Fads & Fantasies

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Since we published "Fads & Fallacies" in the February 1977 PILOT, *we have received numerous letters — some agreeing with author Schiff's explanations of aeronautical phenomena, others strongly differing. Well, find your reference books and sharpen your pencils, because here we go again.*

Every once in a while, pilots are presented with an operational procedure that seems logical in theory, but fails miserably in practice. One of my favorite such pieces of advice falls neatly into this category. It is the commonly suggested method of escaping structural icing when flying in the vicinity of a warm front.

As every pilot knows—or should know—a warm front separates a cold air mass from an overriding, warmer air mass. In theory, therefore, icing conditions can be evaded by climbing from the cold air, through the frontal surface and into the *relatively* warm air above. This procedure is presented in numerous flight training manuals, but I doubt if the authors have ever put such a technique to the test in light, general aviation airplanes. Otherwise, they would have been compelled to revise their books.

Advocating that a pilot climb through a warm front to escape structural icing is like throwing a concrete life jacket to someone who's drowning.

Figure 1 is a typical cross section of a warm front. Of prime concern, however, is the 0°C isotherm, a line that defines the lower limits of freezing temperatures and icing conditions across the frontal system In other words, structural icing can be expected when flying in clouds above the isotherm, but can be avoided by flying below them.

Of particular significance is that freezing temperatures and structural icing typically can be found in the "warm" air mass above the frontal surface.

Consider Aircraft A, for example, which has just flown through the "freezing" isotherm into icing conditions while in the cold air mass below the frontal surface. Should this pilot climb toward the warm air mass? No, because this would not be an escape route from subfreezing temperatures; he'd still be above the 0°C isotherm. In all probability, the climb simply would parallel the sloping frontal surface and keep the airplane in the thickest cloud layers.

Now consider Aircraft B, which is heading toward the frontal system from the opposite direction when it begins to accumulate ice. Would a climb result in warmer temperatures and ice evasion? Nope.

In each of these cases (and in most others), the most prudent procedure is to employ one of aviation's most valuable and proven safety tools, the 180° turn (unless a safe and timely descent can be executed to warmer temperatures or visual conditions).

There may be isolated instances when a climb through a warm front can result in the shedding of accumulated ice, but only when a pilot is intimately familiar with the dynamics of a given frontal system. But this data rarely is available.

