PILOT PRINCIPLES

An almanac for aviators seeking to learn the facts of flight/compiled by Bruce Landsberg

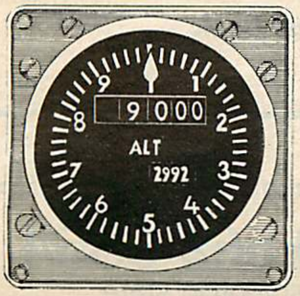
FLYING CAN BE a formidable mental excercise. Pilots gather all sorts of data, and there always seems to be one more figure to be factored into another equation. At such moments, rules of thumb can come in handy. They save time, are based on fact or experience, and can serve suitably for all but the most exacting needs.

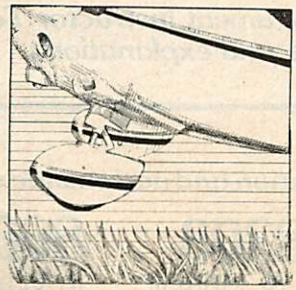
There are rules of thumb that apply to every phase of flight. Here are some of the more useful we have found.

It always takes longer than you think. This cardinal rule applies to all flight operations. Experienced pilots use it when contemplating estimated times of arrival, terminal delays, forecast weather improvement, takeoff and landing distances or aircraft repairs.

Use 150 percent of a headwind or 50 percent of a tailwind to determine block-to-block groundspeeds. For quartering headwinds or tailwinds, use half the value. A headwind has a greater effect on a cross-country trip, because the aircraft flies in it longer. A tailwind has less effect, because a smaller percentage of flight time is spent in cruise. Time spent taxiing and maneuvering for an approach is equal, headwind or tailwind.

A fuel stop will add 45 minutes to total trip time. The average fuel stop includes personal refreshment, at least one phone call, paying the fuel bill and a walk-around to check fuel caps and sumps. Add 10 minutes if a squall line is approaching and you're hoping to depart before the weather arrives.





A fuel stop will use half an hour's worth of fuel for most light singles. A landing and climb back to altitude uses between five and eight gallons more than would have been used if the flight could have been completed without the stop. If you are operating at turbocharged altitudes, increase that by 50 percent; double it if you fly a light twin.

An airplane loaded with an aft center of gravity is faster. When the CG is aft (closer to the center of lift), the airplane is better balanced, reducing the need for negative lift and the resultant drag from the horizontal stabilizer. The stall speed is lower with an aft CG, and landings in heavy aircraft are easier because pitch control forces are lighter. Obviously, the CG must be within specified limits.

The most efficient en route altitude is between 6,000 and 8,000 feet msl for normally aspirated engines at 75-percent power. This is the highest altitude at which the engines will maintain 75-percent power, and it allows the highest true airspeed for a given amount of fuel burn. As the power setting is lowered, the optimum altitude increases. When choosing altitudes, though, winds aloft and time and fuel used to climb probably have more to do with efficiency than does optimum altitude.

Turbocharged engines are most efficient above 20,000 feet. Some turbos, however, have a maximum operating altitude (usually due to engine cooling requirements) that is well below the altitude at which the engine could maintain good cruise power. This maximum altitude will be most efficient for those aircraft.

It's inefficient to climb more than 10 minutes per hour of estimated time en route. Climbing to the engine's optimum altitude may not be efficient on a particular trip. Unless there are spectacular tailwinds, high-altitude cruise efficiency will be offset by fuel burned in the climb.

Fuel consumption is equal to horsepower times percentage of power used times specific fuel consumption (approximately .43 pounds per horsepower per hour when leaned to best economy—.48 for turbocharged engines). A 200-hp engine times .65 (percentage of power used) times .43 (specific fuel consumption) equals 55.9 pounds per hour. Dividing by six converts the pounds into 9.32 gallons per hour.

Add half a gallon per cylinder to determine climb fuel for a normally aspirated light airplane. Add two gallons to the estimated fuel burn for climb with a four-cylinder engine. Also add a couple of gallons for taxi and takeoff.

