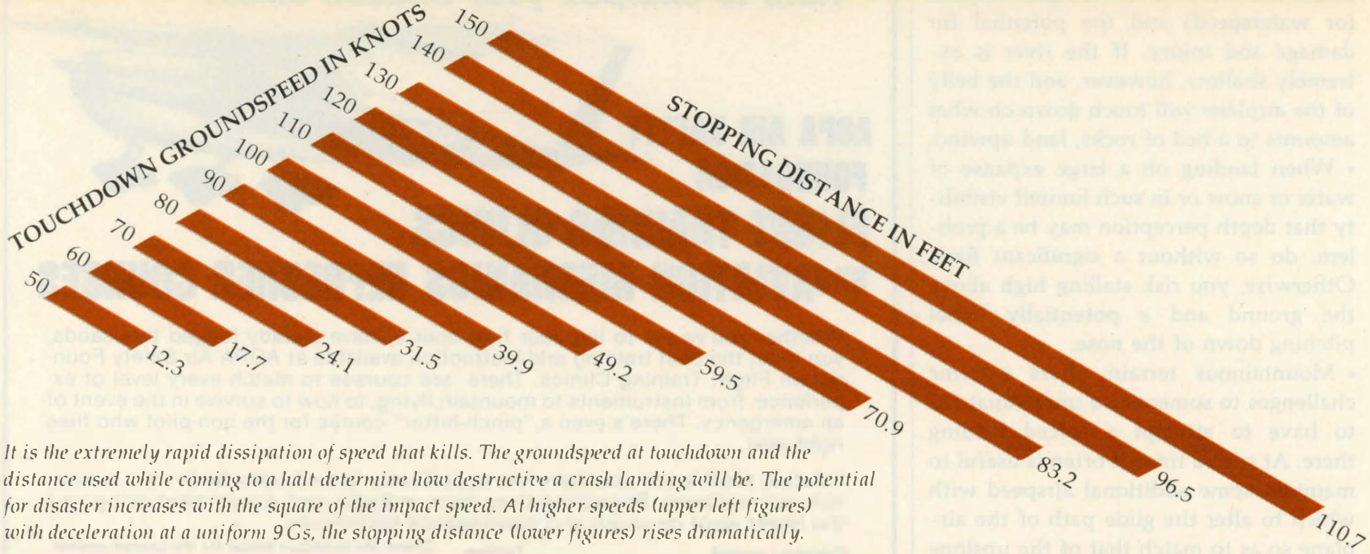
When confronted with having to land and decelerate within a very short distance, a pilot obviously cannot rely on the wheel brakes. He must be willing to sacrifice some or all of the airplane's dispensable structures and use them as shock absorbers. The techniques to use vary with the terrain, and this makes it extremely difficult to offer specific advice. One of the best known involves aiming the nose of an airplane between two trees during runout. This may shear the wings from the fuselage, but a considerable amount of destructive energy and speed will be dissipated in the process. Landing distance is reduced substantially before the airplane reaches something else (such as a cliff) that poses an even greater threat. (Several years ago, a student pilot applied this technique quite successfully. The only problem was that the two trees he headed for were the only obstacles on an otherwise flat, 80-acre field.)

There are, of course, numerous other options, such as intentional ground looping; landing with the wheels up (when possible) to reduce rolling distance; landing with the wheels down to allow the gear to be broken off by rocks (which act as shock absorbers that help to dissipate forward speed); and aiming for soft spots (such as brush, bushes or small trees) that offer reasonably good cushioning and braking effects.

The point is that a pilot must use his wits and be prepared to sacrifice dispensable airplane structure to absorb speed and destructive energy, while keeping the cabin intact. Only during rare and extreme circumstances should the nose of the airplane be allowed to hit a solid object.

It was mentioned earlier that touchdown should be made as slowly as possible, but not so slowly as to sacrifice controllability. Insufficient airspeed invites a stall, an excessive sink rate and an impact with the ground in a nose-low attitude, factors that can reduce the probability of survival to nil. Touchdown requires a minimal sink rate to reduce the possibility of creating vertical Gs. Although the rigid bottom construction (especially of low-wing airplanes) might sustain such a shock, the frail, human vertebrae may not. The backbone is very intolerant of such abuse. When landing on soft terrain such as a dry, sandy beach, an excessive sink rate may also cause the nose to dig in and cause extreme forward deceleration.

(Simulated forced landings occasionally lead to actual emergency landings at a high sink rate when the engine fails to respond immediately to throttle movement. Automatically raising the nose without waiting for power to develop can result in a hair-raising rate of descent. During any go-around or missed approach, maintain a safe attitude and



It is the extremely rapid dissipation of speed that kills. The groundspeed at touchdown and the distance used while coming to a halt determine how destructive a crash landing will be. The potential for disaster increases with the square of the impact speed. At higher speeds (upper left figures) with deceleration at a uniform 9 Gs, the stopping distance (lower figures) rises dramatically.

airspeed until power really is available.)

An emergency landing on rugged terrain also should be made with the wings parallel to the ground and the aircraft in a somewhat nose-high attitude. Every effort must be made to prevent the nose from burrowing into the ground or hitting a solid object. In addition to excessive deceleration, a nose-low attitude can cause the airplane to tumble.