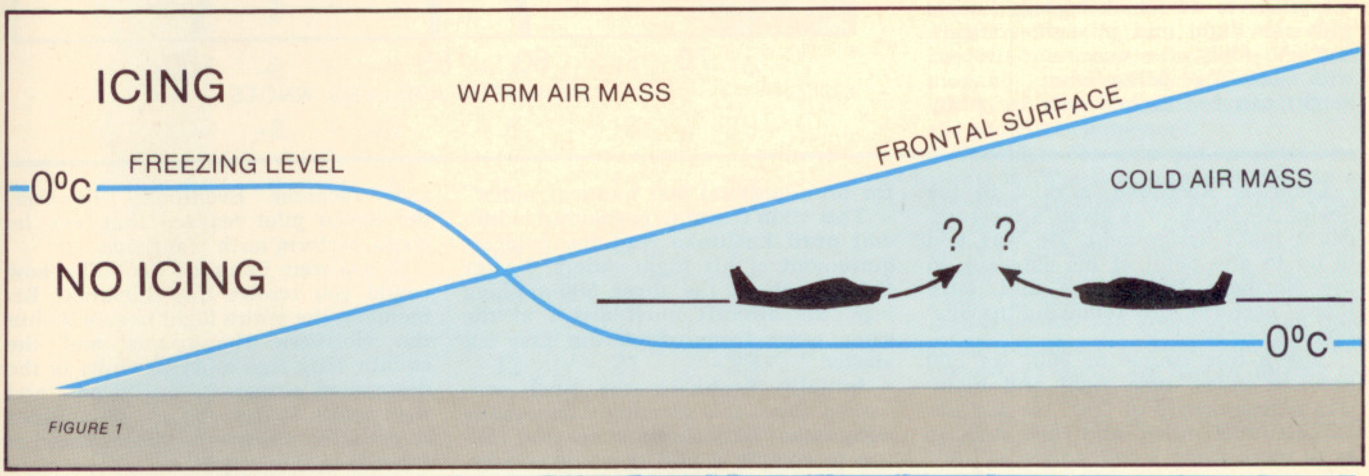

FIGURE 1

continued

Whenever a pilot executes a stall, he is exploring a slow end of the airplane's performance envelope. When he nudges the airspeed needle toward the red line (in smooth air, of course), he approaches the other extreme of the envelope.

But one "outer limit" seldom investigated by most pilots is the absolute ceiling, the altitude at which further climb is no longer possible. Reaching such a performance pinnacle has no significant practical value; it simply is an engineering expression that helps to evaluate an airplane's overall climb capability.

But what is life at the top really like? Since so few have been there, misconceptions abound. The most popular states that when at its absolute ceiling, the airplane hangs on the verge of a stall and that no airspeed loss can be tolerated. Wrong. Another notion claims that control reactions are sluggish and it may be difficult to maintain a safe attitude. Wrong again.

In reality, life at the top is quite nice, thank you. Although control responses are not crisp, they are certainly adequate. And, believe it or not, there is a healthy margin of airspeed; a stall is not imminent.

This may seem incongruous because so much additional airspeed above stall should enable the airplane to continue climbing, but not so. The answer to this apparent contradiction can be found with the help of Figure 2 which represents some climb data for a typical lightplane.

At sea level, notice that the airplane has a stall speed (V_s) of 70 knots, a best-angle-of-climb airspeed (V_x) of 80 knots and a best-rate-of-climb airspeed (V_y) of 100 knots. As altitude increases, the stall speed remains constant, but V_x and V_y do not. It is typical for most light airplanes that V_x increases slightly with altitude and that V_y decreases slightly so that at the absolute ceiling, V_x and V_y become one and the same, which in this case is 85 knots.

A climb to absolute altitude requires the patience of Job, a certain finesse with the flight and mixture controls, and the ability to maintain airspeed with exacting deliberation. Such a height can be reached only by maintaining the appropriate values of V_y. (But once there, prepare to head for the barn because most of the onboard fuel may have been spent.)

Upon reaching the top, airspeed will equal V_y, otherwise the airplane would not have gotten there in the first place. In the case of our fictitious airplane, this means that airspeed will be 85 knots, no more, no less. And notice that this is fully 15 knots above stall.

If a turn is initiated or if airspeed is allowed to either increase or decrease even slightly, altitude will be lost. When at the top, only V_y and a wing's-level attitude will keep you there. But note that a slight speed bleed does not result in stalling. And while maintaining V_y (85 knots in this case), control response will be no different than when flying at the same airspeed at sea level.

Explaining the upper limit is an educational experience and provides a challenge to those who think it easy to get there.

