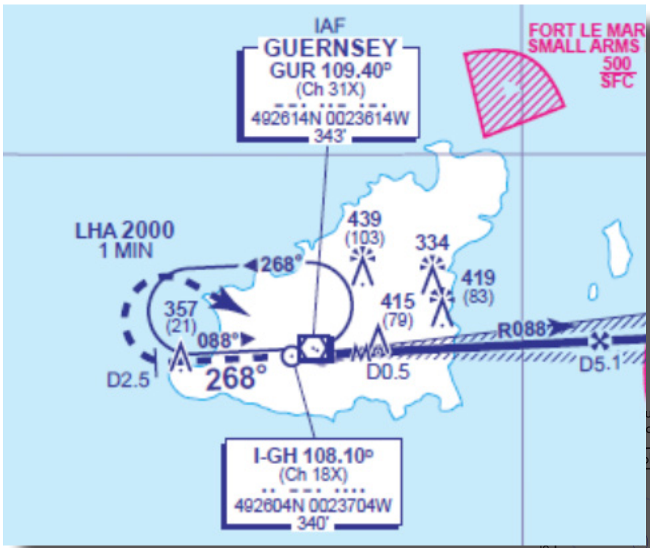
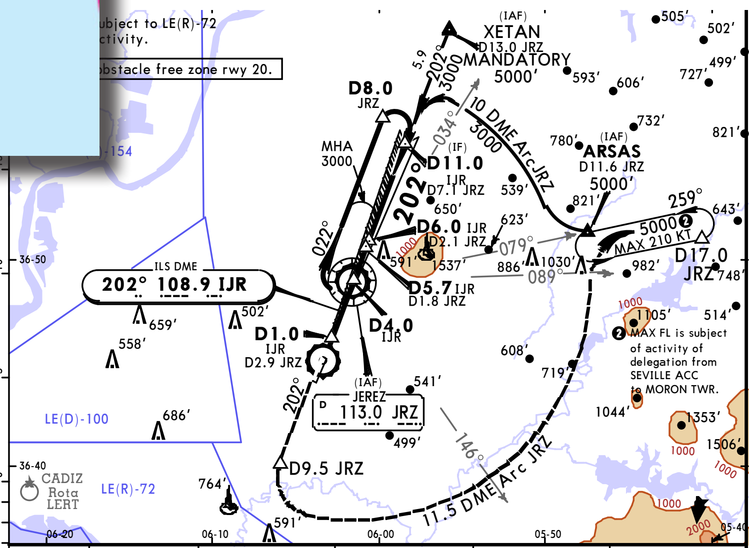
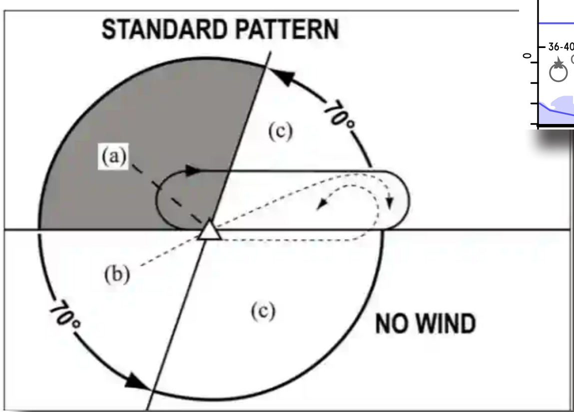
Student Study Guide

Final Approach and the Drop-In

Stephen R.S. Evans







EvansAbove !

Final Approach & the Drop-In

"Do not allow a trend to become an error"

Introduction:

This is the next part of a series of Applied Instrument Flying notes from EvansAbove.

It is often said that *"A good landing starts with a stable approach"*, equally it can be said that *"A stable approach starts with an accurate Drop-In"*.

The Drop-In is the transition from level flight at the procedure "Platform" altitude onto the Glideslope, at the Final Approach Fix ("FAF").

It is imperative for a stable approach that the Drop-In is executed cleanly, promptly and accurately to ensure stability is assured from the start of the final approach. It is much easier to maintain a stable approach if you are starting from an accurate Drop-In then trying to have to compensate afterwards.

