DAVID PILKINGTON WITH MORE PLANE ENGLISH ON PART 91PERFORMANCE REQUIREMENTS

My earlier articles on the performance requirements of Part 91 were based on the draft so, as it is only a few months before it takes effect, we should consider it again. Being a former flight performance engineer, I like to take an interest in numbers so let's discuss take-off and landing performance as required by 91.795 and 91.800.

We'll discuss take-off performance in some detail and just touch on the similar landing performance requirements.

Let's limit the scope of the discussion to small single-engine aeroplanes certified to FAR 23 and that is important for several reasons:

- **There is nil requirement in FAR 23 for any performance limitations and any operating limitations must be specified in the airplane flight manual (look in the limitations section).**
- **FAR 23 specifies the minimum performance information which must be provided to the pilot and that depended on which version of FAR 23 the airplane was certified to. Manufacturers don't continually revise their manuals for airplanes that were built many years ago, especially if it was a different company that built them under the same type certificate.**
- **There are different amendments of FAR 23, for example, earlier versions required only that take-off and landing may not require exceptional pilot skill and later ones "not require more than average pilot skill". There is a difference in the way a test pilot addresses each!**

The Sept-Oct 2002 issue of Flight Safety Magazine included an article which addressed these issues:

"….. It is tempting to simply say the whole episode could have been avoided if the pilot had consulted his aircraft's take-off performance charts … However, it is unrealistic to assume that all light-aircraft pilots will calculate the exact take-off and landing distance required before every flight. ……. A word of warning about aircraft performance charts. ….. the production of uniquely Australian charts ceased and pilots ….. calculate performance using information supplied by manufacturers.

Aircraft manufacturers' performance charts do not include built-in safety factors and in most cases reflect best-possible performance achieved with: Highly experienced test pilots …". All true!

It is good that CASA's Part 91 Plain English gives advice on this:

For aeroplanes with take-off performance charts which are unfactored it is recommended that the following factors are applied to the take-off distance required:

- *MTOW 2,000 kg or less – 1.15*
- *MTOW above 2,000 kg but below 3,500 kg – linear interpolation between 1.15 and 1.25*
- *MTOW 3,500 kg or more – 1.25.*

WHAT IS IN PART 91?

From the Part 91 Plain English Guide, we must consider the MOS to know what to do.

Take-off performance for aeroplanes (MOS 24.02)

You must ensure, during and after take-off, until reaching the minimum height, that the aeroplane has the performance to clear all obstacles by a safe margin after considering:

- 91.265 Minimum height rules – populous areas and public gatherings
- 91.267 Minimum heights rules – other areas
- 91.277 Minimum heights – VFR flights by night, or
- 91.305 Minimum heights – IFR flights.

The primary requirement is therefore to determine that the aircraft has adequate performance to get off the ground and clear the fence, trees or other obstacles near the end of the runway. “By a safe margin” is the rider. The general principle is to look at the distance to clear a 50 ft obstacle and that would ensure a safe margin over a typical fence, perhaps even over typical power lines and trees.

You must determine the aeroplane performance from 1 of the following:

- the AFM
- the manufacturer's data manual (if any)
- other data approved under CASR Part 21 for the purpose.

This is quite different from the rules in effect prior to Part 91 and is very onerous as we shall see with a couple of examples.

In addition, you must also consider:

- the take-off distance available
- the pressure altitude and temperature
- the gradient of the runway in the direction of the take-off
- the wind direction, speed and characteristics
- the take-off and en route weather forecast
- the obstacles in the vicinity of the take-off flight path.

I find it interesting that the type of runway surface is not required to be considered as that will make quite a big difference to the take-off and landing distances required.

Another significant change is that the previous rules per CASA's VFRG: "it is acceptable to base all take-off and landing weight limitation calculations on declared meteorological conditions …. alone and you may only be required to determine weight limitations three times per year (for summer, winter and autumn/spring seasons)." Now we must use "the pressure altitude and temperature".

