

In the good old summertime.

The Heat is On

By

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IT'S always surprising how much hot weather takes out of an airplane—a wintertime tiger can turn into a real pussycat come summer. This happens at a time when airplanes are often used in smaller airports, and when they are likely to have bigger loads, too. One of the more important things here is to be able to tell how much runway it's going to take to get off, and how the airplane is going to climb after that. The big airplane people compute required runway lengths and have concrete information on a go/no-go decision. In small airplanes the available information isn't as cut and dried, and there's more variation in runway surfaces and obstructions in the fields used.

So, as the season changes to Hot, it's not a bad idea to look at what causes performance to sag, how to compute required runway lengths with some margin for error, and the technique of getting out of a minimum space in the most efficient manner.

First, the airplanes don't do as well in hot weather because hot air is thinner than cold air. Most performance calculations are based on what's called standard air, and that simply means the temperature is at the standard for whatever elevation

is being discussed—usually sea level where the standard temperature is 59 degrees F. Run it up to 100 degrees at sea level, and while the airplane is still on the ground the air is actually of the same density as standard air at about 2,750 feet. Hot air does two things. It gives the wing a thinner medium in which to do its work, and it causes the engine to have relatively less air to mix with the gas to make the *GO*. The effects of this are presented to us in the owner's manuals, and on the Koch chart from which it's possible to figure percentage deterioration in performance figures as the temperature and/or altitude increases. FAA also offers a computer for figuring the same thing.

There are important items some owner's manuals don't include, but by looking at a lot of different manuals and by soliciting the opinion of Dave Ellis, an Aeronautical Engineer and pilot, it was possible to come up with a figure for some of the variables.

Example

For an example, let's take a Cessna Skyhawk on a 100 degree day and put it on a moderately rough 3,000 foot long grass strip at an elevation of 2,500 feet with 50 foot

obstructions 500 feet from each end of the runway. The wind is calm. Can it go at gross weight, with no thrills?

The book gives a figure, at 2,500' elevation, of 1910 feet to clear a 50 foot obstacle in standard air (50 degrees at that altitude), and says add 10% for each 25 degrees above standard. This would increase the required distance to clear 50 feet to 2,292 feet. That would put the airplane 50 feet high and climbing, with 708 feet to go before the end of the runway is reached, and 1208 feet to the 50 foot obstacle.

Something else needs to go in, though—an allowance for the grass. The Skyhawk book doesn't give a figure for this, but Cessna's 180 book says on a grass field add 7% to the distance required to clear a 50 foot obstacle. The 180 has a conventional gear, and not as much tire in the grass as a Skyhawk so 10% might be added. That gets the distance required to take-off and climb to 50 feet up to 2,521 feet.

How about something for the roughness of the field? The best we got was that it would prolong the take-off run. No manual here says anything about it, but add 5%, for a total distance of 2,647 feet required to clear 50 feet, with no margin for error, downdrafts, turbulence, or pilot technique.

The Skyhawk charts show an indicated airspeed of 70 when the obstacle is cleared at gross weight. It's hard to interpolate the owner's manual figures and get the rate of climb for the hypothetical case, but using the Koch chart and the

sea level, standard air, figures it appears that the rate of climb will be 50% of the basic figure, 645 fpm, or about 323 fpm.

No Sweat?

Now, follow this, for if you've ever sweated a take-off that you thought was going to be no sweat this might explain why. At 70 indicated, the speed upon which the figures in the manual were based, the true airspeed (and groundspeed with no wind) would be 75 mph, which is 110 feet per second. So, the 854 feet from the point the airplane reached 50 feet to the obstacle itself would be covered in 7.8 seconds during which time the airplane would have climbed only an additional 42 feet. That is not much margin for error—especially when it's considered that the basic figures are for new airplanes, perfect piloting technique and smooth air, the additions were rules-of-thumb, and nothing was included in the figures for a possible upslope. Also, that grass could be 12% grass instead of 10% grass, and the field might have been a little soft. A soft field can lengthen the take-off distance to infinity—it all depends on how soft it really is.

Pad

How much margin to add for contingencies? That might depend on how conservative you are, but, all things considered, 30% would appear to be a minimum. In the preceding example 30% on top of everything else would have indicated a required distance of 3,340'

to clear a 50 foot obstacle, which would have alerted the pilot to the fact that it might be very close.

Don't despair, there's a sure cure for this. Another rule-of-thumb is that the distance required decreases by twice the percentage of a weight decrease. In other words, if 5% of the gross (115 pounds) is left out of a 2,300 pound gross airplane, then the distance required decreases 10%. A 10% weight decrease cuts the distance by 20%. This rule-of-thumb works the other way, too—if an airplane is 10% *over* gross, the distance required increases 20%. Airplanes shouldn't ever be overloaded, especially in the summer on short fields.

The Skyhawk's performance figures are about the same as the other airplanes in its horsepower and weight class so any of the others would come out about the same in the example used. The rules-of-thumb can be applied to any airplane, and the example cited would take the zoom out of anybody's gross weight figures.

Twins

Hot weather is also a very important consideration in twin-engine summertime flying. Most twins have a lot of reserve performance with both engines running, but if there's to be a margin in case of engine failure it is very important to lighten the load come summer. Say the average twin climbs 300 fpm on one engine in smooth standard air at sea level at gross weight. If it's flown at gross weight in conditions like those used a moment

ago, you can imagine what would happen to the single-engine performance unless some weight is left out to compensate for the heat. Most owner's manuals have charts or graphs that explain this.

The Speed

Last, a short discussion of technique.

