# Student Study Guide

## Introduction to the Instrument Rating

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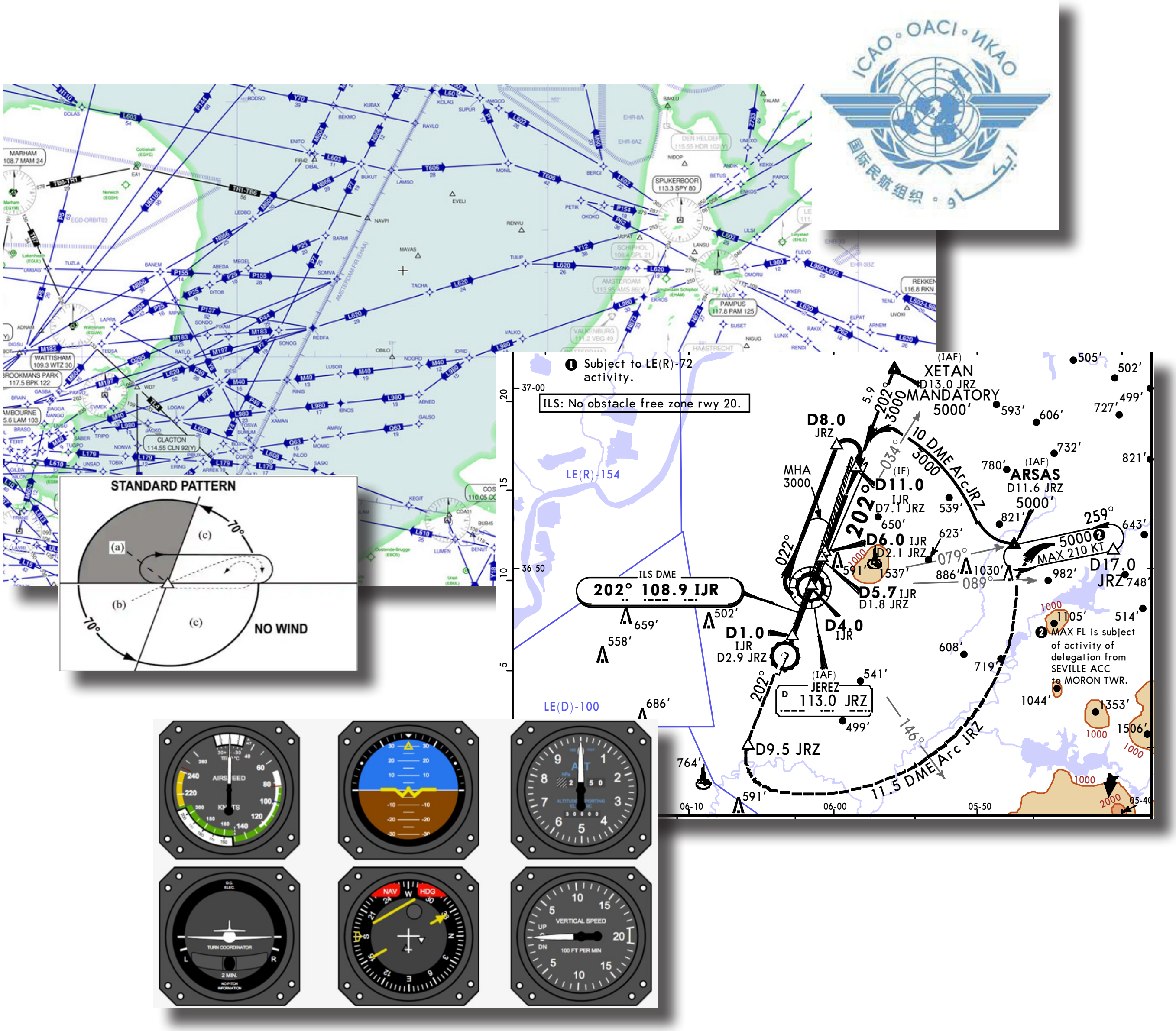


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The document has a nominal value of €15.00, which is equivalent to approximately 2 minutes in a MEP such as a DA42 or Seneca (less than one hold !).
Therefore, if my notes save you triple this, maybe you can see my point?

Please see the last Chapter for more details on how you can contribute to this effort. Thank you

# Contents

# Introduction to the Instrument Rating

*"In the Empire of the Clouds, there be dragons"*

## Start Here.......

If this is the first document you have read on the Instrument Rating, then you are starting in the right place. I am Stephen Evans and I have been flying IFR for over 20 years and teaching the IR for 4 years. I currently work at Fly-In-Spain at Jerez Airport in southern Spain.

These notes have been written from the experience I have gained from watching many Students and their common and sometimes not-so-common mistakes they have made.

I was once told as a young man there are three types of people in the world. There are those who make mistakes and never learn from them, you already know these people, they are ones who have been married and divorced three times. Then there are those who make mistakes, but learn from them. This is the majority of us, but then there are the really smart ones out there, who *watch and learn from other peoples mistakes*.

Be smart ! These manuals are a gift from all my previous Students to you. Learn from their mistakes and be part of the "Smart Ones". To be fair, you have already taken your first steps towards being "smart", as you have actually bothering to sit down and read this document.

As you are reading this document, you will have completed either your ATPL or CPL exams or maybe the EASA CBIR exams.  As such the authority believes you have all the theoretical knowledge needed to be able to go flying in Instrument conditions, but they are wrong.

### The Skills Gap

What you have learnt so far is "**what**" and "**where**" and the "**rules**" . All of the EASA exams are multi-choice and theoretical. So you know what a Hold is, but you do not yet know HOW to fly on. Unfortunately much of the ATPL question bank was written by old *fuddie-duddies*, put out to pasture after a long and illustrious career in aviation and given  some kind of reward by the national Authority like you give a dog a biscuit for good behaviour.

Maybe these people were not even pilots, maybe an Air traffic controller or worse still a manager? This is the reason much of the syllabus is narrow and dogmatic. Each "subject" was written by a different Authority (member) of EASA with their own opinions and agenda.

> By way of example "*Thunderstorms are only ever 1 hour long*". That is because the Swiss author of that particular Met question only has experience of Swiss thunderstorms! A friend in the UK Met Office  fell off his chair laughing when he read that one.

Why am I explaining this? Simply because  the "ATPLs"  for example, go into great length to explain the construction of an ICAO Hold, but not how to practically fly one in bumpy weather with minimal equipment. Doc 4444 has filled your head with rules and regulations, but nothing about practical mental arithmetic that can be done under pressure and on-the-fly.

As a result of EASA's spectacular focus on facts and figures, there is a massive skills gap between practical Instrument Flying and the studies you have had to undertake to get over the (sometimes arbitrary) hurdles that were the Exams.

EASA
European Aviation Safety Agency

The purpose of these Student notes is to fill that gap by not telling you **WHAT** flying under IFR conditions is about, but **HOW** to fly under Instrument rules with simplicity and accuracy.

## The Last Hurdle

If you are reading these notes for the first time, then arguably you are about to embark on the hardest course you will face in your flying career.

Very few people who obtain a good pass at ME-IR will have any problem with their CPL or Type-rating or MCC / JOC / APC course and in this respect the ME-IR is the last big hurdle a prospective commercial pilot has to face from an airmanship point of view.

## The Rating

You are going to apply for an Instrument Rating, Single Pilot Operations.

Some pilots take the CB-IR route. To explain, there is no difference between the standards and accuracy expected of an IR or CB-IR candidate in the IR Test. The only difference is the route they took to get to the Flying section of the course.

Some CB-IR applicants have a dismissive approach to the IR. Often I hear something quoted like this:

> "*Why should I learn how to use an RBI and NDB, my Wangdoodle-500 back home has got twin Garmin G1000, SBAS and autopilot, why do I need to learn about such ancient equipment?*"

The answer is in the small print on the Pilots License, it will state **IR(A)**, not "*Herr Schmidt, certified to fly in rain in a Wangdoodle 500*"

The Authority makes no distinction between an Instrument Rating that entitles you to fly your Wangdoodle-500 or a Boeing-737 in IMC. This is why the test is professional and difficult.

You do not get to pick and choose in the course what you think is relevant or not. You are being tested to become an Instrument Rated Pilot, Single-Pilot Operations.

XII. Habilitaciones / Ratings to be revalidated.

| Clase / Tipo / IR<br>Class / Type / IR | Observ./Restric.<br>Remarks/Restr. | Válida hasta<br>Valid until |
|---|---|---|
| **MEP (land)** | | **31.12.2021** |
| **SEP (land)** | | **30.09.2022** |
| **IR(A)** | | **31.12.2021** |
| **AEROBAT** | | |

********* No hay más habilitaciones / No more ratings *********

Instructor / Instructor

| | | |
|---|---|---|
| **CRI(A)** | **MEP (land)** | **31.10.2024** |
| **FI(A)** | **PPL CPL SEP MEP IR NIGHT AEROBATIC** | **30.04.2022** |

******* No hay más certificados / No more certificates *********

Certificados de Examinador / Examiner Certificates:
********* En certificado anejo / In separate document *********

## Reality Check #1: Responsibility

If you believe that flying IR is just about following the "magenta line", you are just about to have a very rude awakening and if I cannot persuade you otherwise, then maybe you are not ready for the responsibility, duty, trust and obligations which come with the grant of the Instrument Rating.

You must therefore approach the course from the point of view of your IR Examiner, who will be the one to grant you your IR. Put simply, they have to decide:

> "*Would I be happy putting my children and another 120 people on board a plane piloted by this candidate as a single pilot (the Captain is incapacitated), in icing conditions, at night and in IMC conditions on an Approach into Innsbruck?*"

You need to be honest with yourself first and foremost. Would you be confident with your flying skills to take on this responsibility when you put yourself forward for test? These are the "reality-checks" that you should use to assess and be self-critical of your progress.

It is often said that the Private Pilots License is a "*license to learn*", not so a profession rating such as the IR.

You will have to demonstrate all the skills necessary to pass the Skills test **BEFORE** the test, and not think that you can pick them up along the way afterwards. Now, before you think it; no, you are not expected to fly a B737 in IMC at the end of the course, that is what a type-rating is for.

However, you and four of your mates in a rented Seneca, on your way back from a Skiing weekend trying to divert to Munich due to icing, with all your ski-gear in the back. That is real and **is** what is expected of you.

If there is any flying course that will show up your inadequacies as a Pilot then the ME-IR is it.

Please be under no illusions that this course will test your understanding of aircraft management, planning and accuracy to the limits, but believe me when I tell you that the hard work and focus will all be worth it in the end.

### Reality Check #2: Be Realistic

The second reality check for you is the realisation that the EASA-stated number of hours for the IR course are absolute minimums. Unless you are an utter Sky-God in the making, you will need more hours of training than the minimum stated.

The hours stated by EASA are legal minimums, written by Lawyers, and politicians. It may form the basis of a Training Course, but less than 5% of students will pass the ME-IR on minimum hours.

The reasons are many-fold; poor weather, lack of resources, training interruptions, bad luck and to be frank, your capabilities.

Whatever you do, budget an extra 10-15% of time and money, be prepared to knuckle down and study hard and do not put yourself under undue or unnecessary pressure.


If progress is slower than you had imagined, just accept it and keep moving forward.

Under no circumstances set artificial deadlines by cancelling accommodation or booking return flights, as this will create a pressurised negative learning situation in what is already an highly stressful environment.

### Reality Check #3: Listen to your Instructor

They know how to teach, because they themselves are constantly learning from the mistakes their students make. *This makes you the beneficiary of other peoples errors*, so be happy when your Instructor makes suggestions and debriefs you, they are trying to help you.

Lastly be humble and accept the comments made to you and be prepared to be self-critical. Don't over-do it so you lose confidence, but be prepared to laugh at yourself when you really mess-up, it will help your learning mentality and relieve pressure. This is important as very few people learn under excess pressure.

You are at the School to learn and humans learn from making mistakes. You are here to make mistakes and fail in a safe, controlled environment.

> My Dad once told me: "*If you make a mistake and you can imagine yourself sometime in the future looking back and laughing at it, then laugh at it now*". What he meant was, if you make a mistake, pick yourself up, dust yourself down and *get back on the horse*!

**Don't take your eyes off the prize.**

Once you have your IR and the first time you execute a flight in real-IMC down to minimums; you will suddenly realise the enormity of your achievement and the immense sense of pride in achieving a safe flight. This will make everything worthwhile. This I promise you.

### It's not all bad..

One last piece of encouragement. Your Instructor will only put you forward for test if they think they are ready. You will also know when you are ready if you are being honest with yourself.

Therefore when you sit down with your IR Examiner for their exam briefing, there is an assumption you have already passed the IR Skills Test. It is now only your errors that will stop this from happening.

### Reality Check #4: Homework: ....... *no pain, no gain*.

Homework. You will need to set aside at least one hour of personal study, per day, outside of the lessons to minimise repetition of Instructor-led lessons.

You need peace and quiet to practice what you have learnt and to prepare for the next lesson.

This could be used for practicing on a personal simulator, reading through your notes of the previous lesson and the feedback from the instructor. It may well be preparing for the next lesson or reading about the next subject.

If the comments in **Reality Check #2** concern you, then good-quality personal study is the most effective way to reduce the possibility of over-running on your hours.

### The Course Structure

The Instrument rating is actually two synergistic disciplines that compliment each other.

These are:

- Applied IF, and
- Radio Navigation

Applied IF is covered in the next section of this series and is about how to fly an aircraft with sole reference to its instruments. Crudely put it is, "*how to fly in the crap and deal with problems when they come up.*" *

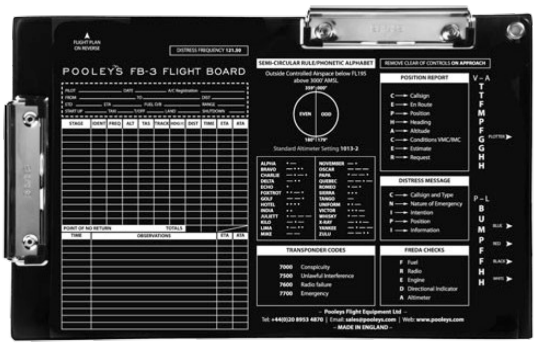
Radio Navigation, is, rather facetiously, "*now you are in the crap, how to fly to where you want to go, and if you can't, what are you going to do about it?*"

## Getting Organised

You should get yourself organised before the course starts.

### Kneeboard

Get an A4 kneeboard. You want the Pooleys FB7, which has a side-ring clips for A5 hole-punched binder pockets. **Price: ~€27.00.** Don't bother with A5 kneeboards, they are way too small, and frankly embarrassing. *Buy A5 in haste, repent at leisure.*




What you are going to do is print off your Approach Plates for all the Airports you are likely to visit, their SID's, STARS and the Radar Sectors for your local area.

** Crying out "inshalla", and letting go of the controls is not a valid option !*

You will then, for every flight,  arrange these plates like so, in the following order:

- Aerodrome Taxiway Plate
- SID(s) for Departure Aerodrome
- Radar Sector Minimum Altitude Chart / Relevant Airways Chart
- STAR(s) for Arrival Aerodrome
- Approach Plates for your Arrival Aerodrome
- STAR(s) for your Diversion Airfield (Home Base?)
- Approach Plates for the Diversion Airfield.

Can you see what you have done? You have told the story of your planned flight and arranged the information you need in the order that you need it. The issue is, every flight is different and the A4-sized PDF's of the plates that come off of the National Authorities web-site or Jeppesens are bulky and cumbersome.

**Solution:** we print our plates two-per-A4 (within the browser or Acrobat print dialog box), and then cut the A4 in half. This gives us two A5 plates.

You then buy A5 transparent Binder Pockets and put your Plates in them. You will need to buy at least 15, but it is now a simple job to select and arrange your required flight-plates prior to each and every flight.
**Price: ~€5 for 10 pockets from Amazon/eBay**

Now you will understand the reason for getting a Kneeboard with side-rings. As you progress the flight, you simply flip over the last (now unwanted) plate to reveal the next one relevant to the next stage of the flight.

**So for example:**
You have completed the power-checks and are ready to taxi. The top plate when sitting on the Apron will be the Taxiway/Aerodrome plate so you know where to find "*E4 via T7 and A2*" before you move off blocks. Once at the runway hold, just flip-over the  Taxiway plate, and bingo!

Here is your Standard Instrument Departure. ("SID").

Once the Sid is completed, you move to the En-Route phase of the flight.

Simply flip over the SID and there is either the Radar Minimum Sector  ("RMS") chart waiting for you, or if "On Airways" then you need the Airways Chart.

If flying "Off-Airways" then the RMS chart will give you Minimum Safety Altitudes to work with. If you make reference to your position on the RSA to your Examiner at Top of Climb ("ToC"), and declare you have achieved Minimum Safe Altitude ("MSA"), you have got another tick in the box and because you have referenced the RMS, they know your are not bulls**tting.
(*this assumes you have of course reached MSA, if not, say not*)

On arriving at your destination, you come off Airways and flip the plate over to reveal the Standard Arrival ("STAR") to the Intermediate Approach Fix ("IAF"), where you might do a Hold, but in any case, you can then flip that over to the relevant Approach Plate.