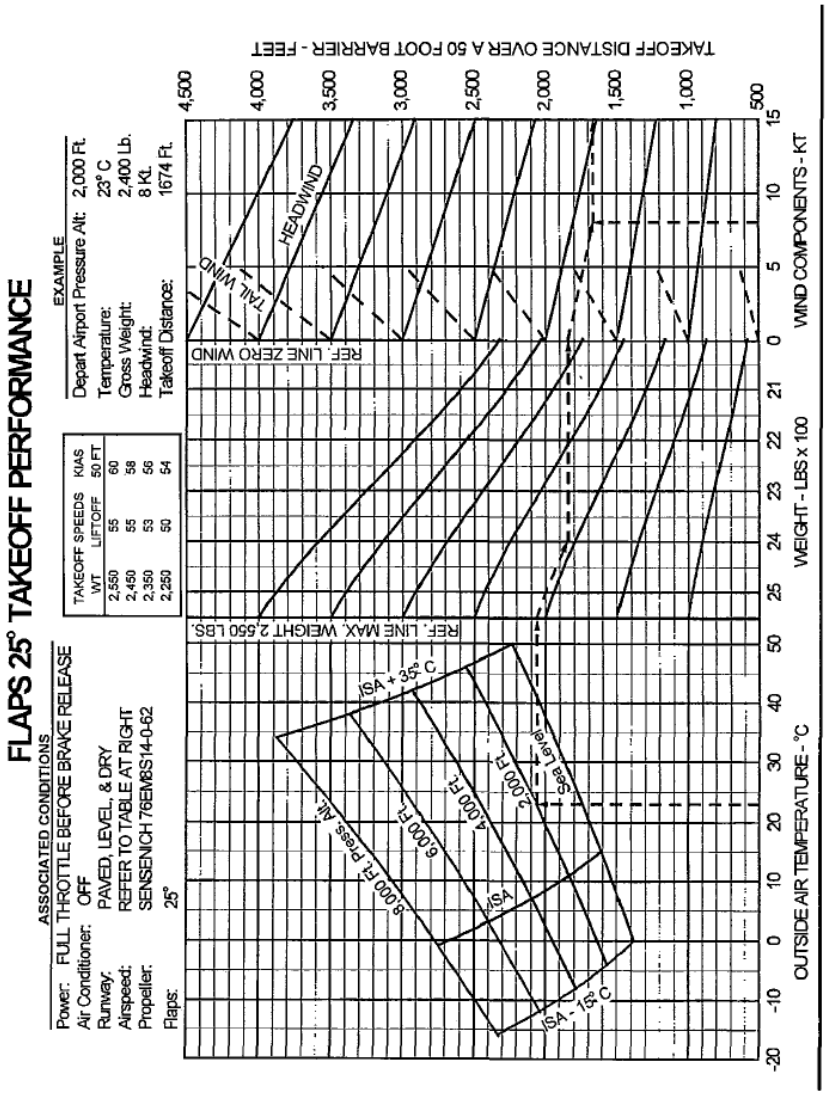
The landing performance requirements use the same wording.

PIPER ARCHER AS AN EXAMPLE

Let's use a new Piper Archer III as an example. The POH states: "The performance charts are unfactored and do not make any allowance for varying degrees of pilot proficiency or mechanical deterioration of the aircraft." It was certified to CAR 3 (which preceded FAR 23) plus a small selection of requirements from earlier

versions of FAR 23. It seems to me that the POH is trying to say that it will not be easy for the average pilot to achieve the take-off and landing distances quoted.

The Piper Archer III POH goes on to state: "This performance, however, can be duplicated by following the stated procedures in a properly maintained airplane." So it is possible to achieve those distances if you nail those airspeeds and your ASI has nil error. Of course, the airframe must be in reasonable condition and the engine must be developing rated power. Check the slow idle RPM as anything higher than Lycoming's recommendation will lengthen the landing distance.



25° FLAPS TAKEOFF PERFORMANCE
Figure 5-9

The usual CASA tolerance of up to 5 kts over the specified speeds will result in a significant increase in distance and there is no margin in the POH chart to cater for it. The FAA's excellent Handbook of Aeronautical Knowledge Chapter 11, Aircraft Performance states that "ten percent excess airspeed would increase the takeoff distance 21 percent"! It is worthwhile reading that chapter to fully understand performance data in the POH for an American aircraft.

https://www.faa.gov/regulations_policies/handbooks_manuals/aviation/phak/media/13_phak_ch11.pdf

The first thing that many pilots would notice about this is that it is different than what they used in their theory course. As noted in that 2002 Flight Safety Magazine article those uniquely Australian "P Charts" were withdrawn many years ago.

It is important to note that the Archer III POH does not allow extrapolation beyond the limits of the charts so you must not take-off above an ambient temperature of 50°C for example.