An increase in power setting causes fuel flow to increase twice as much as the speed. In an average light airplane, flight at 75-percent power uses 13 percent more fuel but is only six percent faster than at 65-percent power. Flight at 55-percent power uses 25 percent less fuel with only a 12-percent speed loss compared with 75-percent power.

True airspeed increases about one percent per 1,000 feet of altitude. This relationship will help you determine how high to go when flying into a headwind. An airplane that will cruise at 150 knots at 2,000 feet will have a true airspeed of about 159 knots at 8,000 feet. Remember that turbulence will reduce airspeed, so the lowest smooth altitude may be the best compromise.

To figure density altitude, add 1,000 feet to the field elevation for each 15° F. above standard temperature. The standard temperature at sea level is 59° F.; it decreases at about 3° per 1,000 feet.

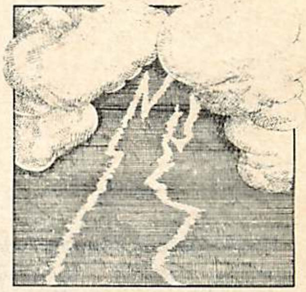
Increase sea-level takeoff distance by 10 percent for each 1,000 feet of density altitude. Decrease the takeoff distance by one percent for each knot of headwind, and increase it by 10 percent for each two knots of tailwind. It's worth noting that tailwinds have five times the effect of headwinds.

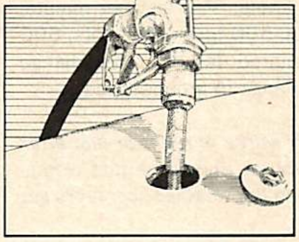
Double any computed takeoff roll distance to maintain options. Eyeball a halfway point on the runway; if the airplane isn't ready to fly there, it isn't performing properly. And in most airplanes, there'll still be room to stop, because most are better at slowing down than speeding up.

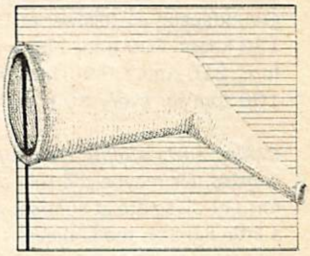
Determine climb gradient by dividing the rate of climb by nautical miles per minute. Feet climbed per nautical mile is important in mountainous terrain, or at anytime there are obstructions to be cleared. For example, a 100-knot groundspeed equals 1.666 nautical miles per minute. A 600-foot-per-minute rate of climb divided by 1.666 equals 360 feet of climb per nautical mile. If a 5,000-foot mountain is 10 miles away, better circle while climbing.

Figure the estimated time of arrival over the first checkpoint by adding half a minute to estimated cruise time en route for each thousand feet of climb. If, for example, the climb is to 6,000 feet, estimated groundspeed is 120 knots, and the first checkpoint is 40 miles away, the estimated time en route would be 23 minutes.

Maneuvering speed is roughly the square root of the limit-load factor times the stalling speed. The limit load for normal-category aircraft is 3.8 Gs; it is 4.4 Gs for utility-type aircraft. The square roots are 1.95 and 2.2, respectively, so doubling the stalling speed gives a close approximation.







Maximum endurance is attained at Vy. Vy, the best-rate-of-climb speed, approximates the maximum lift-over-drag ratio; it requires the least amount of power to maintain level flight. If you become lost, this speed will stretch the fuel supply and give you more time to spot landmarks or summon help by radio.

For instrument pilots going nowhere, or holding, fly at Vy. If you know about the delay in advance, slow down en route with ATC's permission. Just watch out for rising engine temperatures.

Maximum range is attained at Vy plus 25 percent. This speed will be close to the 45-percent-power setting that is usually the lowest shown on range charts or graphs. In some aircraft you may only gain a few miles, but they could make a difference.

One degree off course equals one nautical mile off course 60 nautical miles from the station. Relate this to the VOR: a full deflection is 10 degrees off course. If the needle is halfway out and you are 60 miles from the station, you are five miles off the selected course.