This is what is meant by Cockpit management. In addition there is the Pilots Log ("PLOG", more on this later). Together the Plates and PLOG are tested for Cockpit management as part of your exam.

If you walk into to the Examiners briefing room and meet them for the first time and they see that you have a fully prepared Kneeboard, Plate plan and PLOG, then Tick ✓

## Pen Clips

Pen-Clips for your Kneeboard. Get the 3x holder version, that is for :

- 1x Chinagraph pencil / felt-tip pen
- 1x ball-point pen
- 1x Pencil

If you are right-handed, mount it on the Kneeboard along the right-hand (short) side at the bottom. This way you can easily slide your pen/pencil etc in sideways and it puts them out of the way. **Price: ~€5.00**

## Pencil

Take my advice, get a propelling pencil for the cockpit.


The best one is the Staedtler Mars Micro, work a bit harder and try to get the rarer 0.9mm model, go for soft leads, HB or 2B.

This pencil has a sprung head, so if in turbulence you press too hard, it's less likely to break the lead.
**Price: ~€7.00 for pencil, €3.00 for a pack of spare leads**.

In 22 years of IF and aerobatics flying in some fairly rough weather, they have never let me down. Once you have used one, you wont go back to ball-point pens.

Sometimes the 0.9mm is difficult to get hold of, in which case the 0.7mm is a good compromise.

## Timepiece.

You need something with a second-hand on it, preferably analogue for reasons that will become apparent later. Don't waste your money on "bling" at this stage with a Breitling.

> *Once you have passed your A320/B737 type rating and completed your line training and you have your Second-Officer wanker-bars, then maybe get a Breitling.*
> *But realistically you will be so broke anyway it will be the last thing on your mind !*

A Seiko or Casio is absolutely fine. If it has a Stopwatch function then good, if it has a resettable Second-hand, then perfect. **Price: ~€50.00**

## Procedural Self-Study and Homework

If you do not have a personal copy of the procedural training software, **RANT XL**, get one. **Price: £80.00**


You can download a Demo version for free.

https://www.oddsoft.co.uk/downloadt1.html

If you are lucky enough to be a Student at Fly-In-Spain, then we have a copy available for use by the Students in the Briefing Room.

Your Instructor will show you how to get the best from it, but more important it will raise your situational awareness so that you are able to absorb the lessons being taught, especially the Single-needle work.

However I thoroughly recommend and encourage you to buy a personal copy for use at your home/hotel/Air B&B etc during the course.

Trust me, I still use my copy of RANT XL today for practicing.

The Author can get a discount of £5 if you buy from him and he will even throw in a Staedtler pencil for free in the price and better still we have them off the shelf in Jerez.

RANT XL needs an Intel Windows PC/Laptop to run on, but does not require much processing power so even an old Pentium with Windows XP will do! If you are an Apple fan, you have two options, Parallels/Virtual Box plus a copy of Windows (ouch!) or WINE.

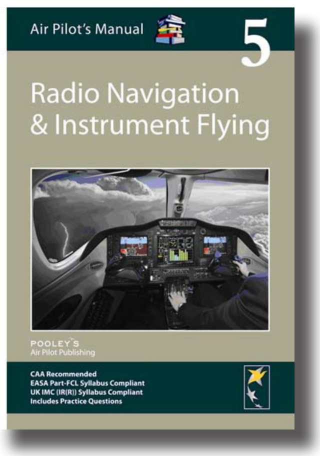
WINE on a Mac does not need a copy of Windows to work so saving money and time as you don't have to boot Windows first. The trouble with WINE is that it is a bit convoluted to setup, but the author has successfully got it working on an Intel Mac, albeit with some minor, insignificant issues. Buy from him, he will set it up for free for you.

Also consider getting Microsoft Flight Simulator/X-PLane to practice hands-on instrument flying. The costs of the software and a USB-yoke are minuscule compared with the total cost of a fATPL.
Try eBay for pre-owned equipment as often these kits get sold once an IR student passes their Skills Test, as I am sure you will do in good time.

If these pieces of software can save you just a few hours of Simulator lessons, or more importantly aircraft time, then it will be worth it.

## Student Manual

For a Student Manual there are many books written about the IR. My notes are meant to supplement what has already been written and to offer practical advice on how to fly under Instrument Conditions rather than be a definitive guide.




For this reason I recommend the "Air Pilots Manual" produced by Pooleys and their "Radio Navigation & Instrument Flying Book", which is derived from the original work of the CAA-respected author, Trevor Thom, from his series of PPL books.

At Fly-In-Spain ("FIS") the IR instructors have standardised the use of this book for theory. At FIS your IR Instructor may give you homework based on certain chapters of the book before your next lesson as we use the material inside as part of our syllabus.

### Starter Pack

If you are a Student of Fly-In-Spain, we have produced a Starter Pack of all of the essential items previously mentioned (except the watch) which is held in stock for simplicity, so saving you time and delivery costs. If you want a pack, speak to the ladies at reception

## Reality Check #5: False Economies & Conclusion

The total cost of all of these items listed above, will be approximately €200, which is equivalent to approximately 25 minutes flight training in a Seneca/DA42. You can now see, that a modest investment early on, may easily pay for itself later-on as well as getting you *ahead of the game*.

Separately, I often have Students present themselves for the course who believe that "attendance" alone is sufficient to pass the IR course. They are sadly very wrong.

So again a commitment to self-studying without any self-imposed deadlines, is one key to success.

# Introduction to Applied Instrument Flying

*"Let go of the Force Luke, trust your Instruments"*

## Applied IF: Re-Learning how to Fly

### Introduction

This section introduces fundamental skills needed for Instrument Flying ("Applied IF", or just "IF") section of the IR course. Applied IF flying starts with learning how to handle inadvertent flight into IMC conditions and builds from there.

As explained previously the Instrument Rating is two complimentary skill-sets, Applied IF and Radio Navigation. Applied IF is the ability to fly an aircraft, control, manoeuvre and safely recover from upset conditions with sole reference to the Instruments, even when some of them may fail.

This document does not attempt to duplicate the already excellent material in the recommended Student Manual "Radio Navigation & Instrument Flying Book", what instead we shall do is look at techniques to enable you to fly efficiently under IF conditions.

The starting point is the "Selective Radial Scan" or "**SRS**" or simply "**The Scan**" for short. This is covered in detail in the book for both Full Panel and Limited Panel (simulation of a vacuum pump failure). Take the time to read it now, and understand the different priorities of the scanned instruments dependant on the type of manoeuvre being carried out before returning to this document and the following techniques.

## Motor Skills.

If practical to do this, go and sit in an aeroplane when it is quiet on the flight-line. If you ask Operations which aircraft have finished flying for the day pick one of these. Then sit in the cockpit, close your eyes and practice finding controls, switches and actuators without looking for them.

This will build your motor skills, so that you do not have to look at a control for your hand to find it, this is especially useful when in turbulence and you need to concentrate on the Attitude Indicator.

## The Scan

It is absolutely essential for accurate and stable "IF" that great attention is paid to the Artificial Horizon/ Attitude Indicator ("AI").

Take some time to completely familiarise yourself with the following two Applied IF techniques, namely the "**Attitude Scan**" which is used for manoeuvring and the "**AI Focus**" used for avionics and controls/actuators. Both techniques always start by looking at the AI and then finish with the AI whenever you make changes to aircraft attitude, equipment or controls.

Almost one complete SIM session will be used getting the SRS polished. It is important to get the SRS into muscle-memory, so it is automatic. As you practice and the SRS becomes habitual, you will be surprised at how much easier Applied-IF becomes.

Expect a headache at the end of the first few lessons, but it gets easier from there!

### The Scan Technique #1: "Attitude Scan".

Whenever you plan any attitude change, you should start by looking at the AI, then without taking your eyes off of the AI, perform the manoeuvre. If turning, wait until the wings are stable and at the correct angle of Bank before restarting your Scan.

If climbing/descending, wait until the aircraft attitude is stable and trimmed before continuing the scan.

Either way, maintain your concentration on the AI until the aircraft has ceased its rolling or pitching motion and is stable on its new intended attitude or trajectory and trimmed, BEFORE doing anything else.

This means start and complete the manoeuvre whilst looking at the AI and do not become fixated or stare at any other NavAid / control / switch / gauge or actuator when you are making any changes.

When levelling off or rolling out, again look at the AI; perform the input and maintain focus on the AI until the wings are level from rolling out, or the required pitch is achieved when levelling off.

### The Scan Technique #2: "AI-Focus"

This method ensures that no deviations from pitch, speed or direction take place when manipulating non-flight controls. The correct technique for making changes to any power setting, NavAid frequency, propellor speed, fuel pump switching, tank change etc is as follows:

"Glance-Check-Change-Glance-Check". In between each "*glance*", **your eyes should return to the AI**.

**DO NOT STARE AT ANY CONTROL WHILST CHANGING ITS SETTING**

This is called the **AI-Focus Technique** and it ensures that your focus is on the AI whenever a change is made and no deviations occur from your intended flightpath whilst making any change.

Using this technique you will be slower to make adjustments initially, but you will be able to maintain your selected attitude and heading, which under IF conditions is more important than (for example) setting a standby frequency.

### Example #1: Power Change:

You wish to throttle the engine back from 2500RPM to 2000RPM.

- Glance at the RPM gauge, confirm it is reading 2500. Look back at the AI.
- Place your hand gently on the power lever **whilst still looking at the AI**. (remember "Motor Skills" ?)
- Do not move anything!
- Glance at your hand, confirm it is on the Power Lever (not the propeller or mixture control!).
- **Eyes back to the AI.**
- WITHOUT TAKING YOUR EYES OFF THE AI, slowly retard the throttle lever a small amount and then stop. Glance at the RPM gauge, note the gauge reading and eyes back to the AI.

If the gauge reads 1900, then with your eyes still on the AI, increase the power slightly, then glance at the gauge and back to AI.

After 2-3 iterations of the AI-Focus, you will now have the correct power setting, and the aircraft will not have deviated from your intended flightpath or altitude.

Why use this technique when it takes sooooo much time? Simply because the time to recover from a deviation that occurs if staring at a control will be much longer (typically 2-3x longer) than that used when applying the AI-Focus technique. Given that Exam standards stipulate heading deviations of no more than +/-5˚or Altitude deviations of +/- 100', then AI-Focus trumps staring at a control every time.

### #2: Setting a NavAid frequency.

You wish to tune the next VOR station into the standby frequency.

- Without taking your eyes of the AI, extend your hand and find the frequency setting knob on the NavCom box.
- Glance at your hand to make sure it is on the correct knob, take a mental note of the current standby frequency.
- Look back at the AI, if tuning from 128 to 125, this will be 3-clicks anti-clockwise.
- Whilst looking at the AI, rotate the control, *click-click-click*. Then glance at the frequency meter to confirm the correct Mhz setting. Look back at the AI.
- If incorrect, then whilst looking at the AI, rotate the knob in the correct direction to adjust. Repeat for the Khz frequency, eg 128.500 to128.125.

Do not look at the frequency gauge, no matter how tempting it is, when setting the frequency. Always maintain your attention on the AI whilst you make any changes.

### Conclusion: The AI-Focus Technique

Although the "glance" techniques are undoubtedly slower, they will protect you from large deviations from your intended attitude or flightpath, which will be longer and more difficult to correct, or may even be dangerous if allowed to develop.

I can promise you that the time you might save by staring at the Radio receiver when you are tuning it, will be a lot less than the focus, attention and time required to correct for a 5˚ deviation from heading that might occur as a result.

If you don't believe me, just wait until you get in the aircraft in turbulence!

### Radar Vectors

When ATC are looking at their radar screen and issuing Radar Vectors, they are looking into the past by about 1-2 seconds. This is due to the propagation delay of the radar transmitter head, the transmission time from the radar station to the data distribution controllers, and the processing time of the computer system that drives the Radar Display. Each individual delay, although small in itself accumulates to a total of about 1-2 seconds.

In other words your aircraft position appears to the controller where you were about two seconds ago.

If the controller needs to get you to change direction, you are already 2 seconds further along your track than they think you are. Now add to this the Radio Telephony delay.

Look at your watch and its second hand, and measure the time it takes to read out the following Radar vector communication ATC might give to you.

- Dingbat69, turn right, heading two seven zero
- Turning right, heading two seven zero, Dingbat69
- Dingbat69, readback correct

And now you start turning !!     How did you do? About 14 seconds?

Add to this about 1 second for propagation delay and we have 15 seconds. At 145Kts (75m/s) that is about 1200m. In other words you are  about 1200m/0.5nm further along your track before actually starting to turn.

If you were on a conflicting course with another aircraft this delay could have critical consequences !

## Radar Vectors (contd.)

The correct technique to avoid this situation is to immediately start a turn on hearing the words "Dingbat69, turn right..."

If you immediately start the turn in the correct direction on hearing the spoken direction ("left/right") before hearing the vector or carrying out the read-back, you will save aprox 10 seconds, which is about one kilometre of distance.

This method, because it is more accurate, can save the controller having to make further corrections or vectors, which in turn reduces their workload and yours. The same technique should be employed for instructions to climb or descend.

As before, on hearing the words "climb/descend", start the manoeuvre whilst simultaneously listening for the cleared Altitude and before the read-back.

## Radio Navigation Instruments.

Although you will have covered the use of Radio Navigation instruments in groundschool, it is worth revising how to interpret their output. In addition, before we use any navigation aid (¨NavAid¨) we always "TIMS" the groundstation / beacon / instrument readout first. So what is TIMS?

**T:** TUNE: the frequency and select the correct Mode for the NavAid receiver.
**I:** IDENTIFY: the ground facility for its transmission and Morse code identification.
**M:** MODE: Check the operation mode of the instrument and correct sense.
**S:** SELECT: the QMD/QDR you require, check that the reading is "Sensible" and "Stable".

### TUNE:

It is always a good idea to setup all the NavAids before take-off.

Always think in terms of "Now and Next". So setup your avionics with "now" on the active frequency and the "next" one on Standby.

Whenever you do a "FREDA", the "R" refers not just to Radio's but avionics as well.

**Example SANTA 2V**

You have just taken off from Jerez on the Santa 2V departure and reached NAVUT using the JRZ VOR. "next" is a navigation to MRN VOR. If you are smart, before taxiing out, on your NAV radio you will have the JRZ frequency in "Active" and MRN on "Standby"

As you reach NAVUT and switch over to navigate directly to MRN (115.50), the JRZ frequency (113.00) is now in the Standby frequency doing nothing and so is redundant.

Don't waste time. As soon as you are established towards MRN, and absolutely no later than the next FREDA check, put your next Beacon frequency into the Standby frequency, probably in this case, "SVL".

This is what we mean by ***Now and Next,*** "*what am I using now, and what do I need next?*"
The Nav2 and ADF box, can each have an active frequency and a standby frequency set, so take the time to program them as well before take-off if you can.
Carrying on with this example, as part of ground setup, why not have NAVUT programmed into your GNSS receiver? This way, if ATC say "*route direct to NAVUT*", you can punch the "DIRECT" button, switch to GNSS mode and now have a ready-made route.
This example is exactly what we mean by "*proper pre-planning*".

## IDENT.

Never use a Beacon you have not Identified.

Always try to Ident a Beacon before turning towards it. In the previous example 2-3 minutes before reaching NAVUT and starting your track towards MRN, start the Ident of MRN, so that in the 40seconds it takes to Ident both the VOR and co-located DME, you have full Ident before turning on-heading.

That is not to say you can't turn towards a Beacon before you Identify it if you are late, but in such circumstances as soon as the wings are level, start the Ident procedure.  Using a Beacon without Identifying it is a possible Exam failure and flags poor airmanship to the IR Examiner.

You can either learn Morse code (not a bad skill to have) or make sure you read the Morse Ident from the chart accordingly BEFORE use. Remember, unless you have the Autopilot selected, use the AI-Focus technique for reading the plate.

**Confirmational Bias**

Listen to all of the Morse code of an Ident, not just the beginning.

Also check that it is the correct Ident. Seems obvious really but every Student will fall for this at least once.

Therefore don´t let "Confirmational Bias" lull you into thinking you have Idented "ISE", when in fact you have just listened to "ISV".

If you don´t want to learn some basic Morse code, then as an absolute minimum learn the Morse for those beacons you will be using regularly (eg. Jerez, Sevilla and Vejer VOR, NDB´s and ILS).

In a DA42 with a G1000, VOR´s and ILS are Auto-identified, but the DME is not, so you still need to aurally Ident the DME. If in doubt, check.

## MODE:

Almost all Avionics have multi-functions, from the oldie-but-goldie GPS150, through to the G1000, all of them of which, if set to the wrong mode, are just waiting to trip you up.

Therefore before relying on a track from a Radio-Nav aid, make sure that the equipment is set to the correct mode.

The following examples are not an exhaustive list, simply because every piece of avionics kit is different, but this should make you think about how well you know your equipment before you rely on it to keep you away from the side of a mountain!

Here are some common items and associated errors.