May one take off if the pressure altitude is less than sea level pressure? When we could use the declared density altitude then obviously it was not an issue. Now we must use the pressure altitude so can we extrapolate to higher pressures?

Those "P Charts" included the effect of different runway surfaces and runway slope but the Piper chart above does not have that information.

The Archer 3 POH usefully states: "Effects of conditions not considered on the charts must be evaluated by the pilot, such as the effect of soft or grass runway surface on takeoff and landing performance ...".

Part 91 requires us to "determine the aeroplane performance from" those specific sources. If we only have such data from the POH then are we restricted to just using that data or may we supplement it with "effects of conditions not considered on the charts … evaluated by the pilot"?

It seems to me that the wording in this plain English guide is not clear enough to answer that. Having dealt with many lawyers over the years my view is that their opinion would be that one is strictly limited to the data in the POH. As a former Aircraft Certification Engineer (an FAA Designated Engineering representative for FAR 23) and commercial pilot my view is that one should follow the words of the POH allowing evaluation by the pilot.

Prior to Part 91, CAO 20.7.4 allowed us to do just that, but how to do it? CASA provides nil guidance. Aviation theory texts provide nil guidance as they use the obsolete "P" charts which you must be familiar with to pass the CASA exams. I know that some flight schools properly address it depending on the type of aeroplane that they operate as well as the diligence of the flight instructors.

I like to use the UK CAA's Safety Sense Leaflet 07 on Aeroplane Performance which you may find online at https://publicapps.caa.co.uk/docs/33/20130121SSL07.pdf

This information was presented in CASA's Flight Safety Magazine of May-June 2001 but, unfortunately, this issue is missing from the government archives. The article, Running Out of Runway by James Ostinga and Peter Goodhew, had excellent practical advice on take-off and landing performance. "Determining take-off and landing distance is child's play. Even so, pilots of light aircraft get caught out on short strips around the country every year – mostly because they didn't take the time to do some very basic pre-flight preparation." Finishing with "Many pilots commit to memory the take-off and landing distances required for their aircraft on a sealed level runway, in nil-wind, ISA conditions at sea level. This gives them a rough idea of when they need to consult the performance charts. Halfway through the landing or take-off roll is no time to find out you don't have enough runway." And this table:

Performance factors for light aircraft

Take-off

Condition	Increase in take-off distance to height 50ft	Factor
A 10% increase in aeroplane weight	20%	1.2
An increase of 1,000ft in airfield altitude	10%	1.1
An increase of 10°C in ambient temperature	10%	1.1
Dry grass – up to 20cm (on firm soil)*	20%	1.2
Wet grass – up to 20cm (on firm soil)*	30%	1.3
A 2% uphill slope*	10%	1.1
A tailwind component of 10% of lift-off speed	20%	1.2
Soft ground or snow*	25% or more	1.25+

Landing

Condition	Increase in landing distance from height 50ft	Factor
A 10% increase in aeroplane weight	10%	1.1
An increase of 1,000ft in airfield altitude	5%	1.05
An increase of 10°C in ambient temperature	5%	1.05
Dry grass – up to 20cm (on firm soil)*	20% or more	1.2+
Wet grass – up to 20cm (on firm soil)*+	30% or more	1.3+
A 2% downhill slope*	10%	1.1
A tailwind component of 10% of landing speed	20%	1.2
Snow*	25% or more	1.25+

**Effect on ground run/roll will be greater.*
+When the grass is very short, the surface may be slippery and distances may increase by up to 60% (a factor of 1.6).

1. These factors are cumulative and where several factors are relevant they must be multiplied.

2. Any deviation from normal operating techniques is likely to result in an increase in the distance required.

3. Where a manufacturer specifies a particular factor which is greater than any of those listed, the manufacturer's advice should take precedence.

Adapted from the from the UK Civil Aviation Authority document: "Take-off, climb and landing performance of light aeroplanes" (AIC 12/96).

SUPER DECATHLON AS AN EXAMPLE

The 8KCAB was certified to an early version of FAR 23 and even recent production examples of the Super Decathlon have retained the same take-off distance data. Certification flight testing is expensive and there is no requirement for the manufacturer to provide additional information for operators. The manual notes that "This data is to inform the pilot what he can expect from the aircraft in the way of performance and to assist in flight planning."