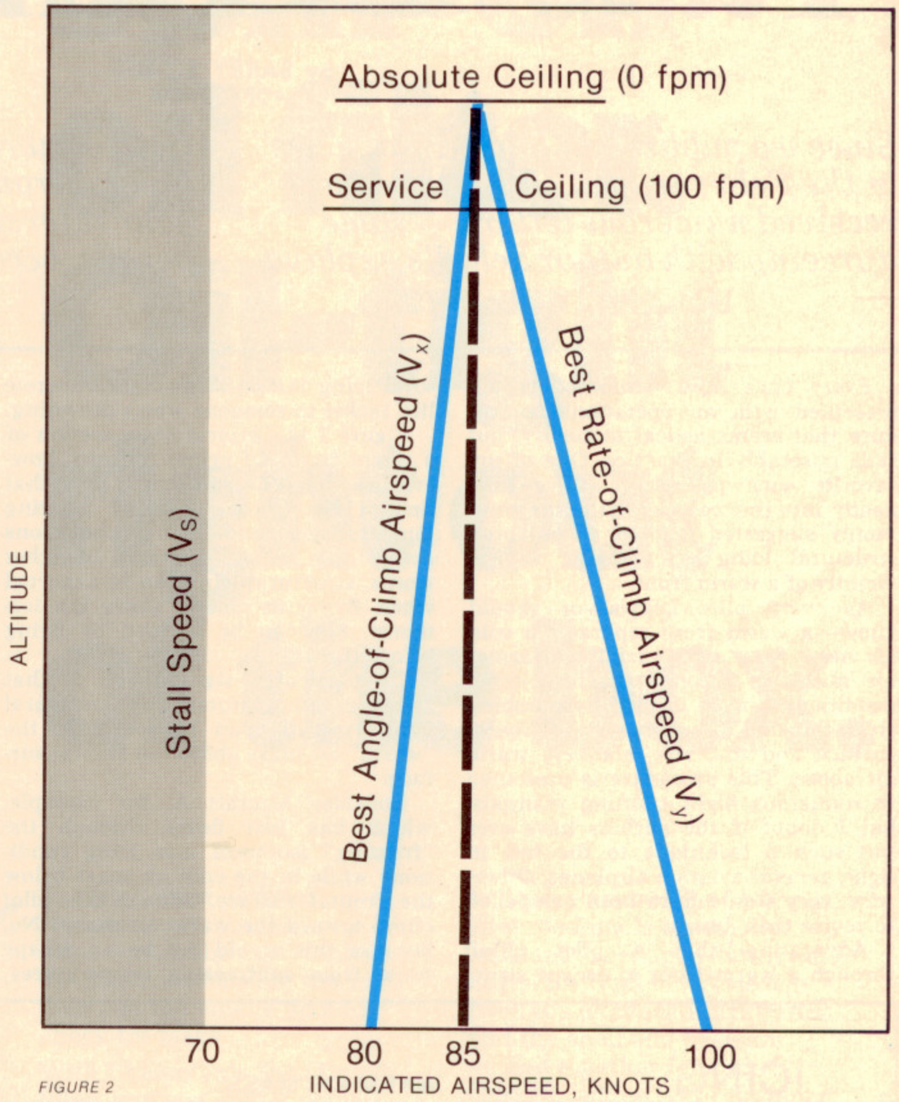

FIGURE 2

Comrade Kochinko, a pilot in the Soviet Air Force, was given a most unusual flight assignment. He was told to fly to any point of his choosing in the Northern Hemisphere and, once there, perform the following navigational exercise:

"Fly a true course of 360° for 500 nautical miles, turn right and maintain a true course of 090° for another 500 nautical miles, and then turn so as to track along a true course of 180° for an additional 500 nautical miles."

This didn't sound particularly difficult until Kochinko read the final requirement of his flight orders: "After flying each of the three 500-nm-long legs, the aircraft must arrive at the same point from which the first leg started."

Initially, Kochinko was much concerned about this seemingly impossible assignment because he knew that failure to comply would result in a Siberian vacation. Eventually, however, the Soviet pilot realized that, yes, he could perform such a mission.

If *you* were Comrade Kochinko, how would you resolve this dilemma? Remember, the entire flight occurs within the Northern Hemisphere and the equally long legs must be flown in the designated sequence: north, east and then south. So that you are not tempted to peek, the solution has been placed at the end of this article.

Murphy's Law claims that whenever something can possibly go wrong, it will. There are, of course, numerous corollaries to this adage, but one of concern to pilots states that headwinds occur more frequently than tailwinds.

In a way, the statement is accurate, especially with respect to round-robin flights. Given any specific wind direction and speed, a round trip takes longer than when the wind is calm.

For example, assume that a pilot is flying due east from A to B, a distance of 300 nautical miles. With a calm wind and true airspeed of 150 knots, the round trip (600 miles) would require exactly four hours (excluding time lost during climb, departure and arrival maneuvering).