**ADF Mode Check:**

In the case of the ADF, check that "ADF" mode is selected on the receiver, not "ANT" or BFO.

If you are using an ADF to maintain a Hold or are using it for a Procedure Turn or Racetrack and are using it for a descent, <u>LEAVE THE IDENT ON</u> !

The reason is simple, there is no warning or fail flag on an NDB/ADF, so it is good airmanship to leave the Ident running in the background during any NDB-assisted descent to confirm that at least the signal is still being transmitted. Set the Ident to a low volume so as not to miss any ATC calls, but high enough that you would notice if the signal was lost.

**RMI Mode Check**
If using the RMI, check that the RMI source selector is set to the appropriate NavAid receiver. It is quite common to have two VOR receivers fitted in a plane, so the RMI is often wired to be able to receive from both of them (though obviously not at the same time). Here the Mode check means checking that the RMI is connected to the correct receiver.

Again as an example, If you using RBI/DME to fly a DME Arc, ensure that the RMI is using the same Beacon as the DME (it sounds obvious, but often students get this wrong).

**HSI Mode Check**
If using the KNS80, then this RNAV box allows you to run as pure VOR mode or in RNAV -Waypoint mode.
*Oh for a beer every-time a student got the wrong mode on their KNS80 !*

Make sure you have set the correct mode for the task at hand, that is either VOR Mode for tracking with the HSI and RMI or RNAV mode if you are tracking to a RNAV Waypoint.

Again, students often forget to reset the Mode when finishing with it.

If you don't have a KNS80, then most likely you will have a GNSS (GPS) receiver instead.

In this instance, the Mode check, will ensure that you have got the correct navigation mode.

For example, on a Garmin 530 or similar there is a "VLOC" mode for pure VOR tracking bearing information and "GPS" for use of GNSS Waypoints and GNSS approaches etc. One in three Students will, at some point, have the wrong mode set, as they then blissfully head off at 90˚from the intended track with the wrong Mode set.

**OBI Mode Check:**
Learn the difference between a QDM (tracking TOWARDS a beacon) and a QDR (tracking FROM a beacon).

When using the OBI, if tracking toward the Beacon, you need the Mode set to the "TO" flag for a QDM, or if flying away from the beacon on a QDR, then you want to see the "FROM" flag.

The OBI will ONLY give you the correct direction to fly when deviating off a course if the correct "sense" mode is selected. If the wrong sense is set, the reading will be reversed and you will fly off in the wrong direction.

> i.e. *If flying TOWARD a VOR and you are actually flying away ("FROM") it, then the OBI will give you the reverse deviation correction indication, that is it will indicate a "fly left" when you* ***actually need*** *to "fly right" and vice versa.*

**DME Mode Check:**
In some aircraft the DME frequency in "Master" mode is derived from the VOR/ILS frequency of the NAV1 box.
However there may be a DME "Hold" button which allows you to "hold" the tuning of the DME when switching to a different VOR or ILS (and vice versa).

This is useful, for example, with the ILS approach at LEJR when the turn procedure is based on the VOR-DME, distance and not the ILS-DME which at this point needs to be tuned to the ILS in order to intercept the Localiser.

As part of your TIMS check, make sure the DME is tuned to the correct Beacon.

If a DME does not have a HOLD function, then it will support the use of an internal Frequency. As stated before, do not assume and remember to independently IDENT the DME. Diamond DA42's with a G1000 will auto-Ident VOR's but the DME needs to be checked manually. Don't fall for this one!

Just to add to the confusion, some aircraft will have a DME-slave switch. This means that the DME can be slaved to either NAV1 or NAV2. So along with its internal receiver, your DME could have three possible sources of frequency. Don't assume; check.

### SELECT / Sensible / Stable:

Select the correct QDM or QDR or RNAV waypoint, or the right Departure, or the correct GNSS Waypoint.

Then cross-Check that the instrument is displaying  the expected or a sensible reading, warning flags are not displayed and the reading is stable. Instability could be an indication of a weak signal due to being outside of the promulgated range, or worse still you have selected the wrong frequency and are picking up a spurious signal from a different beacon.

> For example, if flying towards a VOR/NDB is the RMI/ADF pointing ahead?
> If possible cross-check the instruments´ reading with another instrument to confirm and provide a gross-error check.

It is very easy when under pressure, in turbulent conditions and under stress to momentarily have a "brain-fart" and set the wrong selection, hence the SELECT Check, it is the last opportunity to check that you have the right information loaded or track chosen before moving onto the next part of the flight.

Get it wrong and you could be off-track by some considerable distance. Use your "SELECT" check to double-check before moving on with your Navigation or planning.

## LEARN ON THE GROUND

### Use of the KNS80.

Although a 1980´s design, the KNS80 is a very powerful piece of NavAid equipment. At FTE Jerez is it connected to the HSI and RMI and it is capable of Area Navigation (RNAV). Take some time to read the full students notes on its use before first getting into a plane to use it.

If you wish to practice setting up the KNS80 on the ground, you can do this without the engine running on the apron. To do this, make sure all unnecessary electrical services are off and limit yourself to no more than 5 minutes practicing to avoid flattening the aircraft battery.

For those students with access to Microsoft Flight Simulator, there is an add-on that can add KNS-80 capability to certain aircraft. It can be found here, although the author has not used it personally.

**https://library.avsim.net/esearch.php?CatID=fsxpan&DLID=204474**

### Garmin GNSS

At FIS, the Seneca is fitted with a Garmin GNS530. This unit is again a very powerful piece of equipment that provides RNAV capability through GNSS.

It is significantly more powerful than a KNS80 as it can be loaded with Jeppesen charts. These include SID's, STAR's, and GNSS equivalents of NDB, VOR and ILS Approaches. FIS Garmin units have the latest up-to-date databases. In addition they also support RNP approaches.

Because of this complexity, the best way to learn their functionality is in a classroom with an equipment simulator.

Garmin produce such a simulator, which can be downloaded from here:

> https://www8.garmin.com/include/SimulatorPopup.html

It is a Windows App designed for WinXP, but can be made to run on later versions.

In any event, at FIS there are various copies installed on the computers in the training room that you can use, so there is no excuse for being familiar with their function.

## Radio Navaid Simulators

### Luiz Monteiro

An American-based flying instructor called Luiz Monteiro runs a website with Radio Navigation aid software simulators. You can use this simulation software to become competent at quickly and accurately interpreting the NavAids in the plane.

Click Here: http://www.luizmonteiro.com/Index.aspx

For example to learn how an RMI represents the information from a VOR relative to the aircraft, go to his Web Site and from the left menu, select (for example):

*`Online Simulators: RMI: RMI Version 3 (latest)`*

The Website has Simulators for all the basic NavAids you will encounter. You will most likely need to use a PC/Mac as the graphics are based on Adobe Flash which unfortunately does not work on iOS devices.

Since Flash has been deprecated for some time, be aware that you might get a message saying that Flash has been discontinued. If you have Flash installed you can ignore this and continue to use the Web Site.

If not, there is an open-source project called "Ruffle" that acts as a plug-in to your browser to circumvent the Flash requirement.

I recommend that my students thoroughly familiarise themselves with RMI/VOR/ADF before starting Applied IF flying. The HSI is always a "command instrument", but the OBS/OBI is only a "command instrument" when in the correct mode.

As an exercise find out why this is, and what you must do to make the OBS/OBI work in Command mode. This is your first piece of "Homework".

### RANT-XL

If you have taken my advice and got a copy of RANT-XL, then the knlowledge gained from Mr. Monteiro's site can be applied to some procedural flying practice in RANT. RANT-XL comes with tutorials as well as practice Exercises. Completing 2 exercises per day at the beginning of the IR course will pay dividends later.

## Aircraft Handling

Under IF conditions, the aircraft is flown at a limited number of airspeeds; learn them for the particular training aircraft you will be flying.

For a Warrior (PA28) these are typically:

- 80Kts: for Climbing (Vy)
- 105Kts: Cruise, and for Cruise Descents (all descents are at Cruise speed)
- 95Kts: Holding and Approaches

In a Seneca (PA34) they are typically:

- 90Kts: for Climbing (Vy), 100Kts cruise climb
- 145Kts: Cruise and for Descents (all descents are at Cruise speed)
- 120Kts: Holding
- 100 Kts Approaches

All turns are at Rate-1, which gives a Angle of Bank (TAS÷10 + 7) of ~17˚ for a PA28, and ~19˚ in a PA34/DA42 (at 130Kts). From this you should see you never have to exceed 20˚ angle of bank.

Read the PoH for your particular aircraft and learn these numbers.

In this respect, Applied IF is simpler than VFR as you will be expected to fly at only these speeds and bank angles.

## SIDs, STARs & Approach Plates

Before starting Applied IF, download and print off the Jeppesen plates for all the likely Airports that you will visit, and some you will fly in the Sim.

At FIS, that means Sevilla, Faro, Jerez & Granada. In the Sim you need to have Santander and Valencia as these are used for teaching PBN/RNP Approaches.

Print off all the plates in A5 format for inclusion on your kneeboard, as explained in the previous Section.

## Planning for your Lesson

As part of being a Commercial Pilot, you will need to carry out a fair amount of self-preparation before each Lesson.

If you haven't already done so, download a copy of the "**Learning Objectives Syllabus Progress Checklist for Students**" from my Web Site site (*If you are an FTE student you maybe out of luck as I don't maintain it anymore and the syllabus has probably changed.*)

### Syllabus

As for Fly-In-Spain  the Syllabus Spreadsheet **IS** kept up to date.   It can be found here:

https://evansabove.us/IR-Student-Training/

This spreadsheet contains a matrix of Modular lessons, and the associated Learning Objective for each Lesson. In addition the  matrix gives information on when a Learning Objective will be taught and the type of objective

That is:

- **Teach** (Instructor led demonstration)
- **Revise** (repetition with instructor help) or
- **Practice** ("without the help or assistance from the Instructor").

The Lesson matrix should always be cross-referenced with the Syllabus and used as a self-briefing planner for learning/revising the subjects to be covered prior to presenting yourself for the lesson.

Also, it gives a description of which Approach plate can be expected, destination or route and whether or not you need to file an IFR Flight Plan (if flying for real).

In other words, if you study the Lesson Matrix you are going to know what you will be doing before you get to it. This will help in planning your study time and revision when cross-referenced with the Student briefing Book

### Ask your Instructor

There is no such thing as a stupid question, so do not be afraid to ask questions and seek help and assistance. That is what your Instructor is for!

Your IR Instructor is trying to assist you in passing what could be the hardest flying exam you ever take. Use their knowledge, listen to what they say, soak up their advice and be thankful for their time.

On passing my ME-IR, I bought my IR Instructor, Jon O. his "*favourite poison*",  a 12-pack case of Guinness.
If this document was useful to you, mine is Wychwood's Hobgoblin or similar, if you're asking.... !!

## Conclusion

There is a big step up in cockpit management and handling when flying Applied IF.

It therefore makes sense to prepare as much as possible on the ground before starting the flying training.

If you can run through touch-drills with your eyes closed in the cockpit and know how to interpret the NavAid instruments intuitively, this will help immensely.

If you are also confident with Applied IF procedures, then time spent in the aircraft and Simulator will be more productive.

# The Relative Bearing Indicator

*"Simplicity is a virtue, that is why so many Land Rover Defenders still live"*

## The Relative Bearing Indicator

### Introduction

In the previous sections, we looked at preparation for the course. Then in the second part, we looked at best practices for maintaining control of the aircraft in IMC conditions and started to look at Radio Navigation.

This section builds on RNAV by introducing Single-Needle tracking and Interception. The hardest Instrument to use for this purpose and technically the simplest, is the Radio Bearing Indicator or "RBI".

The design of the RBI goes back almost 100 years when the United States Postal Service needed to provide a means of navigation for their delivery aircraft using a series of radio beacons strategically placed along the postal routes.


These would be recognisable today as Non-Directional Beacons, or NDB's.

By today's standard the receiver in the aircraft was quite crude with the Pilot or Navigator having to manually rotate an on-board aerial to detect where the signal was coming from. With advances in (1930's) technology, the manually-rotated aerial was replaced with an automated one and the Automatic Direction Finder or ADF was introduced.

Further advances, such as digital tuning and electronic antennae (1980's), shown here on the right, further increased the accuracy of the units and their adoption.

In the aircraft the equipment is split into two parts. There is the detection unit (shown at the bottom of the image) with an LED/Gas fluorescent display, and the Indicator device, shown at the top with the Compass Rose with a rotating needle.

The detection unit is the actual ADF, and it is capable of driving a variety of different types of Indicator device depending on the equipment fit of the aircraft. For example it can drive an RBI (shown above), an RMI or even a G1000 flat-panel Primary Flight Display (shown left).

The most common display device is the RBI for its cost and reliability, the next more sophisticated display device is the RMI. They both share the common function of providing a Relative Bearing ("RB") from the nose of the aircraft towards the Beacon. That is, the relative bearing of the beacon FROM the aircraft.

Where they differ, is that the Compass Rose of an RMI is automatically synchronised to the magnetic heading of the aircraft, but the RBI Compass Rose has to be rotated manually by the pilot. However, once aligned, an RBI can be used like an RMI.  On a long straight cross-country segment of flight, this is perfectly acceptable, however in a busy training environment or in a hold or an approach, having to constantly realign the Compass Rose of an RBI is an unwelcome distraction.

For this reason, we teach the "North-Up" method at FIS, where the RBI Compass Rose is setup with the "N" or 360˚ marker on the Rose placed under the lubber line at the top. It is then left alone.

All instrument interpretation for QDM and QDR is by done by comparing the RB with the heading information from the DI/HSI or even Compass. In the above image the Relative Bearing is 220˚.

# Radio Navigation

## Single Needle Navigation

Despite the introduction of GNSS navigation and computer-controlled auto-pilot navigation in a Commercial environment, it is a requirement that Pilots wishing to achieve an Instrument Rating should be able to navigate with sole reference to navigational beacons using direction-finding techniques.

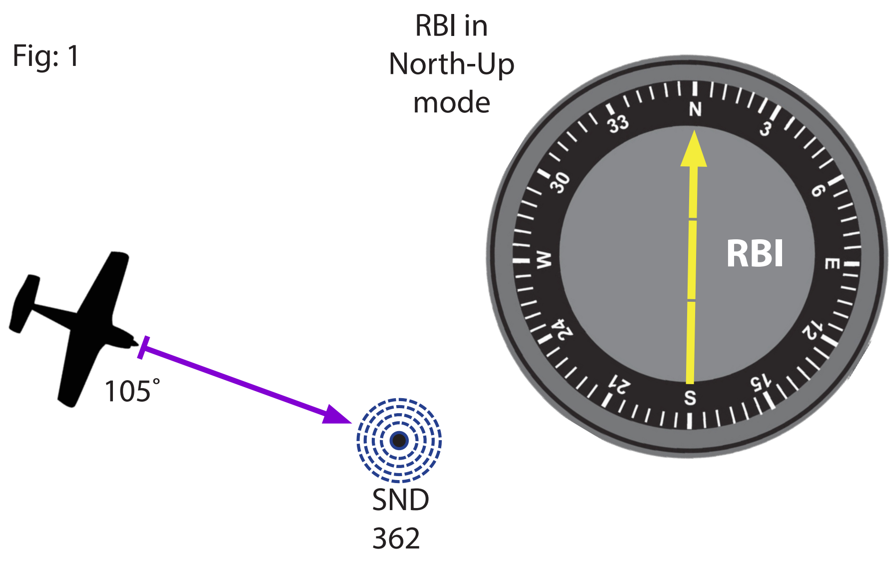
This consists at it's most basic of a single needle instrument that simply "points" at a Beacon. In reality this means either a NDB or a VOR ground station.

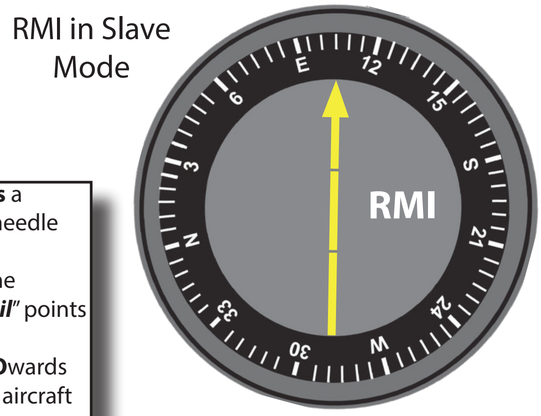
There are two types of bearing indicator, the Radio Bearing Indicator, or "RBI" and the Radio Magnetic Indicator, the "RMI". The difference between them is that the Compass Rose on an RBI has to be rotated by hand, for which there is a rotating knob similar to that found on a Direction Indicator

However the Compass Rose on an RMI is rotated electronically using a signal from a wing-tip magnetometer that detects the Earth's magnetic field and automatically and continuously (at 3˚ per second) synchronises the Compass Rose to magnetic North. This is one of the reasons why all turns under IFR are Rate-One turns, so that no de-synchronisation of an RMI (or HSI if fitted) can take place.