TAKEOFF DISTANCE

CONDITIONS

1. Level, Hard Surface, Dry Runway
2. Zero Wind
3. Aircraft Loaded to 1950lb

PILOT TECHNIQUE: Refer to "TAKEOFF – OBSTACLE" in Section III

1. Speed at Lift-Off – 50 mph IAS
2. Speed at 50 Feet – 58 mph IAS

WARNING

The aircraft must be pitched forward to a safe power off speed should a power failure occur during climb-out; failure to respond immediately may result in a stall at low altitude.

Pressure Altitude (ft)	Distance (ft)									
	0°C		10°C		20°C		30°C		40°C	
	Ground Run	Total to Clear 50'	Ground Run	Total to Clear 50'	Ground Run	Total to Clear 50'	Ground Run	Total to Clear 50'	Ground Run	Total to Clear 50'
0	533	978	564	1032	596	1089	626	1144	656	1198
1000	569	1016	601	1097	634	1158	665	1216	697	1276
2000	610	1116	645	1179	678	1240	714	1305	750	1372
3000	658	1204	694	1268	732	1339	771	1409	807	1476
4000	706	1292	745	1363	786	1436	826	1510	868	1589
5000	765	1398	810	1480	851	1556	894	1636	941	1721
6000	831	1517	876	1599	917	1688	971	1777	1020	1864

NOTE

1. Data presented in this table represents maximum airplane capability at speeds shown and requires aircraft in good operating condition and a proficient pilot.
2. Decrease distance 20% for each 10 mph of head wind.
3. This data does not consider the effects of takeoff from soft and/or grass fields and takeoff with tail wind. Takeoff performance under these conditions varies substantially. Good pilot judgment must be used under all conditions to insure safe operation.

4-3

Again, the data is only for a level, sealed runway as that is all that FAR 23 requires. The range of the data is less than provided for the Piper Archer and there is the advice that “Good pilot judgement must be used …” to guide us.

There is no data for a slight tail wind however that is not a limitation of the aircraft. Again, if confronted by a lawyer familiar with Part 91 I would expect to be prevented from taking off or landing at Moorabbin when it has the usual slight tail wind. The old Australian “P” Charts did include the effect of a tail wind so I have the evidence that it is practical to do so. CASA has withdrawn approval for those old charts and, in any case, the newer Super Decathlons have a higher maximum weight than provided for on those old charts so they cannot be used at all.

Like the Piper, the data covers a range of density altitudes but provided in terms of pressure altitudes and temperatures. We know that performance of these simple piston engine aircraft is a function of density altitude so it is possible to do the arithmetic to get the performance for a very wide range of altitude and temperature conditions.

Achieving the distances given by the Super Decathlon manual is another story as there is that note “Data presented in this table represents maximum airplane capability at speeds shown and requires aircraft in good operating condition and a proficient pilot.” Proficient indeed! There is that WARNING which is explained earlier to mean “An operating procedure, practice or condition, etc which may result in injury or fatality, if not carefully observed or followed.” The salient factor is the airspeed specified at 50 feet – 58 mph compared to the stall speed of 56 mph. Another discussion.

XTREME DECATHLON AS AN EXAMPLE

This variant of the 8KCAB was certified in December, 2012 and, unlike earlier variants, the AFM incorporates all of the performance data. The approved maximum outside air temperature limit is 120 deg F (49 deg C). Incidentally, the AFM for the Xtreme Decathlon has sensible airspeeds for take-off and landing as required by this later FAR 23.

The airfield performance data includes the effect of tailwinds and different runway surfaces.

Take-off and landing performance is only provided up to a maximum temperature of 104 deg F (40 deg C) as specifically required by FAR 23. 40 deg C is simply as far as the provided data goes. Pilots may choose to go flying when the temperature is up to 120 deg F.

IS THIS A PLAIN ENGLISH GUIDE?

I accept that it is in plain English and it is a guide to what is in the regulations: “By following this guide, it is expected you will comply with the general operating and flight rules.“

It is far removed from advice we would expect in an Advisory Circular however. “Advisory Circulars are intended to provide advice and guidance to illustrate a means, but not necessarily the only means, of complying with the Regulations, or to explain certain regulatory requirements by providing informative, interpretative and explanatory material.”

The VIC RAPAC meeting 2017-1 included a relevant letter from CASA dated 14 March 2017 which stated:

“Regulation 138 of the Civil Aviation Regulations 1988 requires the pilot in command to comply with the requirements, instructions, procedures or limitations concerning the operation of the aircraft that are set out in the AFM. This means that a pilot must not operate an aircraft outside the limits set out by the ranges of parameters on the performance charts.”