But now introduce a 50-knot westerly wind. The 300-mile outbound flight would be flown with a 200-knot groundspeed and require only one hour and thirty minutes. The groundspeed for the return leg, however, would be only 100 knots and require three hours en route. Total time for the round trip would be four hours and thirty minutes, half an hour longer than had there been no wind at all.

The reason for the additional flying time is that the aircraft spends more time under the influence of a headwind than it does benefiting from the tailwind. Consequently, the average groundspeed is less than had the wind been calm.

With respect to round-robin flights, therefore, it can be said that *any* wind is an "effective headwind" because flight time is prolonged.

But what about one-way flights? Does Murphy's Law affect these, too? Do headwinds really prevail over tailwinds? Logic suggests that for any given flight, the odds in favor of a headwind are equal to those in favor of a tailwind. Right? Wrong! Sad to say, Murphy is once again correct. Headwinds do prevail, but not simply because the contrite, Irish gentleman has a vendetta against pilots. The reason is a bit more obscure.

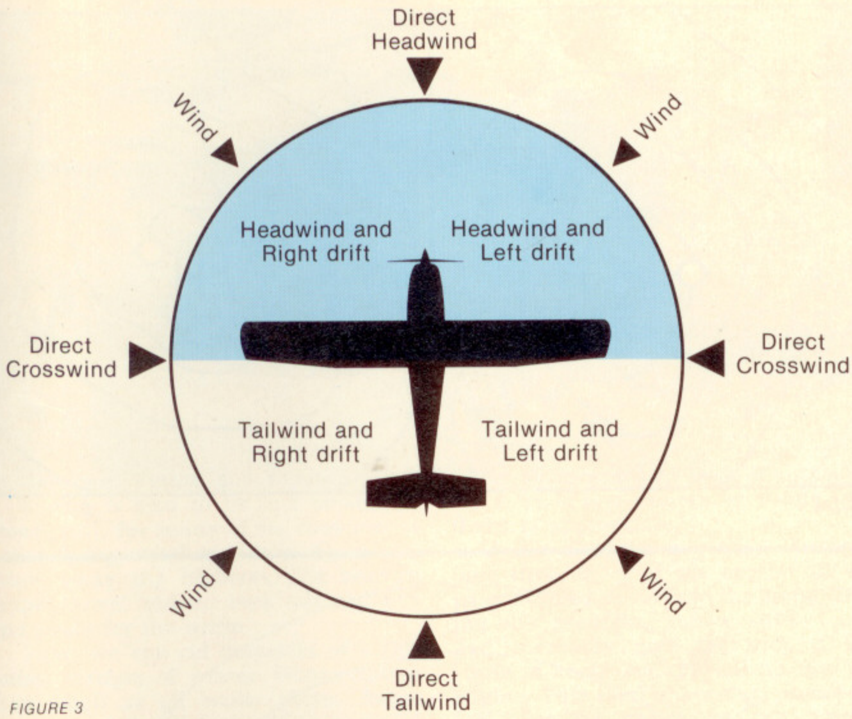

FIGURE 3

TRUE AIRSPEED	WIND CORRECTION ANGLE (CRAB) 10°	15°	20°	25°	30°
80	-1	-3	- 5	- 7	-11
100	-2	-3	- 6	- 9	-13
120	-2	-4	- 7	-11	-16
140	-2	-5	- 8	-13	-19
160	-2	-5	-10	-15	-21
180	-3	-6	-11	-17	-24
200	-3	-7	-12	-19	-27
220	-3	-7	-13	-21	-29
240	-4	-8	-14	-22	-32

Figure 3 shows a compass rose about an airplane, a diagram used commonly in textbooks to describe the effects of various wind directions. For example, winds blowing toward the airplane from the directions encompassed by the shaded area are headwinds while those blowing from the lower two quadrants define tailwinds. Do you agree? Well, you shouldn't. This popular presentation is inaccurate.