In both cases, the Needle of the RMI/RBI points towards the beacon **relative** to the nose of the aircraft, however the RMI gives a direct read-out of the QDM on the Compass Rose from the "head" of the pointer arrow, whereas the RBI gives the bearing relative to the nose.

Fig: 1




**QDM** is the magnetic bearing **towards** a beacon and is what the "***head***" of the needle points at, on the Compass Rose.
**QDR** is the magnetic bearing **FROM** the beacon and is effectively what the "***Tail***" points at.
In the above RMI example the QDM **TO**wards the beacon is 105˚ and the QDR of the aircraft **FROM** the Beacon is 285˚

Imagine an aircraft with both an RBI and an RMI installed, driven by the same ADF.

In Fig: 1. on the left, we have an aircraft flying towards an NDB, in this case the SND on frequency 362KHz.

The aircraft is on a heading of 105˚.

In the top instrument, the Pilot has rotated the Compass Rose of the RBI to what is called "North-Up", that is 360˚/0˚ at the top.

In both cases the RBI and RMI have the needle pointing straight ahead, which is correct as the beacon is straight ahead of the aircraft.

However the RBI only gives the Relative Bearing as being "0°", whereas the RMI is reading out the QDM of 105˚

## Using the RBI

The RBI suffers from two features that makes its' use more difficult than an OBI or HSI,  these are "Needle Dip" and Fixed Card.

### Needle Dip.

The RBI is a display of the output from the ADF, which suffers from antenna cross-feed which manifests itself as the so-called "needle-Dip".  It is not necessary to explain the antenna limitaion that gove rise to this feature just what its effect is.

An ADF uses two antennae to detect the signal from a NDB. One of these, the Sense Antenna picks up an additional and unwanted signal from the NDB whenn the aircraft is banked.

The amount of unwanted signal is proportional to the Sine of the bank angle, but you don't need to know that. What you need to know as a pilot is that  there is a direct relationship between Bank Angle and error.

Each aircraft will be different, but for a metal fuselage aircraft using the most common designs of Sense Antenna, this is a relatively consistent 10˚ of error at a bank angle of approximately 18˚ .

This is conveniently close to a standard Rate-One turn.

This is what you actually need to know as a pilot. In a Rate-One Turn, the ADF error is 10˚

Level right bank


Level left bank


So what does this error look like? Well the error manifests itself as so-called "Needle-Dip". Take a look at the top diagram on the left.

Here, in a banked right turn, the head of the needle (orange) appears to become "heavier" and settles at the location indicated by the cyan needle.

Of course it hasn't become heavier, what happens is that the needle moves towards the bottom of the Compass Rose by, you guessed it, 10˚

Therefore an original (correct) Relative Bearing of 050˚ becomes 060˚ in the turn.

This is Needle Dip and in a right-hand turn the "Dip" is reversed, so a correct  RB of 310˚ becomes 300˚ (see right).
Conversely, the tail of the indicator become "light" and move towards the top of the instrument. Needle Dip immediately ceases once the wings are rolled level.

Needle Dip can easily be compensated by the pilot when turning, but it requires three things.

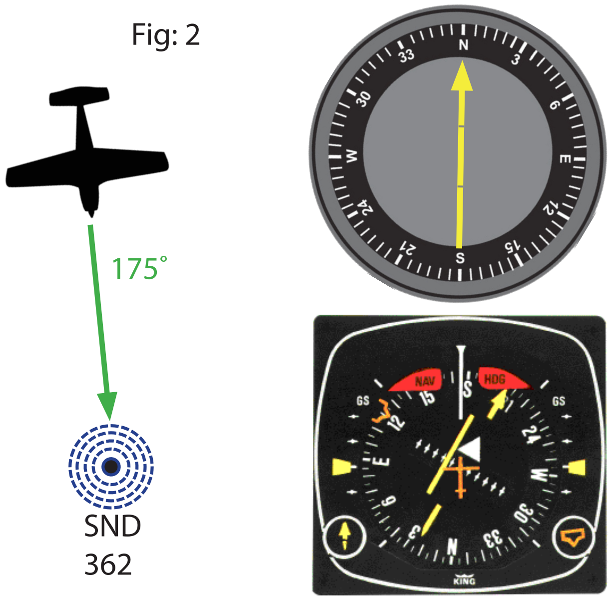
1. You need to know you are turning
2. You must maintain a constant Rate-One turn
3. You must maintain a constant speed (for 2.).

When tracking a NDB, try not to roll the aircraft unnecessarily as it will make the needle unstable and almost impossible to use. This is Needle Dip and how to deal with it, the next section looks at Fixed Card.

## Using the RBI

The RBI uses a Fixed Card or Compass Rose so is harder to use and interpret than the RMI, simply because the Pilot has to mentally convert their Relative Bearing ("RB") to either QDM or QDR using either the magnetic Compass, Direction Indicator or HSI.

Fig: 2



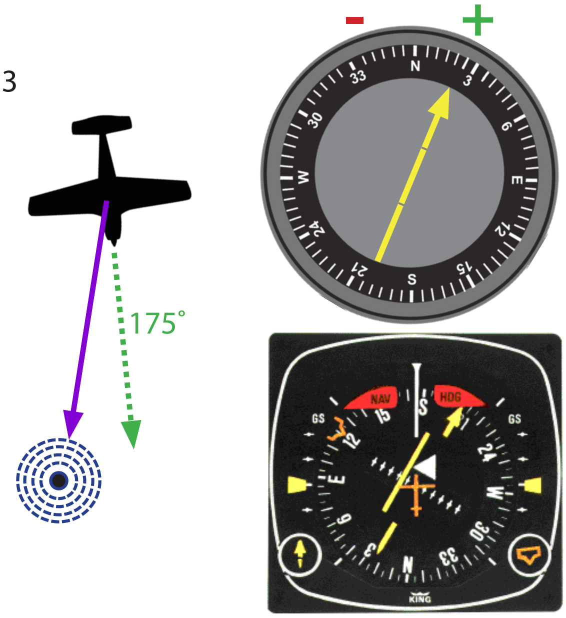

In the example on the left, Fig.2, the aircraft is on a Heading of 175˚ towards the SND beacon.

The RB is 0˚.

The RMI (which has a slaving Compass Card) is indicating a heading of 175˚.

Therefore the QDM is 175 - 0 = **175˚** and the QDR consequently is **355˚**

Fig: 3




In the example Fig.3, the aircraft is again on a heading of 175˚ (look at the HSI)

The RB is **+20**˚

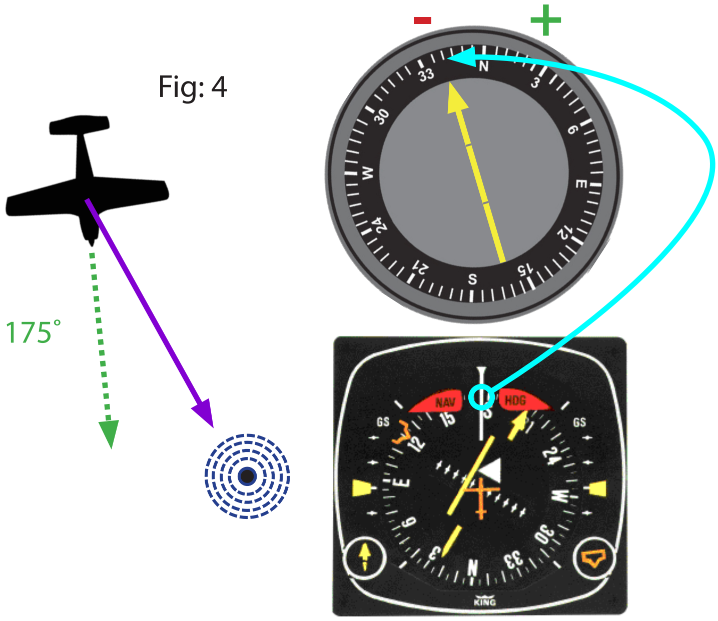
The RMI is confirming the heading of 175˚.

Therefore the QDM towards the beacon is

175 + 20 = **195˚** and the QDR is **015˚**

**Note:** We use a convention of **+** (positive) when the needle is to the right of North and **-** (negative) when to the left of North on the RBI

Fig: 4




In the example Fig.4, the aircraft is on a heading of 175˚

The RB is 340˚or **-20**˚

The RMI is confirming the heading of 175˚.

Therefore the QDM towards the beacon is

175 **-** 20 = **155˚** and the QDR is **335˚**

The key to using the RBI is to quickly transfer the heading from the HSI or Compass to the RBI Compass rose and from there the QDM

## Sources of Heading Information

There are multiple sources of Heading information depending on which type of aircraft you fly and the Avionics fit installed. If you are lucky, you will have a HSI, and maybe an RMI.

You may have EFIS-type system like a Garmin G5, or at its simplest, a Compass and Direction Indicator

HSI with
Mag Hdg


Contrary to the popular belief of many glass-cockpit fans an HSI is in many respects the easiest to use.

The beauty of the HSI is that it gives a simplified, intuitive display for the whole of the Compass Rose, therefore making the conversion of RB's to QDM/QDR's fast and easy.

Given also that the Compass Rose is slaved to the magnetometer flux-gate in the wing-tip it makes the mental arithmetic and visualisation much easier.

G5 with
GPS Hdg


A word of warning about Garmin G5's. They can come in two flavours, one with a Magnetometer and the other without. A G5 with magnetometer will give you Magnetic **heading** at the top of the display.

If it does not, then a GPS **track** readout is displayed instead. Currently European Magnetic Deviation is very low being +/-3˚, so this difference can almost be ignored.

One disadvantage of this layout though is that there is no Compass Rose in this Configuration (granted a twin G5 set will do this), which can make some calculations more difficult. More on this later.

Compass
& DI

At the simplest level, your aircraft may be fitted with a Direction Indicator and a magnetic compass.

If this is the case, then take care to synchronise the DI with the Compass, but once this is done, for short tracks of less than 10 minutes then Earth drift can be ignored.

Every 10-15 minutes, re-align the DI with the Compass to ensure accurate headings.

Once done, the Compass Rose of the DI can be used in the same way as an HSI, both for situational and positional awareness, but also as a circular calculator, more of which later.


Throughout the rest of this document, I shall not refer to any particular type of Heading Indicator, so as to be as aircraft-agnostic as possible.

The Indicator on the left can be thought of as a generic Heading Indicator, with the current heading marked in white lettering at the top. In this case "175˚"

## Correcting for Errors

One of the most basic skills of an Instrument pilot is tracking towards a beacon. Note the use of the word "tracking". Tracking is defined as maintaining a constant QDM towards or QDR away from a beacon or fix. During your IR skills test, the Tracking accuracy expected of the candidate is +/- 5˚.

Due to wind, accuracy of pilot handling or instrument drift, it is inevitable that some deviation away from a desired QDM/QDR may occur. It is vitally important that the pilot monitors and corrects for any deviations before they become an error.

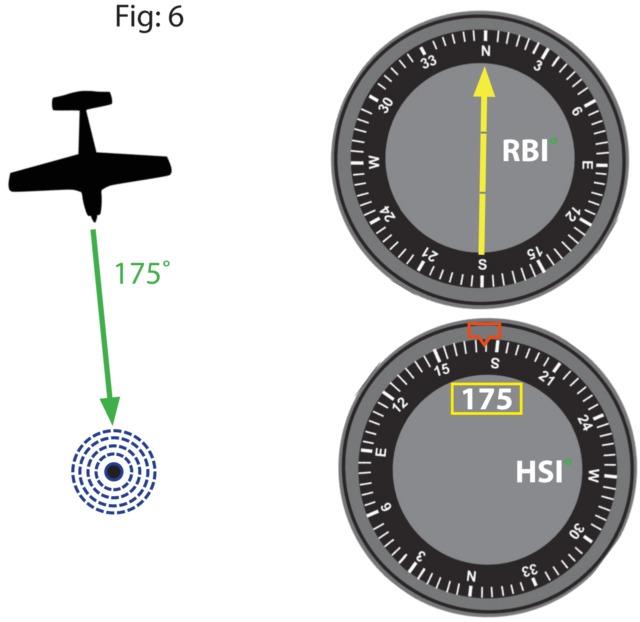


Fig: 6

In Fig 6, the aircraft is once again on a heading of 175˚ with a RB of 0˚, so therefore the QDM is 175˚

However if the aircraft drifts to the East (as shown in Fig 7.), perhaps by a westerly wind, or inaccurate flying by the pilot, then the QDM will increase as the beacon (as seen from the pilots perspective) moves to the right.

This is indicated in the cockpit by the RBI needle rotating clockwise and now pointing to +20˚ and the QDM is now 175 + 20 =195˚ (purple arrow) in Fig 7.

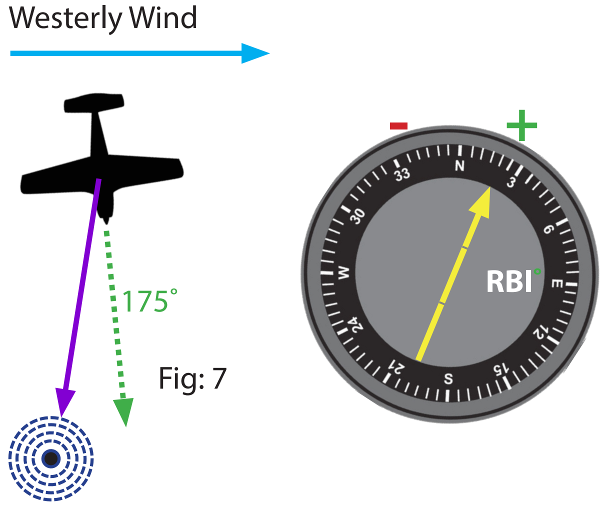


Fig: 7

As an IR Pilot you are expected to Track beacons not "Home" to them, so you need to correct this error.

The solution to regaining the original QDM track of 175˚ is for the pilot to turn to the right, but by an amount that is approximately double the error.

Here the error is 20˚, so turn right by 40˚ onto a heading of 175 + 40 = 215˚. (green arrow, Fig8.)

In Fig 8, the HSI heading is now reading 215˚. The RB is now reading 350˚ or -20˚ as we turned through 40˚so +20˚ became -20˚.

Our QDM is the same: 215˚ - 20˚ = **195˚** exactly the same QDM as before, as the aircraft hasn't moved, it has just turned.

If you now look at the second position of the aircraft (red) after the aircraft has flown on the heading of 215˚ for a while, then the RB has increased from -20˚ (yellow needle) to -40˚ (orange needle) as we "Push the Head".

The effect is shown on the RBI in Fig 8 with the orange-dotted needle. Therefore the aircraft has now returned back to a QDM of 175˚ because:

215˚ - 40˚ = 175˚

The Aircraft can now turn back to the original QDM of 195˚ (the purple-dotted track).

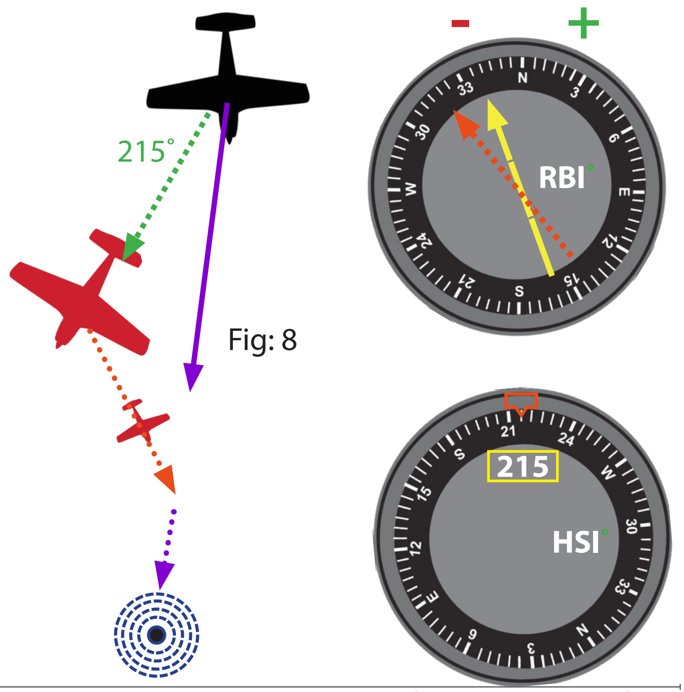


Fig: 8

## Pushing the Head, Pulling the Tail

To help you visualise this process in the cockpit, we use a simple memory aid. "*Push the Head, Pull the tail*".

If we take the previous example, the RBI needle is 20˚ to the left of the nose of the aircraft when the aircraft is in the position shown by the black image on the right.

This is represented by the yellow needle in the diagram. By flying 215˚, the pilot is going to "push" the head of the needle **away** from the North (or 360˚/0˚) position of the RBI.

By continuing to fly on heading of 215˚ (in this example) the head of the needle is "pushed" from the yellow needle position to the orange needle position.