There are a number of issues to consider in that letter:

1. “comply with …. limitations … set out in the AFM”. FAR 23 requires that any limitations be specified in the AFM and one would generally find those in the limitations section. In any case they would be clearly stated as a limitation. In the case of the Super Decathlon, the performance information discussed here is not in the FAA approved AFM, it is in the manufacturer’s Operating Manual so obviously there is no associated limitation.
2. “comply with … instructions, procedures … set out in the AFM”. The Piper Archer POH (and FAA Approved AFM) clearly states that "Effects of conditions not considered on the charts must be evaluated by the pilot, such as the effect of soft or grass runway surface on takeoff and landing performance ...". So, pilots must comply with that and evaluate it.
3. “This means that a pilot must not operate an aircraft outside the limits set out by the ranges of parameters on the performance charts.” My opinion is that this is not a true statement, as it is inconsistent with the above two points.
    a. The Archer III POH does indeed state that extrapolation beyond the limits of the charts should not be used for flight planning purposes. However, it also states "Effects of conditions not considered on the charts must be evaluated by the pilot, such as the effect of soft or grass runway surface on takeoff and landing performance ...". CASA’s letter would prohibit that part about conditions not considered on the chart – being parameters beyond that shown on the chart. CASA’s letter is contrary to the regulation on complying with the AFM and FAR 23 requirements for an AFM.
    b. The Super Decathlon has no performance information governed by the AFM. It is all just information for the pilot in flight planning supported by “good pilot judgement” like the UK CAA’s Safety Sense Leaflet 07 and that article in CASA’s May-June 2001 issue of Flight Safety Magazine.

The CASA letter continues: “Extrapolation of performance data for temperatures beyond the maximum range is not valid.” Early versions of FAR 23 only required airplanes of more than 6,000 lb maximum weight to provide performance data so even current production Super Decathlons have no performance data in the approved AFM. At that time, FAR 23 required data to be provided to a maximum

temperature of 40°F above ISA which is why we often see 40ºC as the upper extent of performance charts.

Later amendments to FAR 23 stated that “the distance required to takeoff and climb to a height of 50 feet above the takeoff surface must be determined for each weight, altitude, and temperature within the operational limits established for takeoff.” So, CASA’s statement really only applies to aircraft certified to recent amendments to FAR 23. Older aircraft have nil limitations as expressed by this statement in the CASA letter.

It is plain to me that CASA’s view of the take-off and landing performance requirements in Part 91 would be as I described above as the lawyer’s view. It is consistent with that CASA letter of 14 March 2017. If this is CASA’s view for all aircraft regardless of the certification basis then I must change my flying operations:

- I have no approved data for take-off and landing distance on a grass airstrip so I am unable to operate from a grass airstrip. Similarly for a wet, sealed surface. Well, I know the MOS does not require consideration of the effect of runway surface but it is important.
- I have no approved data for determining take-off and landing distance with a slight downwind component. When the Tower advises me there is a very small downwind component I must decline the take-off clearance. If landing then I would be obliged to declare an emergency.
- There is nil take-off performance data for a Standard Decathlon with the commonly fitted propeller therefore it should not be flown.

Perhaps my opinion is incorrect so I look forward to an Advisory Circular on this subject or other clarification from CASA. Some suggested questions to ask:

1. The Part 91 MOS 24.02 states “You must determine the aeroplane performance from 1 of the following” then lists the AFM, manufacturer’s data manual or data approved under Part 21. Does this mean that only data from any of those three sources may be used or may other data be used to supplement what is in there? For example, the Piper Archer III POH states "Effects of conditions not considered on the charts must be evaluated by the pilot, such as the effect of soft or grass runway surface on takeoff and landing performance ...".
2. Will CASA be providing guidance in the form of an AC to include aircraft with an older certification basis, or no certification basis, where the performance information provided is quite sparse? Only aircraft certified to later amendments of FAR 23 were required to provide performance data for all conditions within the operational limitations of the aircraft. Two examples:
    a. The 8KCAB Standard Decathlon has take-off performance data provided only for a Sensenich 74DM6S8-0-56 propeller however many examples in Australia have the coarser pitch -60 propeller with worse take-off performance.
    b. The 8KCAB Xtreme Decathlon has a limitation of maximum outside air temperature of 49 deg C however airfield performance information is only provided to 40 deg C.