WHITEOUT

Original idea from Fred George

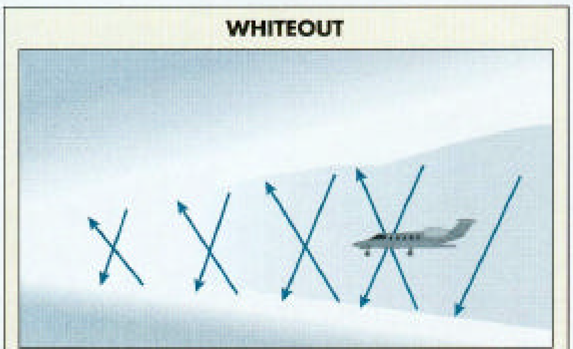
White sky and white ground, no shadow and no horizon set you up for CFIT

A METEOROLOGICAL MILK BOWL

Cold weather is just ahead for many locations in the Northern Hemisphere, bringing with it winter storms, blowing snow, overcast skies and degraded visibility. Even if visibility is good, certain sky and ground conditions can blur the distinction between IMC and VMC.
Pilots who depart from or arrive at certain airports may find themselves in a whiteout-a meteorological milk bowl containing smooth, unbroken snow-covered ground, a uniform overcast sky and light reflections that make ground and sky visually inseparable.
According to the American Meteorological Society, in a whiteout, *"Neither shadows, horizon nor clouds are discernible; sense of depth or orientation is lost; only very dark, nearby objects can be seen."* The result is plenty of vertigo-inducing, sensor illusions when you're trying to make the transition between IMC and VMC on takeoff or landing. Your eyes don't focus on anything in particular. Objects that sudden m not be visible because you're not focusing on anything in the background.

This is known as sector whiteout and it was a *"major contributing factor"* in a DC-10 controlled flight into terrain (CFIT) accident in 1979 on Mount Erebus in Antarctica, according to *Human Factors for Aviation,* a basic handbook published by Transport Canada. The crew of Air New Zealand Flight 901 lost visual reference to the horizon and surface obstructions even though the prevailing visibility was in excess of 40 miles.

The Canadians have become experts in winter flying, having learned from numerous accidents about the factors that can cause CFIT in whiteout conditions. Within the *Canadian Aeronautical Information Publication* (AIP), there's an entire section devoted to the hazards of whiteout.
According to the AIP, whiteout also can be caused by (1) thin clouds of supercooled water droplets making contact with a frigid snow surface, (2) fine, blowing snow that moderate winds can whip up into a cloud and (3) light snow precipitation falling from thin stratus clouds through which light from the sun is reflected.



Thin, white overcast plus snow blanket diffuses light. There is no horizon, no shadows, no depth of field, no clear objects upon which to focus.

Depth perception and spatial orientation are dependent upon the color, sheen and, especially, shadow of light from objects. A whiteout removes the color and sheen cues of objects. The diffused light from the overcast sky is reflected in all directions, thereby eliminating shadow cues. Say goodbye to recognizing terrain features or obstructions before they loom large in the windshield.

Doubtlessly, the biggest hazard from whiteout is its insidious nature. Pilots frequently encounter it in clear air, but don't recognize the condition. The AIP warns that *"pilots have flown into snow-covered surfaces unaware that they have been descending and confident that they could 'see' the ground."* In one accident, pilots of a turboprop inadvertently descended onto the surface of a frozen lake, several miles short of the runway, unaware that they didn't have visual contact with the terrain.

In another accident, the pilot of a helicopter was flying over a frozen lake while using a tree line at the far shore as a horizon reference. He failed to crosscheck the altimeter and flew the aircraft into the surface. But the water doesn't have to be frozen to pose a hazard. When approaching an airport from over water in nearly windless conditions with a low to medium altitude overcast and poor visibility, you can encounter gray-day spatial disorientation that's quite similar to whiteout.
The lack of visible surface features denies you depth perception and horizon reference that are so essential to flying in VMC.

CONQUERING WHITEOUT

Harry Boyko and Ron Coleman, accident investigation experts from Canada's Transportation Safety Board, say that whiteout accidents are preventable. Both of them say that a thorough approach briefing is essential. Both pilots must have current approach plates in clear view and be clear on the roles they will play during the approach. During the approach briefing, the pilots should discuss the weather at the destination, the type of approach to be flown, all the lateral and vertical navigation requirements, including the missed approach, and any runway alignment and glidepath aids that are available. Notably, it's critical to double check the altimeter setting and make any altitude corrections for remote versus local altimeter setting, make extreme cold weather altimetry corrections and heed all altitude crossing restrictions.