Through this document we have a assumed a standard 3º Glideslope, please adjust accordingly for the appropriate descent profile. The use of "Control Column/Yoke" (C172/Seneca/Warrior) or "Stick" (DA42) are used interchangeably.

Preparation

In the Royal Navy, they say there are 6-"P's" for good execution of any action:
"Proper Planning Prevents P*ss-Poor Performance". That is, preparation is everything!

Approximately 1nm from the Drop-In assess the wind direction and make sure that you "bug-up" the Heading Bug so that you are compensating to wind drift and maintaining your Approach Track. This will be needed to help you maintain the Localiser after the Drop-In.

Approximately 0.5 nm from the Drop-In, check your groundspeed ("GS") from either your DME/ILS or GPS in order to calculate your required Rate of Descent ("RoD").

The formula for a 3º glide slope is given approximately by GS (Knots) x 5 for RoD (Feet per minute).

e.g. For a GS of 90Kts, RoD is given by 90 x 5 => 450'/min descent.

If you can't multiple by 5 in your head, then you might find it easier to multiply by 10, then halve the result.
.
e.g 80Kts x10 = 800; 800÷2=400. Ans: 400'/min.

But what about 96Kts , or 107Kts, not so easy? Then use the KISS ("keep it simple, stupid!") principal instead.

KISS

Take a look at the image of a VSI on the right and the graduations on the scale. Do you really think you can fly accurately to 480'/min (96Kts) or 535'/min (107Kts) as in the examples above? Now add turbulence.

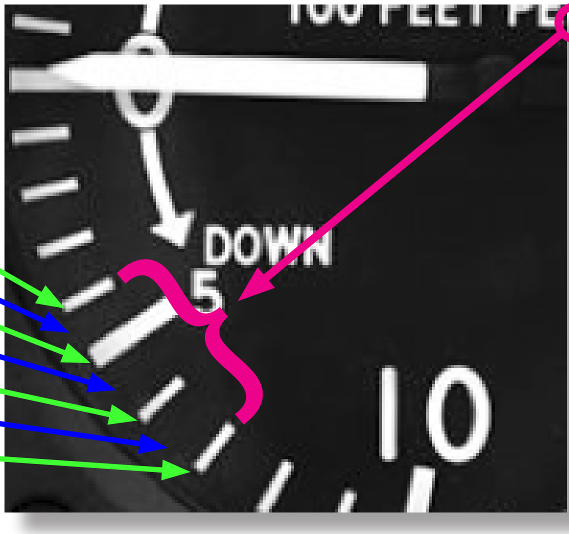
In the case of the Garmin G1000, the VSI, only offers scale graduations in "50's" of feet/min, so you do not even have the choice anyway when compared with an analogue instrument.

In reality the most accurate RoD you can probably fly to is +/- 50′/min, so keep the flying and the maths simple as well.

Take a look at the Table below that compares various ground-speeds with the appropriate rate of descent.

As you can see, if 50′ per minute descent is the limit of your flying accuracy, then this equates to a 10Kts difference in GS, so *Keep It Simple* and numerically round your GS (up or down) to the nearest 10Kts, and then calculate your target RoD, it then becomes easy to do the maths & select and fly the relevant RoD.

GS (Kts)	RoD Ft/Min
80	400
90	450
100	500
110	550
120	600
130	650
140	700



NOTE
The range of 3° RoD's for the speeds from 80-140Kts is represented by a very tight range on the VSI display of just 300′/min.

80-100Kts GS is typical for a PA28/ C172 on an ILS & 100-120Kts for a PA34 / DA42.

Therefore a small deviation from the required RoD as seen on the display, can have a big effect on the descent profile, it is therefore imperative you fly an accurate RoD.

Note from the table the difference between a GS of 80Kts and 120Kts is only 200′/min. This is a VERY narrow range of vertical speed, for a wide variation in airspeed. This tells us two things.

1. Small variations in airspeed will not adversly effect the RoD
2. Large variations of Rate of Descent will have a significant effect on the glideslope.

Therefore deviations outside of these parameters should be dealt with swiftly. I commonly see students allowing RoD's of either 200′/min or 900′/min to develop on an ILS Approach. This will inevitably lead several seconds later to them busting through half-scale deflection and the loss of that Approach.