There is evidence that indicates that low-wing airplanes are the more crashworthy. This is because they usually have more structure (in the form of wing spars) beneath the cockpit to absorb destructive forces and are less likely to nose over. High-wing airplanes generally are more top heavy because of the high-wing structure and fuel in the wing tanks. Consequently, they are more prone to flipping and cartwheeling.

Almost as important as the touchdown technique is the need to prepare the cockpit and those aboard for the crisis. If there are any empty rearward-facing seats, have passengers sit in these, because they offer the most protection during a crash landing. Be certain that everyone cinches their lap belts and shoulder harnesses as snugly as possible and that they know how to unlatch them after the airplane comes to rest. If any clothing or pillows are available, place these between the control wheels and those seated up front. Pilots often are killed or seriously injured by control wheels puncturing their chest cavities during otherwise survivable landings. If practical, and time permits, also cover other sharp objects in the cockpit with clothing. Those persons in front might consider sliding their seats as far aft as possible to reduce the risk of having their heads flung into the panel during post-touchdown deceleration.

A controversial subject involves the cockpit (or cabin) door. Some maintain that it should be kept closed until after the landing to help preserve the integrity of the cabin structure, thereby offering more protection for those inside. Others, this writer included, prefer unlatching the door prior to touchdown, as long as this does not interfere with airplane controllability. An unlatched door better ensures the ability to evacuate after the airplane comes to rest. A fuselage deformed during a crash landing could jam the door and prevent it from being opened without a crowbar.

Other prelanding duties might include transmitting an emergency message to a nearby facility, tuning the transponder to the emergency squawk (7700), turning on the emergency locater transmitter (if possible) and making handy any available emergency equipment (such as a fire extinguisher) that might be needed immediately after landing. Also turn off the electric master switch prior to touchdown to reduce the likelihood of a post-crash fire. Do not do this, however, until you are assured that electrical power no longer is needed to operate vital aircraft systems (such as flaps and landing gear).

Although the magnetos and fuel valve(s) also should be turned off prior to impact (to cool the engine and further reduce the fire hazard), do not be in a hurry to do this if some engine power is available. Even a modicum of power can vary the descent path enough to allow a wider choice of landing sites.

If possible, choose a landing area that allows an uphill, upwind touchdown and has an approach path relatively free of obstacles. It often is better to accept landing on rugged terrain than to risk flying into an obstruction. Once a landing area has been chosen, avoid vacillating and selecting another unless you are certain that the alternate is within glide range, can be reached without excessive maneuvering at low altitude and offers a safer haven. It usually is preferable to accept a controlled landing on inhospitable terrain than to risk crashing uncontrollably in a stall while trying to stretch a glide to a more inviting, yet excessively distant, piece of ground.

The nature of terrain can play a key role in determining the application of other useful techniques. Although it would be presumptuous to attempt to provide advice for all possibilities, the following guidelines may be helpful.

- If the landing site is extremely confined, it might be advisable to force the airplane to contact the ground prematurely with some excessive airspeed rather than to risk floating and delaying touchdown. Deceleration is much better on the ground than in the air, and this can reduce substantially the speed at which obstacles at the far end of the runway may be met.
- A landing on the shallow edge of a body of water generally is more survivable than a landing on adjacent, rugged ground.
- If landing on a beach, do so on the moist, hard-packed sand below the high-tide mark. At high tide, land in the water immediately below the high-tide mark to avoid the risk of nosing over in the higher, drier, softer sand.
- Unless wind is a strong overriding factor, it usually is best to land in a swift-moving stream or river in the direction

of the current. This reduces groundspeed (or waterspeed) and the potential for damage and injury. If the river is extremely shallow, however, and the belly of the airplane will touch down on what amounts to a bed of rocks, land upwind.

• When landing on a large expanse of water or snow or in such limited visibility that depth perception may be a problem, do so without a significant flare. Otherwise, you risk stalling high above the ground and a potentially lethal pitching down of the nose.

• Mountainous terrain offers extreme challenges to someone so unfortunate as to have to attempt a forced landing there. At such a time, it often is useful to maintain some additional airspeed with which to alter the glide path of the airplane so as to match that of the upslope gradient upon which the landing might be made. Avoid touching down with a severe lateral twist, which could snap roll the airplane into an adjacent gulley.

• Landing in a forest is not an attractive prospect, either. Successful tree landings require gliding into the higher branches at slightly above stall speed and in a nose-high attitude. The goal is to have both wings and the belly make simultaneous contact with the crowns. Avoid widely spaced, tall trees, because the aircraft is likely to drop from an uncomfortable height after forward speed dissipates. (A free-fall from 75 feet can result in an impact velocity of 4,000 fpm.) Short, closely spaced trees with dense crowns offer the best hope.

• Perhaps the most ominous predicament is the powerless glide at night to terrain smothered in zero-zero fog. There is little to do except fly the aircraft upwind in a wing-level attitude while maintaining the minimum airspeed and sink rate consistent with controllability. Some airplanes do this best with a slight deflection of flap, but avoid a full-flap descent. Although this allows a slightly slower forward speed, the accompanying high sink rate is unacceptable.

Someone with a bizarre sense of humor once remarked that a pilot in such a dilemma should turn on the landing lights before landing. "If he does not like what he sees—turn them off."

It can be sobering and uncomfortable to review the procedures that might be employed if and when fate's finger points your way toward a crash landing. Perhaps the most valuable lesson to be extracted from all of this is that those who plan their flights with respect to the terrain and modify their routes accordingly probably have the least to fear. □