Performance speeds decrease by half the percentage below gross weight. Stall speed, climb speeds and approach speeds are all sensitive to weight. When your aircraft is 10 percent under gross, optimum speeds will decrease by five percent.

To calculate estimated time en route at 150 knots, multiply distance by four and drop the last digit. With 50 miles to go, this times four equals 200, or 20 minutes. Only going 100 knots? Multiply the distance by six. For 120 knots, divide by two; and for 180, divide by three.

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Begin descent five miles out for every 1,000 feet of altitude to lose. Are you 8,000 feet above the ground? Start down 40 miles out. The rate of descent is dependent on groundspeed as follows: at 90 knots, 300 feet per minute; 120 knots, 400 fpm; 150 knots, 500 fpm; 180 knots, 600 fpm; 210 knots, 700 fpm. Required descent rates change 100 fpm for every 30 knots' change in groundspeed.

Ceiling and visibility are usually worse at night or just after sunrise. Or maybe the rule of thumb should be that clouds form or dissipate at sunrise, when the weather observers get a little light on the subject.

Winds aloft increase in a frontal zone. Honest. Everyone but the winds-aloft forecaster knows this one.

If the wind behind a cold front isn't more or less perpendicular to the front, the front might well become stationary and then return a few days later as a warm front. Beware of northeast winds behind cold fronts.

A wind correction angle to the left means you are flying toward an area of lower pressure. You know what that means.

The base of cumulus clouds can be estimated by dividing the temperature/dew point spread by a lapse rate of 4° F. With a temperature of 88° and a dew point of 62°, the spread of 26 divided by four equals 6.5. The base of the clouds will be about 6,500 feet agl. This method is most accurate with convective clouds in the middle of the day and gives a good indication of how high you'll need to go to avoid thermal turbulence.

If the temperature drops more than 2° C. per 1,000 feet, watch for thunderstorm development. Lapse rate is a measure of instability. And comparing the actual temperature aloft to the temperature forecast for the winds aloft gives a clue to the accuracy of the forecaster's conception of what might happen. If it's colder aloft than forecast, the air is less stable than anticipated.

Thunderstorms are usually meanest on the side toward which they are moving and on the side from which they are feeding, as indicated by the low-level wind flow. Thunderstorms generally move across the ground with midlevel (18,000-foot) winds, and are usually fed by southerly winds.

High to low, look out below. When flying from an area of high pressure or temperature to an area of lower pressure or temperature, be aware that the altimeter indicates higher than your actual altitude.

Temperatures in high-pressure areas tend to be cooler than those in low-pressure areas. Low-pressure air is usually rising while high-pressure air is descending from cooler altitudes aloft. It's also worth noting (and rather obvious) that warmer air can hold (and dump) more moisture than colder air.

Normal approach speed is usually 1.3 times the landing-configuration stalling speed. This would be the airspeed at the bottom of the white arc times 1.3.

If the winds are gusty, increase approach speed by half the gust factor. With the wind 10 knots with gusts to 20, add five knots to the final approach speed. Also add to the runway length required.

A 10-knot headwind will shorten the landing distance by 10 percent from a zero-wind condition, but the equivalent tailwind will add 50 percent to the required distance. It stands to reason, therefore, that an approach speed 10 knots over the normal figure will add 50 percent to the required landing distance.

The crosswind component is one third the wind when it is 30 degrees to the runway. Make it half the wind at a 45-degree angle, two thirds at a 60-degree angle. Naturally, you get the full blast at 90 degrees.

The maximum demonstrated crosswind component of an aircraft is usually set at a 90-degree crosswind velocity equal to 20 percent of the stalling speed. This is the FAA certification requirement.

To determine the speed at which an aircraft begins to hydroplane, multiply the square root of the tire pressure by nine. A light twin with a tire pressure of 36 pounds will begin hydroplaning around 54 knots, which means that aerodynamic braking will be the major source of stopping power above that speed when there is standing water on the runway.

And remember this one: ***Keep the pointy end forward and the dirty side down.*** ☐