The diagram implies that a crosswind from either 090° or 270° has no effect on groundspeed. In other words, these crosswinds would be neither headwinds nor tailwinds. Not so.

In order to correct for a crosswind and maintain the desired true course, it is necessary to establish a wind correction angle, or crab. But the act of crabbing necessitates turning *into* the wind. The result? A loss of groundspeed. The stronger the crosswind, the greater the loss. In other words, a direct crosswind also is a headwind.

The accompanying table provides the groundspeed loss due to crabbing into a crosswind for various true airspeeds (knots or mph). For example, if a 160-knot airplane is required to crab 20 degrees into a crosswind to maintain course, the groundspeed loss is 10 knots.

Very strong winds that blow from even slightly behind the aircraft may appear to be beneficial, but by the time the wind correction angle is applied more groundspeed may be lost (by crabbing) than would be gained from the tailwind component.

Consider, for example, a pilot who wants to fly a true course of 360° in a 150-knot airplane. The prevailing wind is 260° at 60 knots. Certainly this appears to provide a slight tailwind. But if the problem is resolved on a computer, groundspeed along the desired course is only 148 knots. Although this wind provides a 10-knot tailwind component, 12 knots are lost by having to crab 23° into the wind.

So, to the glee of Mr. Murphy, headwinds do prevail.

continued

Several years ago, an airline ground instructor posed a brain teaser to a large group of pilots to test their knowledge of basic meteorology. Unhappily, only a few could solve the problem. Feel like putting your expertise to the same test?

Figure 4 shows two pressure systems; one is a high while the other is a low. Both of the airports shown are at sea level and observers at each report identical weather conditions: clear skies, light winds and standard atmospheric conditions (59°F, dry air and an altimeter setting of 29.92 inches of mercury).

Each of two pilots flying identical light airplanes departs simultaneously from each of the airports shown. Everything else being equal, above which of the two airports will one pilot encounter better climb performance than the other?

Most pilots recall early lessons that teach how air circulates clockwise about a high-pressure system and counter-clockwise about a low (in the Northern Hemisphere. But most seem to forget that a high-pressure system consists also of subsiding (descending) air. Conversely, air rises from within a low.

This helps to explain why there generally is so much more weather in a low-pressure system as compared to a high. Rising air condenses to form vertically developed cloudiness and precipitation.

Being aware of this basic information provides the solution to our problem. The pilot climbing within the low experiences the best performance because his plane is assisted by rising air—a spritely climb because of a "vertical tailwind." This does not refer to local vertical movements such as thermals. Rather, this refers to a huge mass of slowly rising air.

Conversely, the pilot flying in the high-pressure system must climb against subsiding air, which is much like fighting a vertical headwind. This condition has been known to evoke a comment such as: "This thing doesn't seem to be climbing very well today; we must be flying through *dead* air."

Most pilots solve the stated brain teaser incorrectly because they conclude that an airplane performs better in high pressure than in low. Quite true. But recall that the problem stated that the atmospheric pressure at each airport was identical (29.92"). The only difference is the pressure *surrounding* the two airports; one is *in* a high while the other is *in* a low.