This technique of "Push the Head, Pull the Tail" has multiple uses, but let us first look at "Pulling the Tail"

The needle head starts left of the North position (yellow), so by continuing to fly in this direction the Head is pushed further away **from** the North to the left, as shown by the purple arrow, ending at the orange arrow position

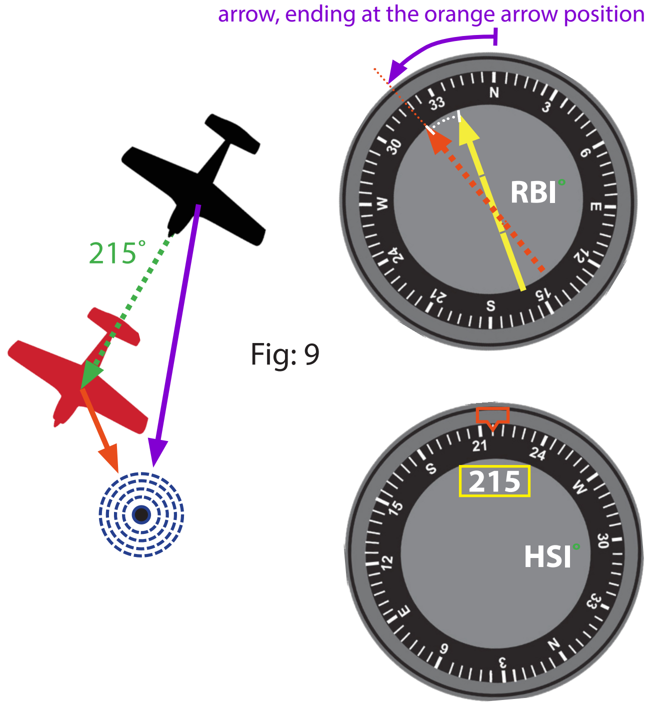



Fig: 9

In Fig 10. Imagine than an aircraft has flown over a beacon and initially has QDR radial FROM the beacon of 340˚ (*magenta arrow*). The Approach plate for this Beacon states that the Outbound track from the Beacon is 020˚, indicated by the green dotted line.

This situation is represented on the RBI by the yellow needle and the position of the red aeroplane.

Therefore, from the plan diagram on the left, the aircraft must turn to the right by more than 40˚ (-20˚ thru' to +20˚) in order to intercept the 020˚ radial. So from a heading of 340˚ the aircraft must turn right onto an approximate heading of 045˚ to intercept the 020˚ radial.

This means that from a pilots perspective looking at the RBI, they must "pull the tail" of the RBI from 340˚ to 020˚ ending up in the orange needle position.

If you follow the red-dotted arrow on the left from the HSI heading around to the RBI, you will see that your Heading is "pulling the tail" from the initial 340˚ to final 020˚.

Once the Tail is on 020˚ the pilot can then turn onto a heading of 020˚ to track outbound on the corrected radial.

The RBI needle tail starts left of the North position (yellow), but because the aircraft turns right, past 020˚ and onto 045˚, then the Heading is now pulling the Tail of the RBI. The actual flightpath is shown as the blue line below.

The Tail is "Pulled" towards the A/C heading of 045˚ as indicated by the magenta arrow below

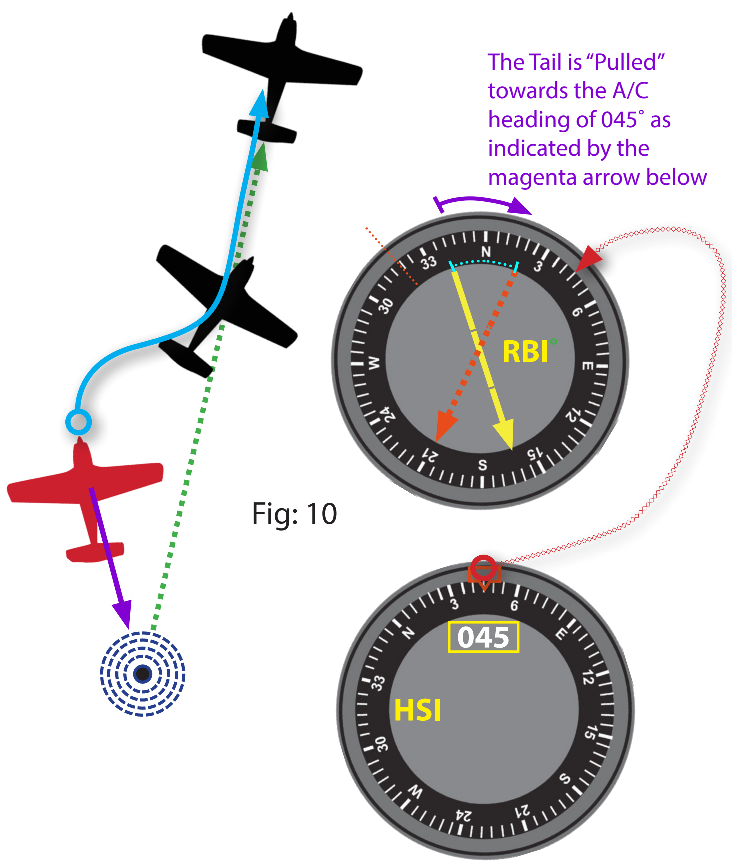
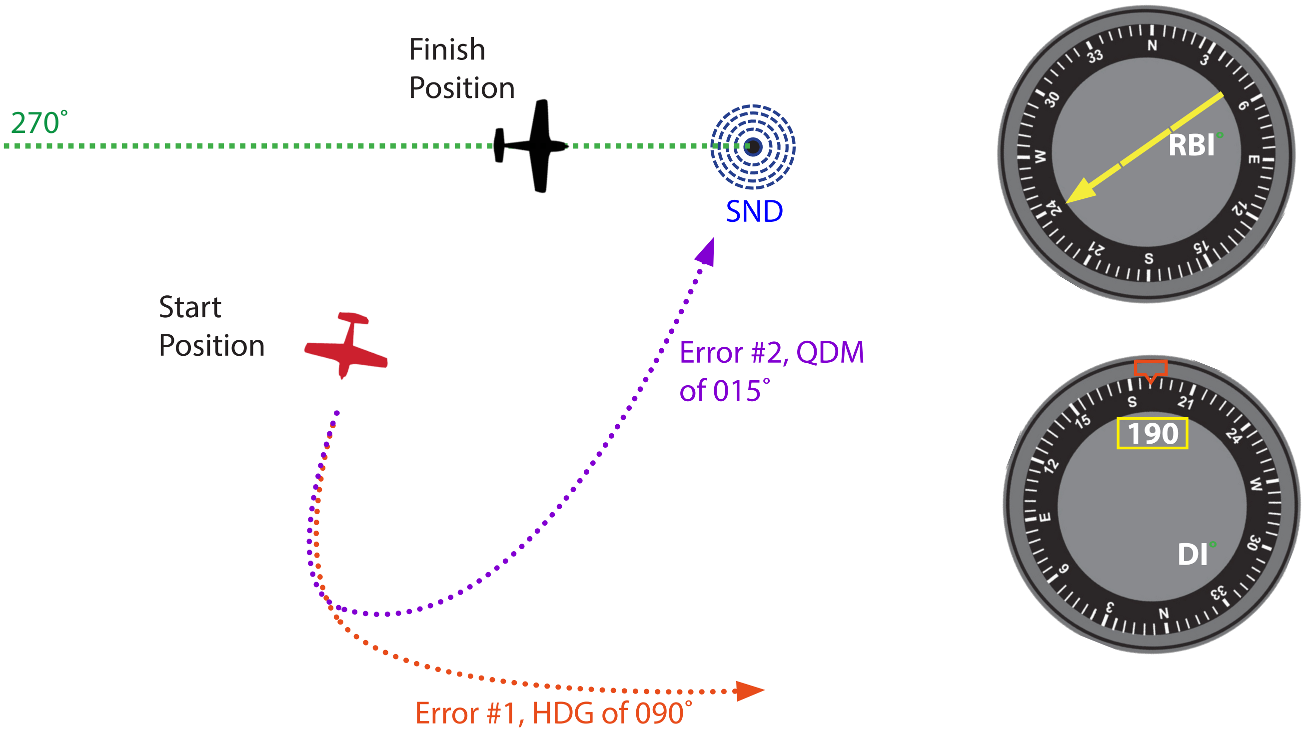



Fig: 10

## Interception with an RBI: Part 1

One of the skills of a Radio Navigation Pilot is intercepting a radial (a QDR) or an inbound track (a QDM) to a Beacon. Take a look at the set up in the diagram below. Here an aeroplane is heading 190˚ to the south. ATC call the pilot and tell them intercept the 270˚radial for SND and fly inbound to the beacon.




How do we approach this situation? Lets start with some facts. You have been asked to intercept a radial, which is a QDR, but the Controller wants you to fly Inbound, now that's a QDM, so first-things-first, convert QDR to QDM.

You need to be easily able to convert the two which will always be 180˚ apart. *Remember this mental trick*:

- add 200 then minus 20, or
- minus 200 and add 20

This makes it easy to convert QDR's/QDM's, so using QDR270˚ as an example: 270 minus 200 is 70. 70 plus 20 is 90, or 090˚. So the QDM is 090˚. We call this the "200/20" rule

Try this again with a QDM of 125, what is the QDR?

125 plus 200 = 325, and 325 minus 20 is 315˚, so the QDR for QDM125˚ is 315˚

So, going back to our example, the pilot is actually being asked to flying inbound to the SND beacon on 090˚. Looking at the diagram above with North at the top and the answer is obvious, but in the plane, maybe not. So the task is get some situational awareness and plot a course to get from the starting position of the red plane to the black plane.

Before we go further lets look at two common mistakes.
**Error #1**. You get confused by ATC and turn right onto a heading of 090˚. This is shown as the orange dotted track.

**Error #2:** You turn right and track towards the beacon. Wrong again, yes you are tracking towards the beacon, but not on a QDM of 090˚, as in the case of the purple track above, more like 015˚.

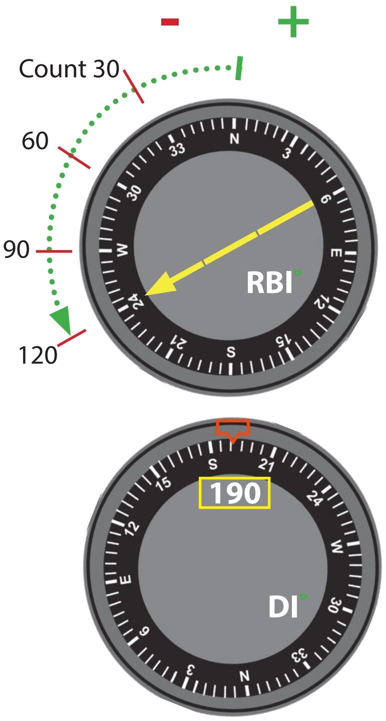
## Understand the Picture

So does the pilot turn left to intercept the QDM or turn right?

To answer that we need to really understand what the needles are telling us. Let us stop for a moment and take a short diversion before we come back to the Intercept example. I promised you practical techniques for real-world flying., sj here are three quick mental methods for quickly determining QDM's and QDRs'

**Revelation time!** The Compass Rose is a circular calculator.

The Big Numbers on the Compass Rose are 30˚ apart. So that's 000˚, 030˚, 060˚, 330˚, 300˚ etc.
The next size divisions are 10˚ and the really small ones are 5˚ apart.




**Method #1 QDM:** What is the QDM? Look at the RBI needle and count (in this example anti-clockwise) the "big numbers" from the top of the RBI around to the head of the needle: "33, 30, W, 24".

An easier way to dot it, is to just count up the number of "big numbers".
Each one is 30˚, so actually count them up in your head by adding 30's together like this: *"30, 60, 90, 120"* *

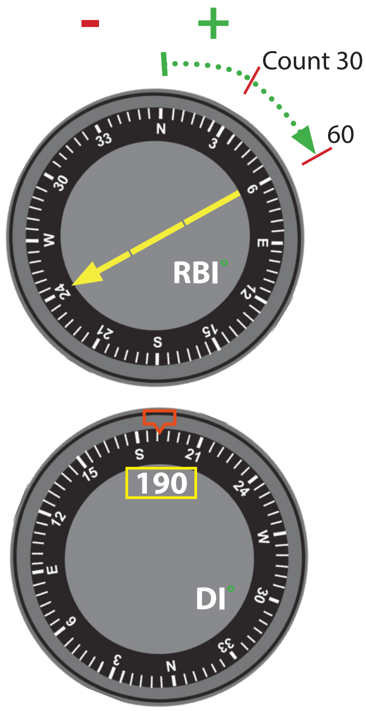
The heading is 190˚ (*from the DI below*), so 190˚ minus 120˚ is 070˚

Therefore the QDM is 070˚ to the beacon.

Work out the QDR from the beacon using 200/20, it is:
70 +200 => 270 then 270-20=>250˚

So the **QDR is 250˚**

(* *or if you prefer 1,2,3,4 so 4x30 is 120*)




**Method #2 QDR:** What is the QDR? Look at the RBI needle and count the "big numbers" from the top of the RBI around to the Tail of the needle: "3, 6".

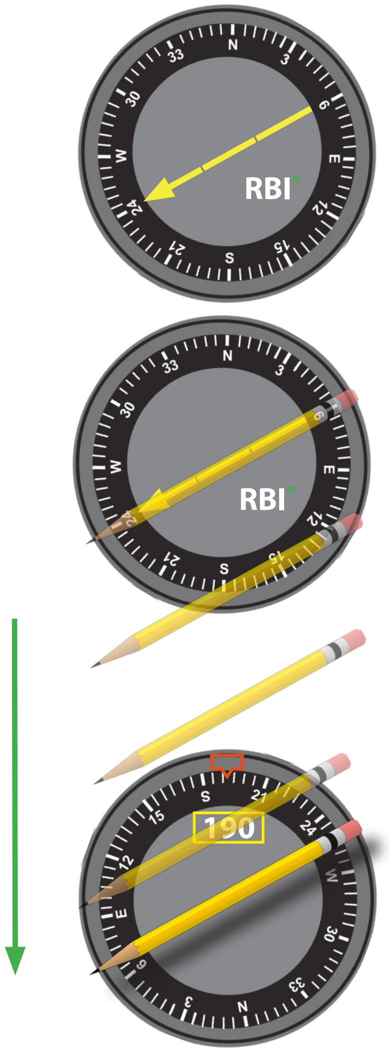
Each one is 30˚, so actually add them up in your head by adding 30's together like this: 30, 60. (or "1,2" so 2x30 is 60)

The heading is 190˚ (*from the DI below*), so 190˚ plus 60˚ is 250˚

Therefore the QDR is 250˚ to the beacon.

To work out the QDM to the beacon using "200/20":
250 - 200 => 50 then 50+20=>070˚

So the **QDM is 070˚** exactly as above.




**Method #3 *Pencil Method*:** What is the QDM? Look at the RBI needle and place your pencil over it aligned with the Head of the needle.

Very carefully parallel your pencil across to your DI/HSI and the head of the pencil will point at the QDM, which in this case is 070˚

To work out the QDR from the beacon, it is underneath the pencil eraser at 250˚

So the QDR is 250˚

Do not be ashamed if the mental arithmetic of Method 1 and 2 are confusing and you have to resort to the Pencil method to start with. Most people won't admit to it, but they usually start this way.

However with practice the "penny will drop" and you will start to actually "see" what the picture is telling you without the aid of a prop such as the Pencil.

But for now, if the Pencil Method works for you, use it.

As Ford Prefect said of the Infinite Improbability Drive,
*"Don't knock it, it works!"*

## How to Intercept with RBI, Part 2

Back to our Intercept example. If you now image replacing the pencil with the RBI needle (see right) we remember that we must "push the head".


The Head is currently pointing at 070˚, but we actually need to "push" it to 090˚.

That means we need to turn to the right (clockwise), as this will push the needle.

But what heading should we use to Push the Head?

There is no hard and fast answer, but I recommend 60˚ as a starting point for any intercept. This is not an exam-testable item so if its 55˚ or 65˚ it doesn't really matter, but for reasons that will become obvious later, 60˚is a good place to start.

If you remember, the QDM you were told to fly inbound on is 090˚, so minus 60˚ (intercept) is 030˚.

So in this case turn right and start flying on a heading of 030˚

If you look at where 030° is on the DI/HSI, then you see that this will indeed start to push the head, towards 090°.

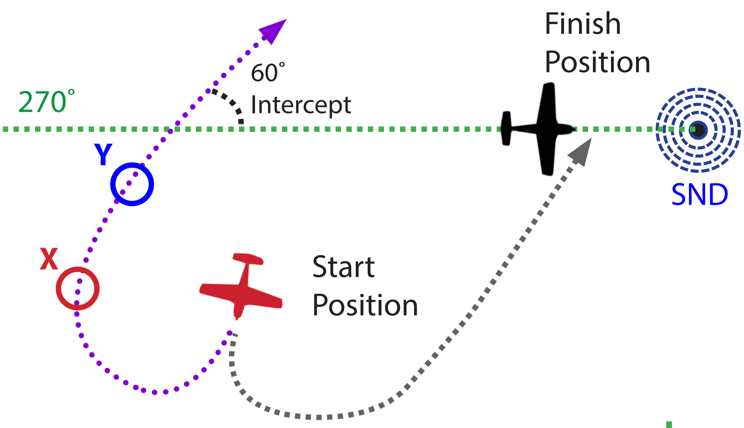
Once the aircraft has turned right onto a heading of 030° the needle of the RBI will start to be ***pushed*** towards 090°, the target QDM.