And here is the clue to flying very accurate Approaches, "Constant RoD". Too often students flying an ILS will focus on the Glideslope/Localiser indicator to the exclusion of what is happening outside.

Good students soon realise that, having worked out their Groundspeed/RoD, then having intercepted the Glideslope, if they work hard to maintain a constant RoD by looking at the VSI, then the GS indicator will not move.

So getting back to the 6xP's; "Preparation"; in good time before the Drop-In, estimate your required RoD and apply it at the Drop-In. Do not wait until you are actually on the Glideslope to calculate your RoD, as it is too late.

The Drop-In

Having calculated your desired RoD before getting to the Drop-In, this allows you to concentrate on executing the manoeuvre accurately.

The Drop-In is the action of changing the flightpath of the plane from horizontal to the required Glideslope.

Take a look at the images of analogue and digital AI's on the right and focus on the vertical scale.

On the analogue instrument look at the width of the orange position "Dot" .

Notice how the vertical scale is compressed and that 3º down is approximately the width of the centre "dot" on the display?
Similarly on the electronic display look at the height of the yellow horizontal "Bars". These again are almost 3˚ high.

This is a very small deflection on the Display, but larger in terms of deflection of the nose of the aircraft. Therefore when correcting for pitch on the Approach, you consider **only moving the pitch in increments of half the width of the Dot or the Bars.**

It is imperative then when dropping-in, that you quickly and cleanly establish the glide slope. The electronic AI's are not quite as compressed, but make sure you correctly identify the 5º and 10º pitch markings.

To achieve an accurate Drop-In, you must focus on the AI and achieving the glide slope whilst simultaneously reconfiguring the aircraft for the descent profile without allowing the nose to pitch up. We do this with the "Push - Pull - Push" technique.

Push - Pull - Push

At 0.5D before the Drop-In, you look at you GS, and calculate your RoD (as above), then at 0.1D **you concentrate on the AI**. At the Drop-In point (usually the Final Approach Fix, "FAF"), you must smoothly **PUSH** the control column/ stick forward until you have achieved 3º down pitch change. Do not take your eyes off of the AI.

Note that is a pitch change of 3˚, so if your AI was set at straight-and-level at +1˚ pitch up, this would equate to a final pitch down of 2˚. Similarly if your Level pitch was +1.5˚, you would aim for approximately -1.5˚ pitch down.

WITHOUT taking your eyes off the AI, reach over to the throttle(s) and **PULL** them back enough to get approximately 2000RPM (PA28/C172), 23" MAP Seneca or 65% (DA42). Do not glance or look at the RPM Gauge or Power meter. It is not important to get the exact figures for power at this stage, just an approximation.

Whilst still looking at the AI, and having not taken your eyes off it, whilst maintaining the pitch down, gently **PUSH** the trim wheel forward until there is no pressure on the Yoke/Stick. This is gross trim. Release your grip on the control column/stick with your fingers to see if the Pitch changes from the 3º down.

If it does, re-trim without taking your eyes off the AI.

Having set *approximately* the correct thrust, and the *approximate* trim, the aircraft should now without any further input *approximately* continue on the 3º Glideslope. This is important because if you get distracted the aircraft should not deviate too much from the intended path.

Settle and Trim

Having now changed the aircraft trajectory, and got it *approximately* on the correct Glideslope, you can now finally take yours eyes off of the AI. Glance at the Power Settings and VSI, and then check that you have the correct RoD reading against the estimate you made earlier before the Drop-In.

In a reversal of your early lessons for "Straight and Level" flight, we are now going to apply "Power for Speed, Pitch for Rate of Descend".

If you need to reduce the RoD, then as a starting point raise the nose of the aircraft by approximately 1/4 of the width of the AI dot (about 1/2mm). This is approximately 0.5º of pitch. Then wait! The Aircraft will take time to respond. This probably equates to a change of about 50ft per minute RoD.

This is "**The Settle**", it takes time (about 1nm / 40 seconds) to respond. Take some very small amount of trim to ensure that there are no stick forces whist maintaining this new pitch angle. After 1nm/40 s, check your descent profile and the RoD "**and TRIM**"

If the RoD is insufficient, then increase the pitch down by 1/4 of the AI "Dot" and again re-trim and wait.