The average light airplane can be flown pretty sloppily in cool weather and still yield good climb performance—there's a lot of margin for everything. When it gets hot, though, and all the performance figures are cut drastically by the heat it is time to fly precisely.

On a field that is close for the temperature, altitude, and load, the best angle-of-climb speed is the thing. At that speed the airplane delivers the most in "up" for the forward distance traveled, which is what counts in clearing an obstacle. If the obstacles loom large and the pilot pulls the nose up a little and the speed drops below best angle-of-climb speed the airplane is going to mush (if not stall). If the pilot gains excessive speed the distance to the obstacle will be covered too quickly and the airplane won't be up when it gets there. Simply, if it won't cut it using the take-off procedure recommended in the owner's manual and the best angle-of-climb speed, it won't cut it at all.

There is one variation here. Some manuals have charts showing the best angle-of-climb speed for different weights, but most just list one speed which is for gross weight. The best angle-of-climb speed is re-

stance, on a reasonably smooth and firm surface—or pavement—it's usually most efficient to let the airplane run in a level attitude to about the best angle-of-climb speed, then go, maintaining that speed until the obstacle is cleared. The reason for this is that in the lower speed range most light airplanes accelerate better while rolling in a level attitude than they do when flying at the high angle-of-attack necessary at the low speed. Also, it helps to know in advance the attitude which will be required to hold the best angle-of-climb speed (it'll vary with weight, among other things, too) so the airplane can be smoothly transitioned from the efficient level roll to the efficient climb. If the field is soft though, it *is* better to get the nosewheel out of the goo or high grass and lighten the back wheels early in the run,—lift off at as low a speed as possible, and then accelerate to best angle-of-climb speed a few feet off the ground.

Flap use should be strictly determined by what the manual says.

An important technique item has to do with the pilot's flying time in type. If not really familiar with an airplane, it's best to stay far far away from an airport on which the calculations are anywhere near marginal.

Airplanes are most useful in the summer (as well as most enjoyable) and all that has to be done to keep the performance on a par with what it was last winter is keep the weight down, and fly for the most in efficiency.



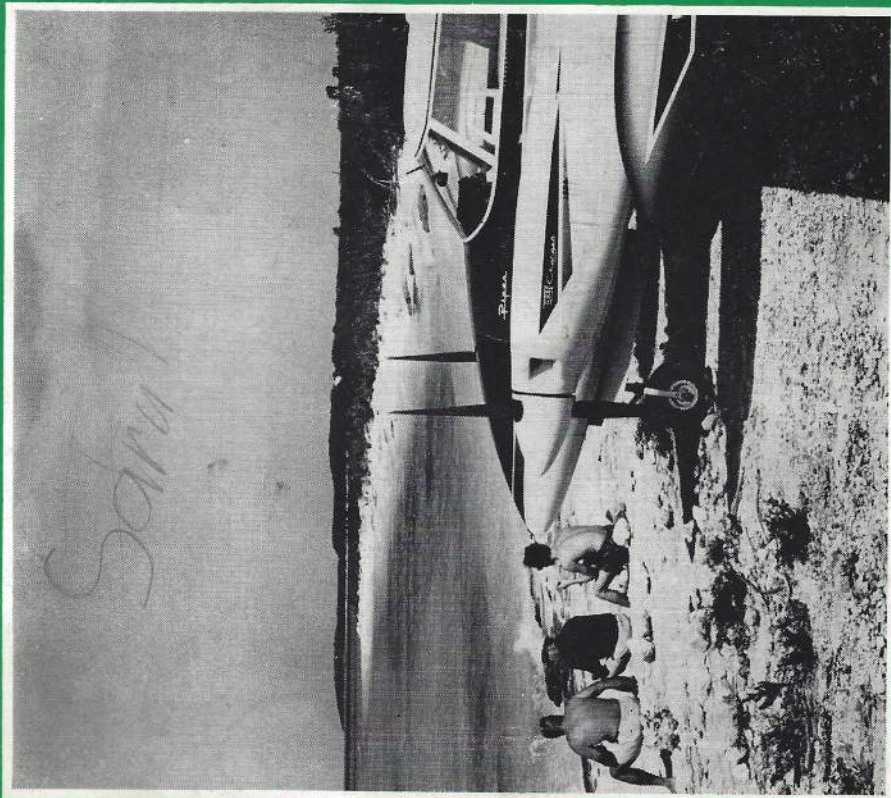
lated to the stalling speed, and as weight decreases so does stalling speed and thus angle-of-climb speed. A conservative rule-of-thumb to use in reducing speeds to match reduced weights (this can be used for best rate - of - climb speed, approach speeds, and maneuvering speed, too, as they are all related to stalling speed) is, to lower the speed in question by one-half the percentage of the decrease in weight from gross. This is approximate and for the average light airplane. It is important, too, for if you lighten the load for better performance you really don't get the full benefit of the lightening unless you adjust the speeds used, as indicated. An example—if the book says accelerate to 70, and then take-off and climb at that speed, but the airplane is 15% below gross, the speed should be reduced 7.5% to 65 (or what the manual says if it has a chart to figure this). Using a speed higher than that would prolong the ground run and flatten the angle-of-climb. And, 65 would give the same margins at the reduced weight that 70 gives at higher weight, so there is no compromise in anything. By the same token, if the airplane is overloaded (which it shouldn't be) a speed higher than the gross weight speed should be used, and the same rule-of-thumb would apply.

Finesse Counts

A fine and sensitive touch on the wheel, and an awareness of the proper technique for the circumstances is probably the hardest thing to define (and develop). For in-

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