When the aircraft has reached point **X** the RBI is pointing at 030° a RB, with a HDG of 030°

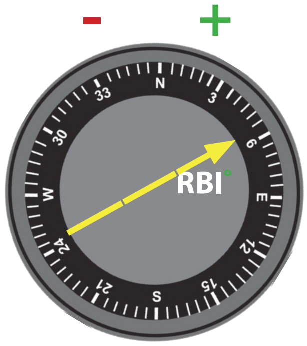
Therefore the QDM is 30 + 30=> 060°

As the aircraft flies on 030° it will reach point **Y**, and in doing so the needle will "fall" (or is being "pushed") right to, in this case ~050°, so QDM of 080°.

You will reach the desired QDM of 090° when the RBI points at 060°, as 030° + 060° => 090°




RB at point X



RB at point Y


### Intercept Timing

NDB's do not provide distance information, so we don't know how far we are away from the beacon. Therefore we need to calculate our rate of Intercept.

Get your stopwatch out and time how long it takes for the RBI Needle to fall 5°; for example from 030° to 035°

If the answer is <*say*> 45 seconds, then we know we are intercepting at a rate of 5° per 45 seconds.

Now we know our closing rate (5° per 45s), then we can calculate when to turn inbound onto the QDM of 090°. So how do we know this? Well earlier I suggested we intercept at 60°.

A Rate-One turn is 3° per second, so it takes 20 seconds to turn through 60°. As we know our closing rate, then we know that when the RB is at 25°(that is 5° to go) it will take a further 45 seconds to reach the QDM. We also know it will take 20 seconds to complete the 60° turn from the Intercept Angle to the QDM.

So what we do is wait until the needle points at 025°. We know it will take 45s to intercept the QDM and 20 seconds to turn, so 45 minus 20 is 25. Therefore when the RB reaches 25° start the stop watch and count 25 seconds, at the end of 25 seconds start the turn, at Rate-One, towards the beacon.
When you roll out, you should be very close to the desired QDM.

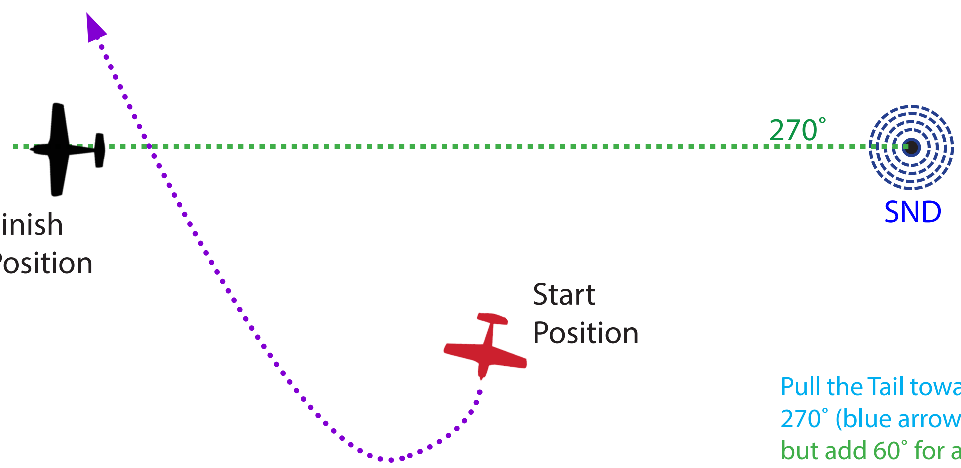
It wont be exact in real-life as wind and of course the fact that the aircraft is following a curved path will conspire to introduce errors, but it will be close enough and any corrections can be made once the aircraft is stable.

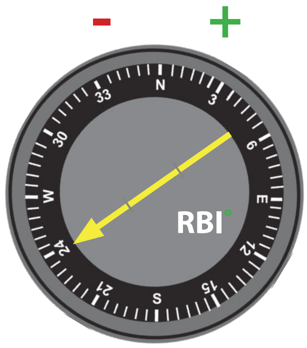
Now you understand how the intercept works, you may ask the question. "*Why turn right and not left, so long as you intercept at 60°it shouldn't make any difference?*". This is quite correct, it shouldn't make a difference.

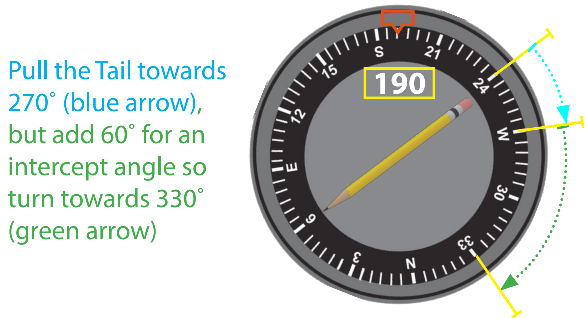
The simple answer is there is no "right" or "wrong", however if you suspect that you are close to the beacon, you may be unable to intercept the QDM before passing the beacon. See grey dotted line above. So by turning away from the beacon you give yourself more space and time to intercept correctly. However, given sufficient distance, both will work equally well and turning left would be more efficient.

## Interception with an RBI - Part 3

Take a look at the set up in the diagram below. As before a aeroplane is heading 190˚ to the south. ATC call the pilot and tell them intercept and track out on the 270˚radial from SND and fly outbound from the beacon.



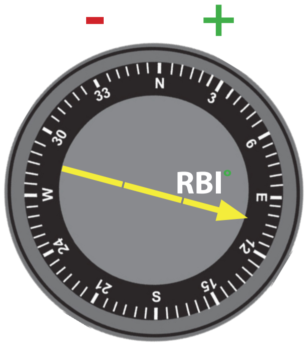




In this scenario, the pilot needs to look at the radial or QDR. No need to convert this time, ATC have given us the QDR and want us to fly out on a QDR.

Find 270˚ on the DI / HSI, so if using the pencil method, we can see we currently have a QDR of:

050˚ (RB - tail of the needle) plus 190˚ (HDG)=> 240˚.





We need to "pull the tail" of the RBI needle (or the pencil eraser) towards 270˚, the desired QDR.

So turn right onto a heading that is 60˚ more than the desired QDR of 270˚, therefore 330˚

Once the turn is complete, the Tail of the RBI needle will be reading approximately -70˚ or an aprox QDR of 290˚ (shown left).

Your heading of 330˚ is now "pulling the tail" from -70˚ up towards -60˚, or from 290˚ towards 300˚, either way it is the same position.

Once the needle reaches 60˚left (or -60˚ if you want to look at this way), then the QDR is 330˚ - 60˚ => 270˚, the desired QDR.

As before check the rate of QDR change, so in this case if the rate is <*say*> 5˚ per 50 seconds, you can calculate the timing of the start of the turn.

In this example when the Tail of the needle reaches 295˚ (5˚ to go, or -65˚), then a 60˚ turn takes 20 seconds to complete.

Start the stopwatch at 295˚, then count for 30 seconds (50-20), then start to turn right, at Rate-One onto the QDR of 270˚

## Needle Dip

For the more astute among you, there is one thing we have not taken into account in the previous two examples of Interception and that is Needle Dip.

The question is, do we need to be concerned with Needle Dip?

The answer is a qualified "no" for two reasons.

The above technique works for both RBI/NDB combinations and RMI/VOR combinations and as there is no needle Dip when using a VOR, it is not an issue. But what about RBI/ADF/NDB? Well, again a qualified "no".

I say "no" on one proviso, and that is that the aircraft when flown on the 60˚intercept heading is kept straight and level. If this the case then the NDB will not suffer Dip and will give a true reading. If there is a lot of turbulence or you do not fly with the wings-level, then Dip will be induced and it will considerably harder to interpret the RBI. The answer, fly straight !

However, temporarily, as the aircraft turns onto the QDM or QDR from the Interception track, there will be some Dip whilst in the turn, but once the wings become level again the DIP will disappear.

However, if as I suggest the turn was initiated based on **Time**, this should not affect the outcome. Sorted !

## The Radio Magnetic Indicator

The majority of this chapter has been dedicated to the RBI, but it is worth noting some features of the Radio Magnetic Indicator ("RMI").

*Typical RMI*

Shown on the left is a typical RMI. As mentioned previously this instrument has one other very powerful feature, that the compass rose is slaved to a magnetic flux gate, which automatically rotates the compass rose to always be in alignment with the nose of the aircraft, or more correctly, its magnetic heading.

As Most TSO'e Radio receivers have both Comm/Nav capability and for IR flying two Comm radios are mandatory, it is usual that two Comm/Nav receivers are fitted for redundancy (the cost of the extra Nav in the second receiver is negligible) .

As a result most RMI's have a two needle arrangement where each needle can be independently driven by either of the two VOR (Nav) receivers, or more typically, one VOR receiver and one ADF receiver.

The pilot can select which needle (green or yellow in this case) represents the QDM to either of the 2x VOR's or 1x VOR beacon and 1x NDB Beacon.
*It is very unusual these days to have 2x ADF receivers fitted, but it is theoretically possible to have 2x ADF's configured, one on each needle)*

The head of the needle gives a direct readout of the QDM to the selected beacon. The Tail by deduction is the QDR or radial from the beacon.

In the illustration, this aircraft has a magnetic heading of ~193˚ and a QDM to the "green beacon" of 288˚ and a QDM of 314˚ to the "yellow beacon"

The pilot does not have to rotate the compass rose to align it with the heading of the aircraft. As a result it is instantly intuitive as to what the QDM is to a particular beacon as the QDM (or QDR) can be read directly off of the face of the instrument. This makes in considerably easier to use than the RBI.

## Conclusion

The RBI is considerably more difficult to interpret for the novice than the magnetically slaved, and superior RMI.

However the RBI is far more common that than the RMI, is also simpler, cheaper, more robust and more reliable than its RMI cousin, so if you find yourself flying a variety of different aircraft, then you are more likely to come across the RBI than the RMI.

That said, once you are well practiced with using the RBI, then switching to an RMI is very easy, however for those with little or no experience of the RBI, the reverse cannot be said. This introduction has focussed on a single instrument, but the skills are completely transferable to the ADF -RMI, VOR-RMI and HSI.

Whether you like it not, Single-Needle tracking is an integral part of the Instrument Rating. If you can understand the fundamental principals of using the RBI and you train to the point where you can instinctively interpret its readings, then I promise you will never get lost again.

Currently it is fair to say that in mainland Europe many NDB's are being decommissioned in favour of GNSS; however above latitudes 70˚ North and South, NDB's may be the only form of navigation due to polar GPS signal restrictions and VOR line-of-sight range limitations.

### Sobering Thoughts....

With the recent discovery by C4ADS of the existence of portable GPS-Spoofing devices, and their covert use by certain Governmental agencies, there has been a very quiet shift in the opinions of some Aviation Authorities that the pace of decommissioning of NDB's, VOR's and especially ILS should be slowed, whilst solutions to such interference can be found. https://www.bbc.com/news/technology-47786248

For this reason, NDB/VOR's might be with us longer than you think whilst the public are kept in the dark until a solution is found. EGNOSS/WAAS may help, but ground-based transmitters can easily flood a space-based geostationary signal. Food for thought: *Windsor Airlines Flight 114 might not be all fiction......*

As a final thought, NDB's work on the Long-wave and Medium wave frequencies where many commercial radio stations operate. It is quite possible to listen to the radio using your ADF receiver and if you know the location of the transmitting Antenna, use it as an uncertified beacon ....*if all else fails or if you just want some music on the Ident!*

# HOLDS

*"Everything you ever needed to know about Holds, but were too afraid to Ask"* *

## INTRODUCTION TO HOLDS

If it has been some time since you read the notes on Single-Needle Tracking then it might be best to revise them now.

The purpose of these Student notes is not to tell you what a Hold is, but rather the practical way to enter and fly them. You should already know about the structure of an ICAO Hold, because you have passed your EASA exams, but what that training material does not teach you is the best way to actually fly them and make corrections in real time, under pressure and with basic instruments.

## The Hold

There are three types of Hold, a Terminal or beacon-based Hold, an en-route Hold and an add-hoc Hold where you may get asked by ATC to Hold at your current position.

All Holds consists of 4 segments, based upon a "Fix" and an inbound track.

- The Fix maybe a radio beacon, such as the Sevilla VOR, "SVL" or the Jerez NDB "JER".
- It can be a RNAV Waypoint defined by a radial or distance from a VOR/DME (eg "TENDU", SVL270/13)
- A GNSS waypoint, (e.g. "KUBAS" N36.xxE060.yy), or
- You may simply be asked by ATC to "*FIS63, Hold at current position until advised*", the FIX now becomes your current position, and the inbound track, your current heading.

### Hold Segments

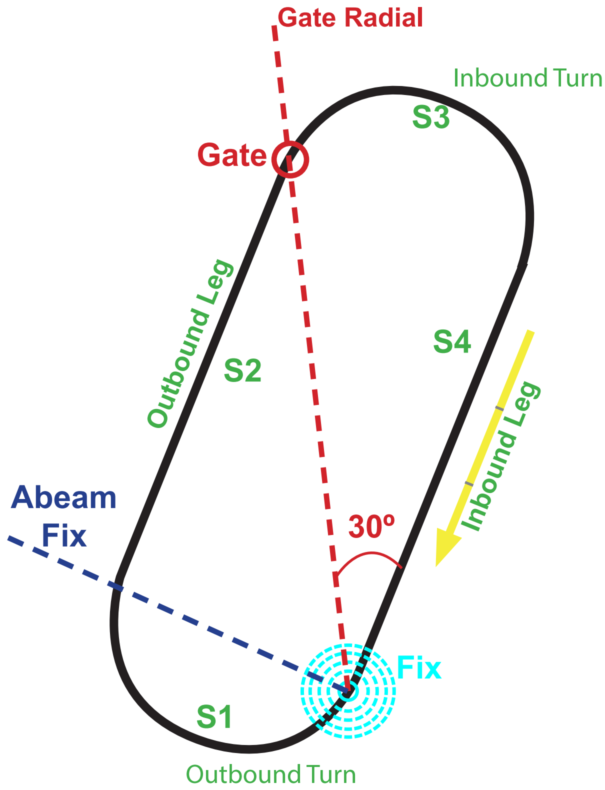
Shown here is a Hold based upon the JER NDB, with an Inbound track of 202º. This Hold is a "Standard Hold", and so therefore is flown clockwise with right-hand turns throughout.
A non-standard Left-hand has a turn to the left at the Fix and is an anti-clockwise circuit. It is effectively a mirror image of a Right-hand Hold.
The Hold starts at the Beacon with a 180º, Rate-one turn, this is called the "Outbound Turn". All turns under Applied-IF are Rate-one. So the Outbound Turn takes 60 seconds to complete and here is shown as segment S1.

The second segment, S2, is called the "Outbound leg" and is flown for 1 minute. S3 is the Inbound Turn, again at Rate-One, for 60 seconds, finishing with S4, the Inbound Leg of 60 seconds back to the beacon. Total time, 4 minutes.

In addition there is "The Gate", which is the place where a radial, 30º offset from the Outbound leg, centred on the Fix intersects the OutBound Leg.

The Gate is where you commence the Inbound Turn. The importance of the Gate will become apparent later when it reaches almost mythical importance.

Lastly there is the "Abeam Fix", again a radial from the Fix and offset 90º from the Inbound Track. It is used for timing purposes.

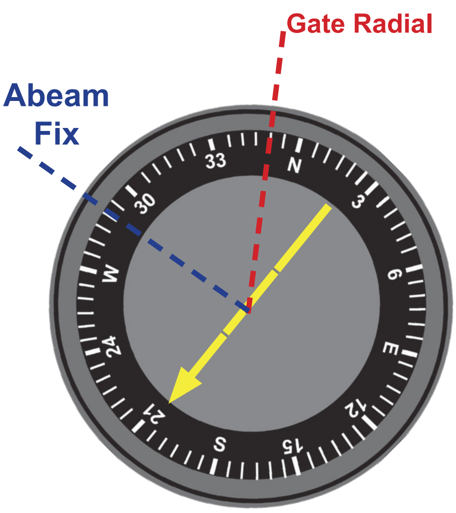



* *How well do you know your Woody Allen movies????*

## Hold Structure

To be able to fly the Hold with the least amount of effort, you need to know the Inbound & Outbound Track and the radial of the Gate and Abeam fix.
You have a choice, the easy way and the hard way. The hard way is to do all the maths in your head, whilst in IMC at 140Kts, in turbulence, icing and whilst carrying out your descent checks, talking to ATC and maintaining a QDM to the fix within 5º tolerances.
Or you can do the following.

On your HSI, rotate the CDI so that it aligns with the Inbound track.