As we have seen earlier small changes of Airspeed have small effects on the RoD, so if your airspeed has reduced, then check your Power setting, if you need more speed, increase power by approximately 100RPM, 1"MAP or 5%, then let the aircraft settle as with the Pitch.

After about 2nm, power and pitch should be stable and only very small changes made to maintain a stable approach.

Monitoring

Do not let a trend become an error. In other words if you see a small deviation developing, deal with it quickly, but equally keep the change small and give it time to work. A common failing I often see is for students to try and recapture a Localiser or Glideslope in seconds rather than thinking in terms of tens' of seconds.

This then leads to increasing erratic changes of flightpath as they fail to appreciate the inertia of the aircraft, in addition an ILS signal becomes more sensitive as you are flying down a virtual funnel towards the Touch-down Zone ("TDZ"), and that funnel gets considerably smaller at 0.5nm from the TDZ compared with 8nm out.

Continuously monitor the the descent profile from the Distance/Altitude table given on the Approach Plates. If you detect a deviation or the Drop-In failed to get you on the correct path, make changes of no more than 50'/min on the VSI and then give it time to work.

This equates to a groundspeed change of 10Kts, and anything greater could lead you to either overshooting or undershooting the target Glideslope.

Remember "Settle and Trim", give the change you make some time to work. This is often 1 - 2nm. Do not be tempted to "chase" the Glideslope.

Adjustments for Wind.

Descending from cruise/platform altitude to ground-level, there is likely to be wind shear in both direction and intensity. Therefore it is important to constantly monitor your DME/ILS/GPS Groundspeed, and make appropriate adjustments to your RoD and/or Power Settings.

Inland it is more often the case that the wind, "backs and slacks", however this can be reversed on the coast due to Sea breezes, or for the southern Jerez flying area the influence of the Poniente (westerly) or the Levante (easterly) which can reach upwards of 30Kts at sea level, but almost zero at 5000'.

Usually when you fly an Approach the wind decreases as you descend, but at coastal Airports, the reverse can be true, so be prepared.

Flying the ILS

There are some variations on the methods used on different aircraft with regards to flaps, undercarriage and power settings. What follows are my recommendations.

Aircraft Specifics

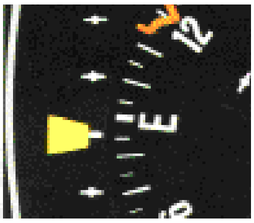
PA28 / C-172

At a commercial airport you are mixed in with, well, commercial traffic, so you need to be mindful not to block the ILS approach with slow flying. The trend amongst flying schools and Examiners is therefore to keep the speed high on an approach for reasons of "playing nice" with everyone else. As a result, look to maintain ~100Kts IAS on the Glideslope and as a result do not take any flap until you have become visual on the Approach.

PA34 Seneca

Plan to intercept the Localiser at or below $V_{FE.}$

At 1nm before the Drop-In, lower 10˚ (one stage) of Flap (taking care to be below V_{FE}) as this allows you to decelerate, prevent the "balloon" and re-trim (if necessary). Target 110Kts IAS.



When the bottom of the Glideslope indicator just touches the top of the Centre Lubberline, start lowering the Undercarriage. In the time it takes for the GS Indicator (or if an electronic GS, then the "Lozenge") to become centralised on the Lubberline, the Gear will have locked down simultaneously to you applying the Push-Pull-Push.

The Seneca, will naturally want to lower it's nose so very little "Push" is actually needed to capture the 3˚pitch down as this is almost exactly what the drag effect of the nose-wheel induces anyway. Sweet !

If Asymmetric, lower the Flaps slightly later, so wait until approximately 0.5nm before taking 10˚ Flaps.

DA42

Plan to intercept the Localiser below the Gear Extension Speed (Not difficult in a DA42!) and lower the Gear 1nm before the Drop-In. If Asymmetric, leave this to 0.5nm before the Drop-In as you don't want too much drag when Asymmetric. Target 110Kts.

Use of Flaps is School dependant. Some suggest taking one-stage at the Drop in, others prefer to stay "clean" until visual. Flap-less has the advantage of being able to maintain a higher speed on the Glideslope, but this is moot.

Discuss it over a coffee with your instructor, but make sure you buy it !!