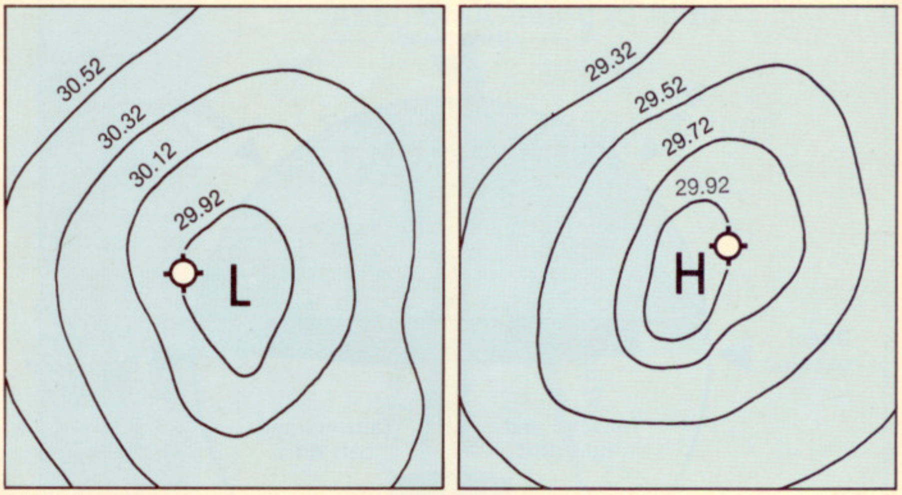

FIGURE 4

Solution to Navigation Problem

Figure 5 is a polar (top) view of the Northern Hemisphere. The geographic North Pole is in the center of the "chart" and the large, outer circle represents the equator.

As one proceeds north from the equator toward the pole, the circles (parallels) of latitude become progressively smaller. If you proceed far enough, you eventually reach a circle of latitude that has a circumference of exactly 500 nautical miles. (At 89° north latitude, for example, the circumference of that parallel is only 377 nautical miles.)

Comrade Kochinko simply began his flight assignment at a point 500 miles south of the circle of latitude that has a circumference of 500 miles. He then flew due north for 500 miles, turned eastward and flew around the pole in a 500-mile circle. At the end of his circumpolar leg, Kochinko turned south and flew for another 500 miles until arriving over the starting point.

(For the technically oriented, a circumpolar track of 500 miles occurs at 88° 40.4′ N. Kochinko began his flight assignment 500 miles south of this parallel, or at 80° 20.4′ N.) □

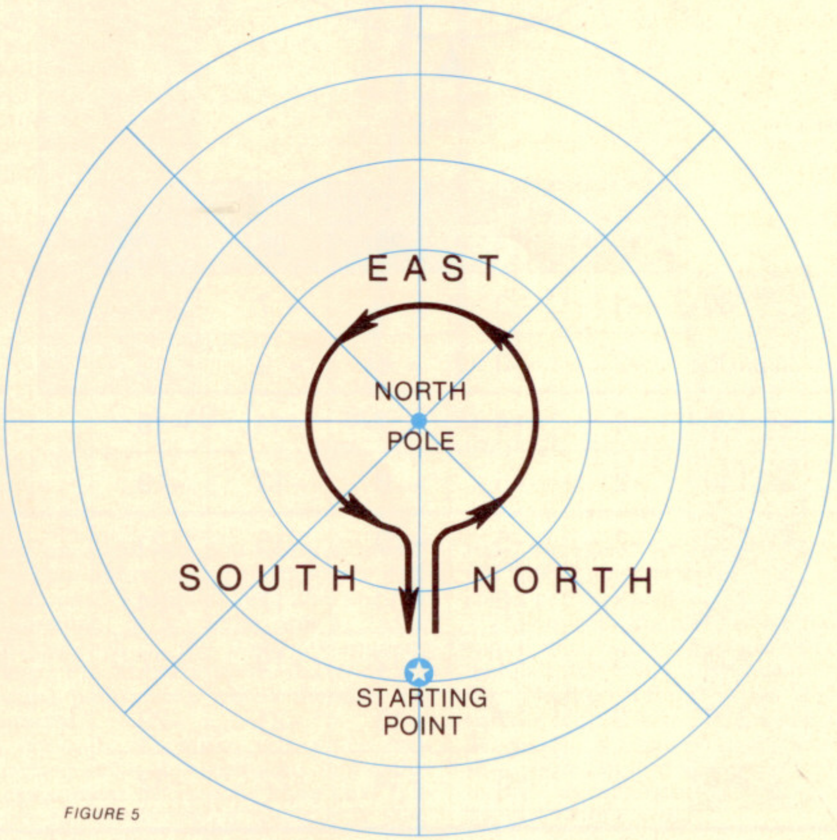

FIGURE 5