Where is the Inbound Track? It's on the Approach Plate !

On the diagram on the left, the CDI has been set to 202º and the plane is on a heading of ~345º, this is the JRZ Hold at Jerez.
Now you can quickly work out using the CDI as a graphical calculator the following pieces of information:

IT: **Inbound track** (taken off the approach plate)
OT: **Outbound track**, from the "tail" of the CDI, e.g. 022º
Gt: **Gate**: the tail of the CDI, minus 30º, e.g. 022º - 30º = 352º
Ab: **Abeam Fix**, the head of the CDI, plus 90, so e.g. 202+90=292º
OT: **Outbound Heading**, the heading to fly to correct for Wind Drift
OT: **Outbound Timing**, the time to fly to compensate for wind

On your Pilots kneeboard , you can have an area prepared, so you can quickly jot down the 6 pieces of Hold data you need, ready for use.

On the right is an example of this format. You can either make one yourself for the cockpit or use one of the ready made PLOG's available.

IT:202 - R
OT:022
Gt:359
Ab:292
OH:013
OT:68

All of this information can be easily plucked off of the compass rose of the HSI once the CDI has been aligned with the Inbound track given to you by the Approach Plate.
No mental arithmetic, quick and easy.
As for calculating OH and OT, this will be covered later.

## Hold Entries

There are technically 3 types of hold entry

- Parallel
- Offset / Teardrop
- Direct

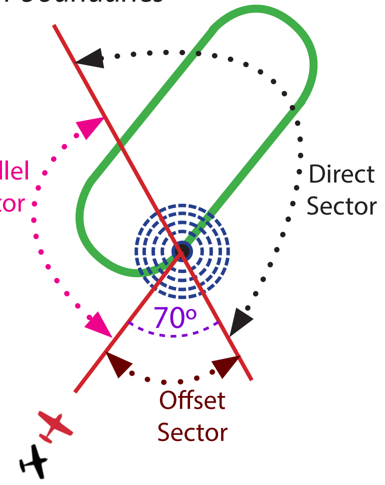
Of which there three sub-species of Direct Hold entry

- Less than 90º
- 90º to 180º, and
- Greater than 180º

In reality, rather than there being 5 hold possible entries, there are actually only 4, as the Direct:<90º is actually flown the same as an Offset, which we explain later.

## Hold Entry Sectors

The Hold can be approached from anywhere within 360º of the Fix. To facilitate aircraft separation and terrain clearance, 3 hold entries are defined.




The decision on which hold entry to used is based upon which sector the Aircraft is approaching the Fix, based on the Heading (not the track) of the aircraft.

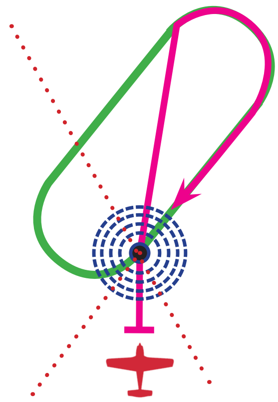
There is a 5º margin of latitude at the edges of each Entry segment where the pilot can elect to use whichever of the two Entries they choose.
Using the example above where the Outbound track of the Hold is 022º, if the aircraft is <u>*Heading*</u> between 017º and 027º (eg. *red plane above, still air*), then the pilot could choose to fly either the Parallel or Offset entry.

It should be noted however, that if there was a strong southerly wind for this 202º Hold, and the aircraft was <u>*Tracking*</u> towards the Beacon at 022º, but had a Wind-corrected <u>*Heading*</u> of (say) 030º (*the black plane above*), then although the black plane is at the same location and track as the previous red plane, the Pilot of the Black plane would have no choice but to choose a Parallel Entry. This is because entry is based on Heading (030˚) not Track (022˚).

## Sector Entry Techniques

Before describing how to fly Holds, it worth taking some time to quickly revise the concepts behind Single-needle tracking.

When using an RMI or an RBI to track a QDM, then you need to "Push the Head" of the needle. If tracking a QDR, then you need to "Pull the Tail" of the needle. If this concept is familiar, carry on. If QDM/QDR/RMI or RBI are unfamiliar, please revise the Student notes on Single Needle Tracking & Interception as part of this series of Student notes.

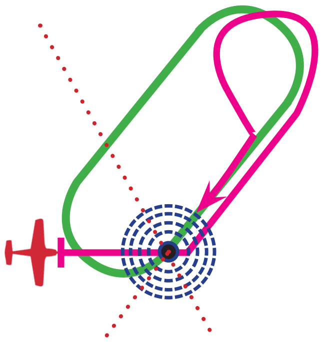


### The Offset Entry

Sometimes also called the "teardrop" due to the path the aircraft takes in joining the hold.

The idea is to fly to the Gate, for a period of 1 minute before turning back towards the Beacon / Fix.

The second time over the Beacon / Fix, you are actually entering the Hold, hence why this is called an "indirect entry".



### The Parallel Entry

Directly track towards the Fix. After passing the Fix, start to turn towards the Outbound Track, in parallel with the Inbound track. After 1 minute Outbound turn left aprox 240º to set up a 60º intercept to the Inbound track.

Anticipate and intercept the Inbound Track to the Beacon. The second time over the Beacon / Fix, you are actually entering the Hold, also an "indirect entry".

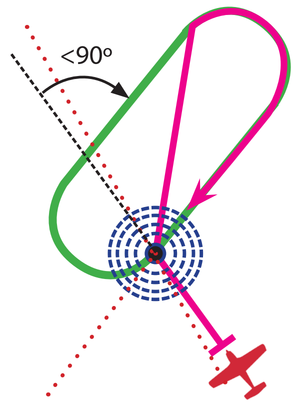
## Direct Entry

As stated earlier there are 3 types of Direct Entry.

- Less than 90º
- 90ºto 180º
- Greater than 180º

The Names refer to the number of degrees you must turn through once you have passed the beacon in order to fly the Outbound Leg.

The diagrams on the right illustrate the different types of Direct entry.



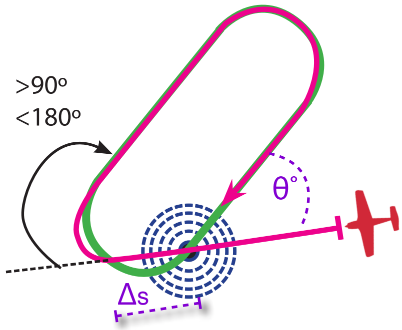

Direct Hold <90º

**Direct <90º** (*Pronounced "Direct less than 90"*)
In a Direct Less than 90 degrees entry, the aircraft starts a turn about 0.5nm before the beacon and turns to intercept the Gate radial. The aim is to be at the Gate at the end of 1 minute.

Note that is the same technique as an Offset entry. For this reason the *Direct <90º* and the *Offset Entry* can be considered the same for practical flying. Hence the explanation at the beginning of this document that there are effectively only 4 different Hold Entries.

**Direct >90º <180º** (*Pronounced "Direct greater than 90"*)
The aircraft passes over the Fix. Then continues in a straight line for Δ (delta) Seconds, before turning towards and flying along the Outbound leg until reaching the Gate.

The number of Seconds to fly depends upon θ (theta), which is the angle between the track towards the Fix and the Inbound track. The equation is:




Direct Hold >90º <180º

$$\Delta = \theta / 5$$

*it does not have to be über-accurate, just approximate.*

For example, if the Inbound Leg is 202˚ and the aircraft Heading (not track) to the Fix is 230˚, then θ is ≈30˚, so 30÷5=6, so **Δ** is 6 seconds.

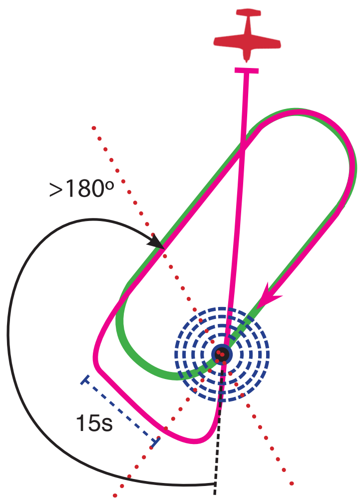
Therefore once you have passed the fix, you continue flying for 6 seconds on a heading of 230º before turning towards the Outbound leg of 022˚. Upon reaching the Gate QDR, start the Inbound turn to the Inbound track Leg.

The number of seconds to fly straight, Δ, should be limited to 15seconds. So if θ was 80˚, Δ <u>should be</u> 16 seconds, but we actually limit Δ to 15seconds.

**Direct >180˚** (*Pronounced "Direct greater than 180"*)
With this Entry, you fly over the Fix, and turn towards the same radial as the Abeam Fix. On crossing the Inbound radial, fly for 15seconds before turning towards the Outbound track, then turn back towards the Fix at the Gate.

In our example of the JER LEJR Hold with a 202˚ Inbound track, once overhead the Fix, turn right to 292˚ and parallel the Abeam Fix radial of 292˚.

On passing the QDR of 202˚ (by GNSS or RBI/RMI), fly the 292˚track for 15seconds, then turn right onto 022˚ until reaching the Gate QDR of 352˚. Upon reaching the Gate QDR, start the Inbound turn to the Inbound track Leg.




Direct Entry >180º

## Choice of Hold Entry: The POD Method

When approaching the Hold, you need to decide which Hold entry is appropriate. There are several methods available, we shall discuss the "POD" and "Visual Overlay" methods, both of which are visual and quick.

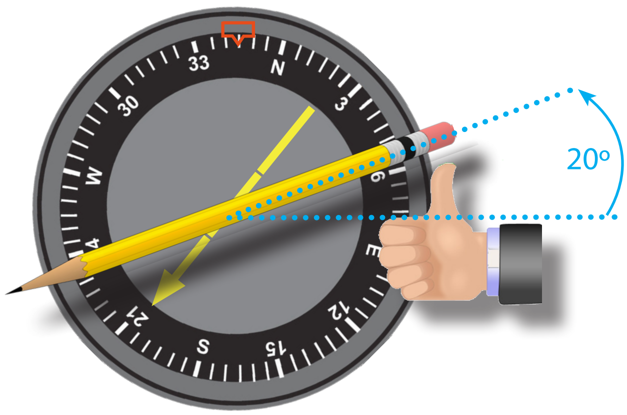
As was explained previously, start by using your HSI as a "Bug" and put the CDI on the Inbound track of the Hold. The Inbound Track can be found on the Approach Plate.

For example, the JER Hold at Jerez, the Inbound Track would be 202˚

In this example on the left, the Aircraft is heading ~345˚ .

Now imagine, or for real, laying a pencil centrally across the face of the HSI from right to left.

The pencil is now laying across the face at 070˚ - 250˚

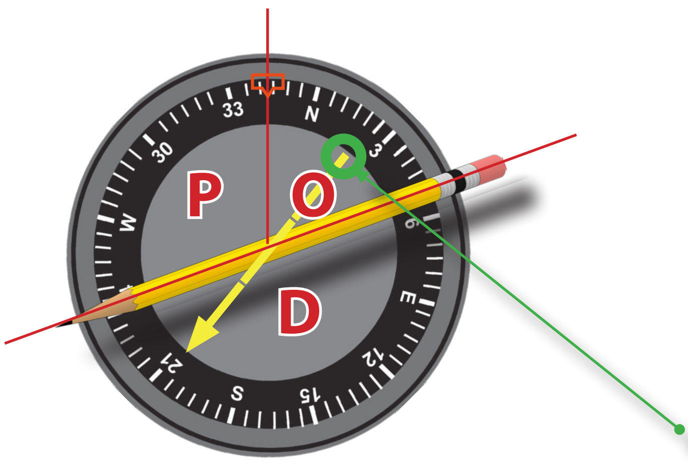




Now imagine, pushing up the back of the pencil with your right thumb by 20˚.

It is now lying 050˚ - 230˚ (as shown left).

*Why 20˚?*
As we are mirroring the Hold on our HSI face and the segments of all Holds are defined by a 70˚offset from the Inbound Track, then 90˚-70˚ is 20˚

Because the JER is a **Right-hand** standard Hold, then we use our **Right-hand thumb** to create the 20˚ offset.



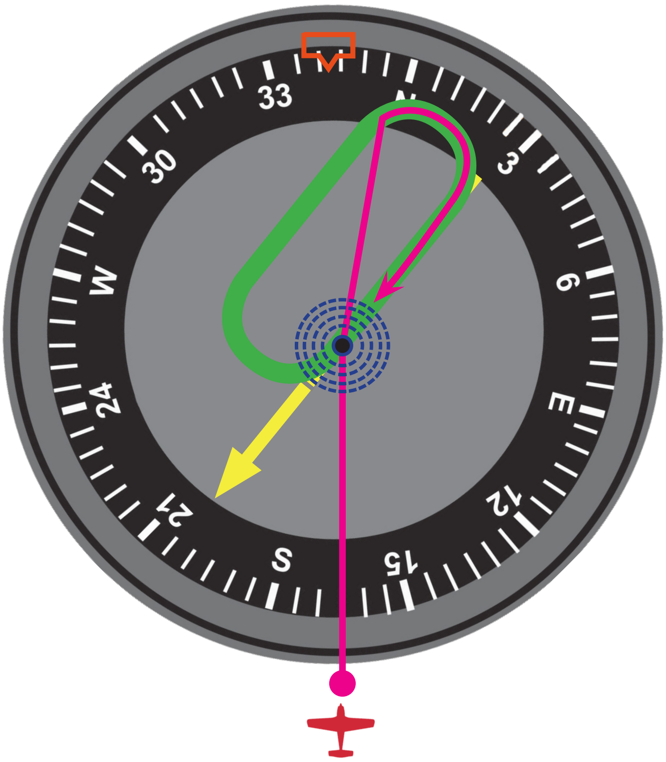

You can now draw an imaginary line down from the top of the HSI down to the centre of the pencil, and another line across the length of the pencil. Shown here in red.

We have now split the HSI face into 3 segments.

These are "P-O-D"; Parallel, Offset and Direct sectors. The largest sector is Direct, next biggest is Parallel and the smallest is Offset.

Look the "tail" of the CDI, it is in the "O", or Offset segment.

Therefore, this is an Offset entry to a 202˚ Hold with a track towards the Beacon/Fix of 345˚.




## Visual Overlay Method

Another way to visualise the Hold entry is to imagine that the beacon or Fix is in the middle of the CDI bar.

The inbound track is in the direction of the CDI arrow, which in this case is an inbound track of 202º

You can then imagine overlaying the Hold starting at the Beacon.
In this case of a Standard (right) Hold, the oval shape of the Hold pattern can be placed over the CDI arrow, shown here as a **green oval**.

The aircraft is approaching the Fix from the bottom of the HSI (165˚) up towards the top (345˚).

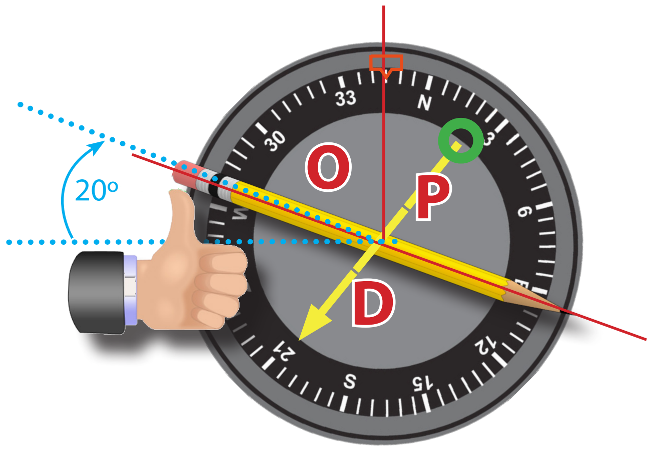
It is now easy to visual that this is an Offset Entry

## Left Hand Hold: POD & Overlay Method

In the case of a Left-handed, non-standard Hold (*such as Kubas for the LEJR RW02 approach*) then we simply use the our **left thumb** to lift the rear of our imaginary pencil by 20˚ for this **Left-Hand** Hold.

The largest sector, as before, is Direct, next biggest is Parallel and the smallest is Offset.

In the example on the right, with a 205˚ Inbound Track and a 345˚ heading towards the Fix, then this would be a Parallel entry as the "tail" of the CDI is in the Parallel sector.

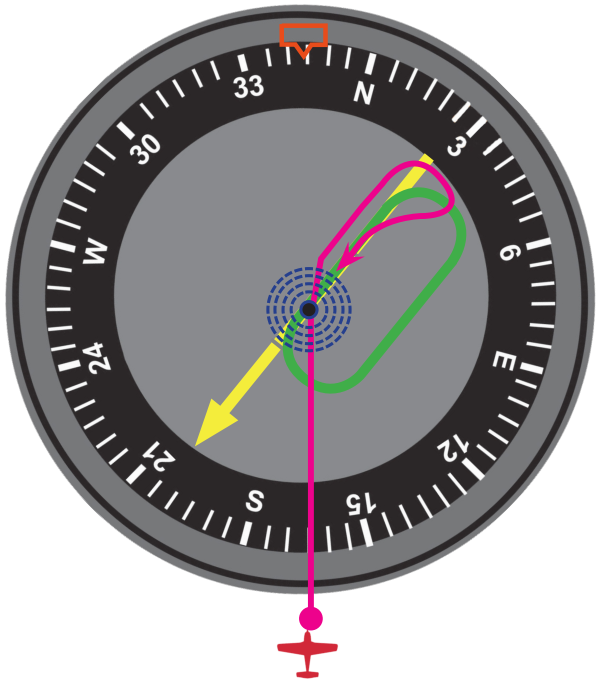



Alternatively, using the Visual Overlay method, this same Hold can be visualised to be a Parallel entry as well.