Boyko says that *"People who are trained to recognize whiteout conditions quickly revert to instrument flying. They frequently crosscheck attitude, altitude and rate of descent during the approach."* As shown in the accompanying illustration, it's fundamental to rely upon flight instruments because visual cues in a whiteout can be misleading. You may believe that your aircraft is well above the surface, but the lack of appropriate visual references quickly can collapse safe terrain-clearance margins.
Both Boyko and Coleman emphasize that cockpit resource management is critical during a whiteout approach. There are two accepted methods for dividing up responsibilities. The pilot monitored approach designates one pilot (PF) to fly the entire approach on instruments. The pilot-not-flying (PNF) monitors the approach and devotes attention to acquiring the runway environment during the final approach segment. When the runway is in sight and the aircraft is in position for a safe landing, control of the airplane is transferred to the other pilot. The PF monitors the instruments to ensure that the aircraft continues the approach to landing with appropriate attitude, altitude, configuration, speed and rate of descent.

The second method also designates one pilot to fly on instruments and the other to monitor the approach and look for visual cues. However, when the PNF visually acquires the runway environment and if the aircraft is properly positioned for landing, the pilot on instruments then looks up and continues to fly the approach with visual cues. The PNF reverts to scanning the flight and engine instruments to provide maximum head-up time for the pilot-flying.

Coleman points out that the aircraft should not be fully configured for landing until the runway end is in sight, and you're ready to descend from the MDA and align the aircraft with the runway. That's the time to extend the flaps to the landing configuration and slow to final approach speed. Until then, Coleman recommends keeping the aircraft in the approach configuration, thereby increasing its performance during a possible go-around or missed approach.
Boyko says *"air discipline"* is mandatory. Several CFIT accidents have been attributed to *"scud running"* during the approach. There is a strong temptation to duck under a cloud deck and proceed VFR. Under ideal visibility conditions, this affords much greater flexibility. In marginal VFR, such as during whiteout conditions, you're exposed to much greater risks.
Contact approaches are especially risky during whiteout conditions. Under these circumstances, the pilot assumes responsibility for obstruction clearance in lieu of flying a standard or special instrument approach procedure, as long as there is at least one mile of visibility. The pilot is free to

deviate from the minimum altitudes specified in the published approach, potentially eliminating the safety margins designed into the procedure. If you're banking on being able to see visual references to keep you safely clear of terrain, you're engaging in high-risk behavior.

ADVANCED AVIONICS FOR NPAs

If you're frequently going to fly non precision approaches, especially NDB or VOR procedures without DME, an approach-certificated GPS navigation system is one of the most cost-effective upgrades to a business aircraft's avionics suite. But you should select a system that requires a minimum of programming prior to commencing the approach and virtually no inputs while you're flying the procedure.
Most FAA-approved GPS receivers can be coupled to the aircraft's flight guidance system. Some experienced pilots have flown several GPS/NDB overlay approaches, and have concluded that it's a quantum leap up from radio beacon navigation because of the precision of its bearing information and the addition of distance-to-waypoint data. It's also a substantial improvement over basic VOR approach navigation, especially if the navaid is several miles from the airport.

As a substitute for VOR/DME approach navigation, the benefits of GPS are less clear. If the VOR/DME is located close to the airport, the performance advantage of GPS compared to VOR/DME is minimal. As the distance between the VOR/DME and the landing facility increases, the benefits of GPS become more apparent because its navigational accuracy is relatively constant.

An approach-certificated FMS that has a multiple waypoint vertical navigation capability also can be a big help. Such systems provide lateral and vertical guidance from the feeder fix all the way to the missed approach holding point, including azimuth and glidepath guidance from the final approach fix to the end of the runway. It's almost like having an ILS.
Caution applies. FMS are programmed with the minimum crossing altitudes for the waypoints in published approaches. If those altitudes must be increased because of the estimated altimetry errors associated with a remote altimeter setting, then the flightcrew must make adjustments, much the same as they would if they were manually flying the approach using conventional navaids.

Some FMS aren't programmed with all the altitude crossing restrictions that are part of the authorized approach procedure. For example, if there's a step-down restriction defined by a DME fix rather than a named intersection, it may not be in the FMS database. In that case, the FMS might compute a glidepath angle directly between two named waypoints, thereby shaving or eliminating a critical obstruction clearance margin. The solution is to crosscheck all vertical navigation commands with the published approach while flying the procedure and be prepared to manually intervene, if necessary.