Localiser
If you have prepared correctly, then you will have a Heading Bug set for the wind-corrected drift at the platform before the Drop-In.

As you descend the wind is likely to change. This is normal.

To prevent major deviations from the Localiser, "**Always Stay in the Bug**"
What is meant by this is, limit your heading corrections to the width of the Heading Bug.

The Bug is 10˚ wide, therefore flying a heading outside the Bug represents a deviation from the centreline of at least 5˚ This, when less than 2nm from the TDZ is too much.

The correct technique to turn your heading towards the edge of the bug. Fly wings-level and hold that heading for at least 20seconds or so. If that corrects the error, return the heading to the centre of the Bug. If however the error remains, but doesn't get any worse, then centre the Bug on your current Heading (maybe the wind has changed), then correct again, but "*stay within the <new> Bug*".

Glideslope
Most students will start their ILS Approaches staring and fixated on the Localiser/Glideslope indicators.

Later on as they get better they start to realise that actually, if they have captured the Glideslope, then if they focus on maintain an accurate RoD by reference to the VSI, then the Glideslope will not move!

On an ILS, we reverse normal teaching methods and apply "Power for Speed, Pitch for Descent".

If your speed decreases, then increase power in small increments (or vice versa), but in doing so try to maintain your constant RoD as you do so. This will prevent large deviations from the Glideslope.

If you need to change your RoD, use pitch. So look at the AI, and move it up/down by approximately 1.5˚ which is the half the width of the "Dot" or "Bars" and be patient. Give it time to work.

Altitude Checks
You are expected to carry out two Altitude/Distance Glideslope checks during an ILS Approach.

If you are at an accurate platform when you intercept the GS at the Drop-In, then that is one done.

Actually verbalise it, so the Examiner know you just did it. eg "*5D, 1800' Glideslope established, dropping in*"

5D is your DME distance, 1800' the platform and by noting that the Glideslope indicator correlates you have confirmed the Glideslope is accurate and working.

You then only have to do one more, which is usually done at either 4D or 3D and if you should forget, then really no later than 2D. The altitude/distance pairs are usually printed on the Approach plate in a table.

Common Mistakes

Loss of GlideSlope

The most common mistake is at the Drop-In when you are tempted to look at the RPM Guage/ Power indicators when throttling back which leads to a pitch-up deviation and loss of the Glideslope.

Because the aircraft is still trimmed for level flight, the distraction of looking at the power lever(s) results in a loss of forward pressure on the Yoke and a subsequent pitch-up.

Solution: Practice "touch-drills" on the ground by finding the power lever without looking at it, and listening to the engine note (in a PA28) as an indicator of power setting.

Overshoot/Undershoot.

Too often Students on reaching a Distance/Altitude marker on an Approach will try to re-capture it by increasing/decreasing RoD by +/- 100'/min and trying to recapture within 1nm.

The MAUW of a PA28 is 2440Lb (1.1 metric tonnes !) , PA34 2.0 mTons and DA42 is 1.7 mTons, these aircraft do not accelerate/decelerate instantly!

Any change to the RoD/Speed must be given time to take effect (Settle 'n' Trim).

Solution: Change the RoD by no more than 50'/min or the GS by no more than 10Kts at a time, and wait and monitor for ~1nm/30seconds . If after ~1nm, a further change is necessary, then change again by no more than 50'/min or 5Kts.

Conclusion

Flying an accurate approach requires patience **and** skill. The skill is more about pre-planning and monitoring than it is about aircraft handling.

The Skill is to get ahead of the aircraft, be at the right speed, at the right platform altitude, with the working wind-corrected heading, with the flaps/gear where you want them, with your RoD calculated BEFORE you need it.

Then its all about discipline and not being tempted to look at instruments when you need to change a setting (See my first article about the AI-Focus method).

Also do not be allowed to become distracted on the task in hand. Aviate Navigate Communicate, in that order.

If ATC need to speak to you, do not be afraid to say "Standby" if you are busy with configuring the aircraft. Conversely do not be tempted to push the PTT switch to talk when you have more important things to concentrate on and the Radio call can wait.

Once you have combined Pre-Planning, with correct configuration, once you have added soem patience, the Final Approach will become much easier.

Stephen Evans