Extremely cold temperatures also can have an effect on altimetry. Altimeters only are accurate in ISA conditions. At very cold temperatures, the indicated altitude is five to 20 percent less than the actual altitude. The effect is greatest at high elevations and altitudes. Glance at the illustration on the opposite page. If the temperature at the airport is –50°C, admittedly an extreme condition, and you're flying a procedure turn at 4,000 feet msl, you'd need to add 420 feet to your indicated altitude as a correction. FMS aren't programmed to automatically make such corrections. Pilot intervention is required.

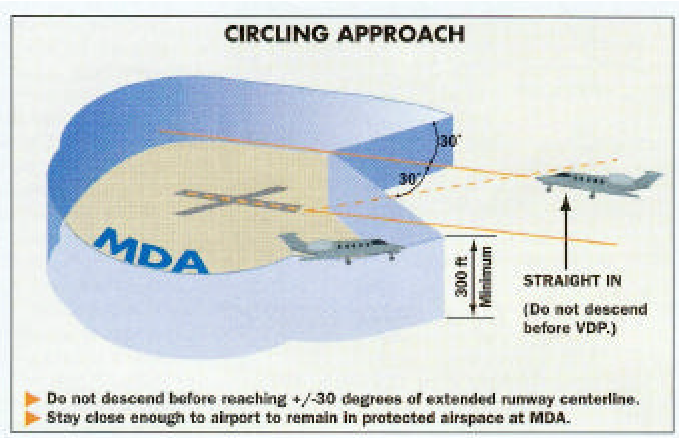
A Ground Proximity Warning System will provide another margin of safety. GPWS boxes react to inputs from pressure and radio altimeters, plus discrete signals from wing flaps, landing gear and navigation radios, to provide timely warnings of CFIT hazards. Newer systems have highly refined software that prevents virtually all nuisance alarms. Some airlines have such faith in GPWS that they require the pilot to discontinue an approach if the box sounds an alarm.

Enhanced GPWS incorporates all of the features of standard, reactive GPWS boxes and adds a predictive alert feature. These systems evaluate the aircraft's GPS or FMS position, plus its altitude, course and speed, in relation to a terrain database. Warnings are displayed graphically on a moving map display and audibly through a voice synthesis system. E-GPWS can provide warnings of CFIT hazards well in advance of the reactive alerts provided by conventional GPWS Units.

A Head-Up Display offers a big step forward in avionics capabilities, if your budget can handle the investment. During a low visibility approach or a whiteout, the horizon line and air data displays keep the pilot aware of attitude, altitude and airspeed. Approaching the visual descent point, a HUD can provide a three-degree glidepath reference line as well as the all-important flight-path vector cue that indicates aircraft trajectory. Align the glidepath line with the runway threshold and maneuver the aircraft to put the flight path vector on top, and flying a perfect approach is virtually guaranteed.

WHITEOUT OR BLACKNIGHT

If you think of whiteout as being the first cousin of a pitch black night, you're well advised. Neither condition provides reliable visual cues from sky or ground references. Both conditions require primary reliance upon flight instruments, especially for attitude, airspeed and altitude information.
Both conditions are unforgiving of altitude deviations or premature descent for landing approach. The runway environment may be much easier to see at night because of approach, runway and taxiway lights, along with the rotating beacon. There are few other distractions on the surface, with the possible exception of highway and building lights.



In a whiteout, the runway may be totally camouflaged by blowing snow that covers the entire area in a uniform white blanket. A corn field, an aqueduct or a roadway may act as an effective decoy.
Either condition requires careful maneuvering once the airport is in sight. If you're going to circle to land, it's essential to fly a tight pattern so as not to lose sight of the runway environment. We suggest flying a minimum approach speed of 1.42 to 1.5 of the Vs1 stall speed for the specific flap configuration. That will keep the turns tight and provide plenty of stall margin.
Once the aircraft is within a 30 degree sector of either side of the runway centerline and within the protected airspace, you can safely descend for landing.
Takeoffs in whiteout or black night conditions require similar skills. Beware of the effect that rapid acceleration has on your inner ear "pitch gyro." This is known as somatogravic illusion. It's an erroneous sensation of pitch (rotation in the vertical plane) caused by linear acceleration. Even highly experienced instrument pilots have to concentrate on attitude and performance instruments while consciously disregarding the erroneous pitching sensation provided by the inner ear.

The Canadian Transportation Safety Board's accident records indicate that somatogravic illusion has proven to be a significant causal factor in black night accidents.
Whiteout is no more dangerous than other marginal VMC. It's just a lot more seductive. If you're forewarned of its potential risks and its insidious nature, you're well on your way to conquering its threat.