Either method is equally valid as a system for quickly determining the Entry type for your current Heading.

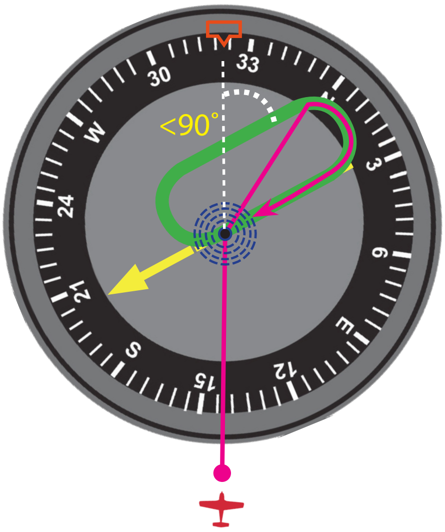
Use which ever one you feel most comfortable with.

In reality, most pilots use both, as a double-check that they have made the correct choice, .



## Visualising Direct Hold Entries

All of the previous images of Hold entries look fine on paper, but how to visualise them when in the air? Use the HSI / CDI as a graphical aid. The diagrams below assume you have "bugged" the Inbound leg of the Hold with your CDI. Once you have done that, this is what the three Direct Hold entries will look like on your HSI/ RMI/RBI combination

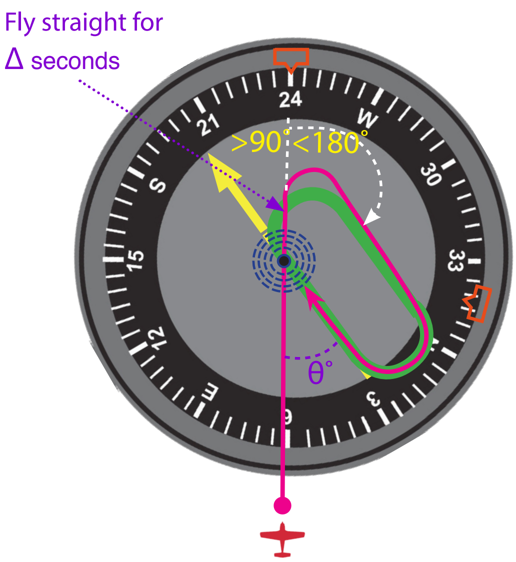



On the left, this is the view from the cockpit as you approach a Beacon for a "**Direct <90˚**" Hold join.

The "*less than 90˚*" comes from the fact that you will turn right through less than 90˚ from the present heading (white dashes) onto the Outbound Track.

In this diagram, if you can imagine to superimpose the Beacon onto the middle of the CDI and then the Hold in respect of the Beacon (the green line), then it is quite easy to visualise how to join this hold and which one it is.

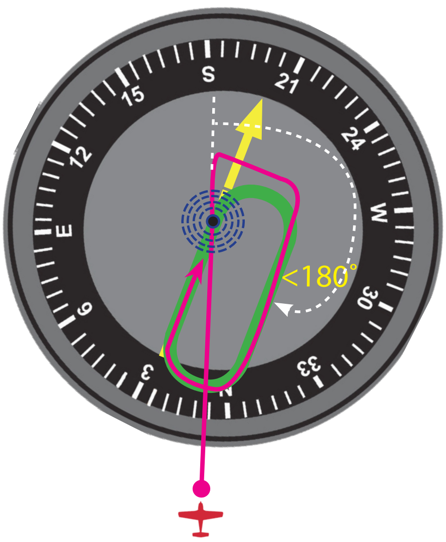
Here you turn right thru' less than 90˚ towards the Gate, fly for one minute, and then turn right back to the inbound track (QDM) to the beacon. The completed path being in magenta.




On the left, this is the view from the cockpit as you approach a Beacon for a Direct "**greater than 90˚ but less than 180˚**" Hold entry.

Once you have overflown the Beacon, continue on your heading for Δ seconds, (θ˚ ÷5), you then turn until you are flying along the Outbound leg. This turn will be more than 90˚, but less than 180˚. (white dotted lines)

You continue to fly out to the Gate and turn back to the Beacon at the Gate. The completed path again in magenta.




Using the CDI as a "bug" and imagining the Hold superimposed on top of the RMI, you can visualise the *direct greater than 180˚* entry.
You overfly the beacon and turn in the Hold direction (in this case "right") and roll out and fly in the same direction as the Abeam Fix (*direction not radial*).

Once you have crossed the Inbound QDM, continue the Abeam Fix track for 15 seconds then turn again to intercept the Outbound leg. This in effect means that you make two turns, the sum of which will be greater than 180˚ in total.

You continue to fly out to the Gate and turn back to the Beacon at the Gate.

## Wind Correction: The real world

Flying an accurate Hold in a simulator with no wind is relatively straightforward. When you do it for real, in IMC conditions, turbulence and windy conditions, it's a *whole new ball game*.

Wind correction for a Hold does not require a CRP-5, or any other calculator, just some fast, simple mental arithmetic.

**Do not** make the mistake of trying to look-up the wind on the ground before you fly and then plan with precise detail the Hold, corrections and drift angles, because the wind changes speed and direction in real-time and is highly unlikely to be as forecast or reported and in addition you may be forced by ATC to climb to unplanned altitudes where the wind is different again. It is much better to be able to calculate on-the-fly.

What you need are some methods that are quick, intuitive and proportional. Most of the time we need to know the **S**ingle **D**rift correction ("SD") for a given heading when Tracking (not "homing"), but first we need to start with MDS.

### Maximum Drift Speed: MDS

Single Drift is the drift speed created by the wind for a given direction. We derive it from Max Drift Speed which is the maximum speed at which the wind will drift you from your intended track over the ground. MDS occurs when the wind is at 90˚ from your heading. Therefore when the wind is at 90˚ to intended track SD=MDS. However it is rare to fly with the wind at exactly 90˚, so we need to calculate SD for all possible heading directions, which always start with calculating MDS and taking it from there.

The MDS is given by the equation:

MDS = 60÷TAS x Wind Velocity

Can you do this in your head, with say, 87 Knots of TAS?

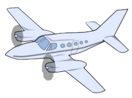
Don't bother, you don't need to.

Imagine an old Biplane, it flies along at **60**Kts. Then its MDS is simply equal to the Wind Velocity (WV)

60 ÷ **60** x WV = 1 x WV

Now imagine a Seneca flying along at **120**Kts, then the MDS will be equal to half of the WV

60 ÷ **120** x WV = 0.5 x WV



When the Wind Velocity is less than 5% of the airspeed of the aircraft, you can pretty much ignore wind drift. This is because 5% equates to a maximum wind drift of ~3˚ which is the limit of the accuracy that most humans can fly at.

*This is unless you are flying for more than 1 hour on a fixed heading, in which case you should recalculate every 45 minutes*

Autopilots are much better and can achieve +/- 1˚ accuracy but given that most winds are variable in any case, wind speed of 5% of TAS and below is below the threshold where it can be safely ignored, but should still be monitored.

So if you are flying a Cessna172 or a WarriorPA28, which cruises at 90Kts, then the MDS will be half-way between the above two examples.

So by way of example, lets take a wind of 20Kts, the MDS for each aircraft will be:

- Biplane: 60÷**60** x 20Kts WV = 20Kts Max Drift Speed
- Seneca: 60÷**120** x 20Kts WV = 10Kts Max Drift Speed

So logically a PA28/C172 at 90Kts will have a MDS of 15Kts, half-way between 10 and 20!

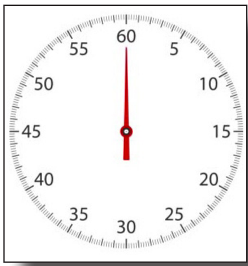
And in fact, as a C172/PA28 will typically cruise at 100/105Kts, just knock off 1Kt of MDS of 15 giving you a final figure of approximately 14Kts.

As the wind will vary, your guestimate will be good enough for real-world flying. What we are looking for is an answer that is quick, close enough and doesn't get in the way of flying the aircraft.

Try this method with a wind of 25Kts, then 14Kts, and then compare your mental calculations with the answer from a CRP-5 calculator. You will be pleasantly surprised.

So now we know MDS, we can now work out our Single Drift Correction Angle for any given heading, *enter stage-left* another simple method, ladies and gentlemen may I introduce the "Clock Code"

## The Clock Code and the Wind Drift




The Clock Code is a quick and simple way to calculate the Single Drift (and therefore the Wind Correction Angle) from a given MDS and a heading.

The mathematical way of doing this involves the Sine of the angle between the heading and wind direction multiplied by the MDS.

Want to get your Sine tables out, mid flight? No? I thought not......... !

Now imagine a Stopwatch face marked in seconds. Wait ! Maybe take a look at the watch on your wrist.

If it is "old school" analogue, you don't have to imagine it, you already have a clock calculator on your arm!

Maybe now you will start to understand why real IR Pilots wear analogue watches! Time to think about treating yourself to a new watch? Whilst you are at it make sure it has a Stopwatch or at least a second hand.

So, split the face into 15 second quarters, that is from 0 to 15, 15 to 30, 30 to 45 and 45 to 60s.

Then take the approximate number of degrees the wind is coming from **in relation to the heading of the aircraft**.

Now convert the number of degrees to the number of seconds around the Stopwatch face and break the face in sectors..

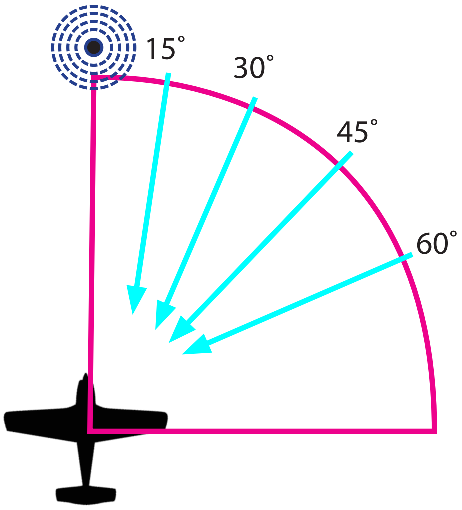
- 0º -> 15˚ is up to 15 seconds, which is a ¼ of the way around the face, so this is the "*¼ Sector*"
- 16˚ ->30˚ is up to 30 seconds, which is a ½ of the way around the face, so this is the "*½ Sector*".
- 31˚-> 45˚ is up to 45 seconds, which is a ¾ of the way around the face and finally for
- 46˚ -> 60˚and above to 90˚, this is 100% of the way around the stopwatch face, so 100%.

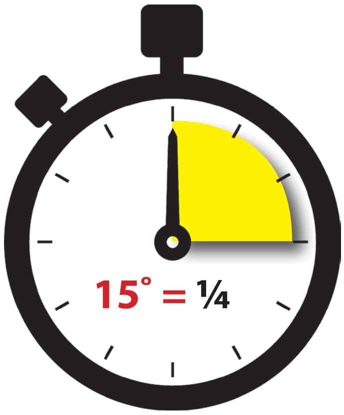
To then work out the wind drift, find which sector the wind is coming from, then multiply the MDS by the angular fraction of the Sector to come up with the Single Drift for a particular heading.

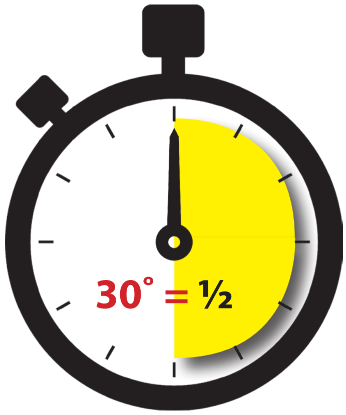
**How to use the Clock Code**

The Clock Code is used to adjust the MDS to give the actual aircraft drift for any given direction.

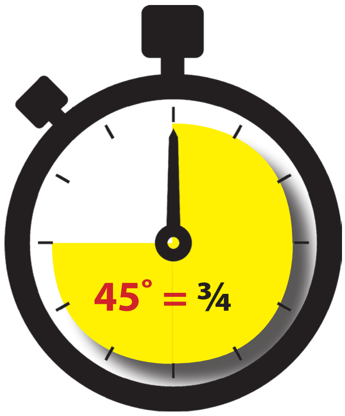
You can then adjust your heading into the wind to counteract this drift, which then becomes your Wind Corrected Angle, or Wind Corrected Heading, its the same thing.



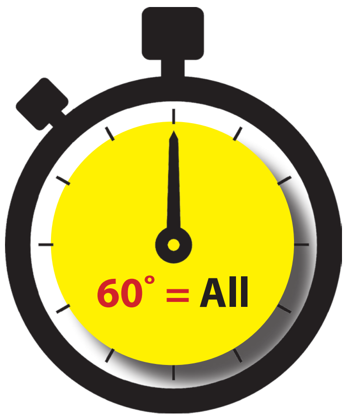

Looking at the diagrams above and right, we can see this in action




**Example #1.**
Aircraft heading North (360˚ / 0˚), MDS is 10Kts at 012˚, what is its Track?
The wind is 12º to the right of the nose of the aircraft and therefore is in the ¼ Sector.

Using Clock Code, Wind Drift is: **¼ x 12˚ =3˚** of wind drift to the left so the aircraft is actually drifting to the right with a Track Over Ground ("TOG") of 357˚ (360˚ - 3˚).

If the Pilot wants to track directly to the Beacon on a QDM of 360, then they must steer 003˚




**Example #2.**
Aircraft heading 120˚ (south east), MDS is 15Kts at 080˚. What is the wind drift & TOG?

The wind is (120˚ - 80˚) 40˚to the left of the nose of the Aircraft, 40º is in the ¾ Sector.

Using Clock Code, the Wind Drift is: **¾ x 15˚ =10˚**

Therefore there is a wind drift of 10˚ to the right, so the aircraft is being blown off the desired track by ≈10˚, so our Track over the Ground ("TOG") is 120+10 ≈ 130˚.

## Tracking: Putting It All Together

So now we have learnt how to calculate the Maximum Drift Speed MDS, we can now use the clock code to work out the wind drift for any direction the aircraft wants to fly which gives us Single Drive or WCA.

"WCA" and "Single Drift" are essentially the same thing, but the term WCA is used more when talking about en-route flying, and the term Single Drift is used specifically with regard to the Inbound and Outbound headings used in a Hold. They are the same number and calculated the same way.

The idea is that when you are tracking towards a Beacon, or a Fix, or flying Inbound on the Hold, you need to fly a Wind Corrected Angle to offset the effect of the wind drifting you to the left or right of the published track.

Why is this important? Well, Terrain clearance and Aircraft separation. The SID's, STARS, Airways and Holds are all based on Tracks, not headings, so correcting for wind to maintain a Desired Track is central to Applied IF.

If you do not correct for wind, you will effectively be "homing" to the Beacon or drifting off your Airway. Do this on test and you can expect to fail your IR Skills Test, burn through precious fuel and demonstrate your poor piloting skills. Your Single Needle Skills Test tracking limit is +/-5˚of Track, so accurate Wind assesment is crucial.

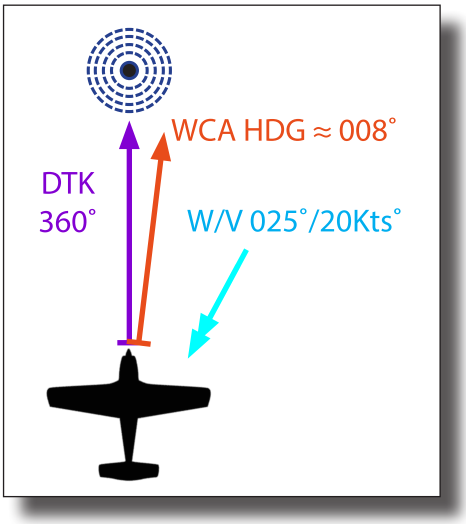
## How to Fix Wind Drift

This may all seem complicated at first, but once you get your head around it, it is ludicrously simple. Here come lots of examples with pictures. Remember these are all aproximations, so for example 15÷2=7.5

Now we don't bother with halves, so we round up "7.5" to "8"

### Example A:

A Cessna 152 is tracking towards a Beacon from the south on a Desired Track ("DTK") of 360˚at 90Kts TAS. The wind and velocity ("W/V") is 025˚at 20Kts.




What heading should the pilot take to continue to track towards the beacon on a QDM of 360˚?

**MDS first:**
20Kts for Biplane, 10Kts for Seneca, so 15Kts MDS for C152 at 90Kts.

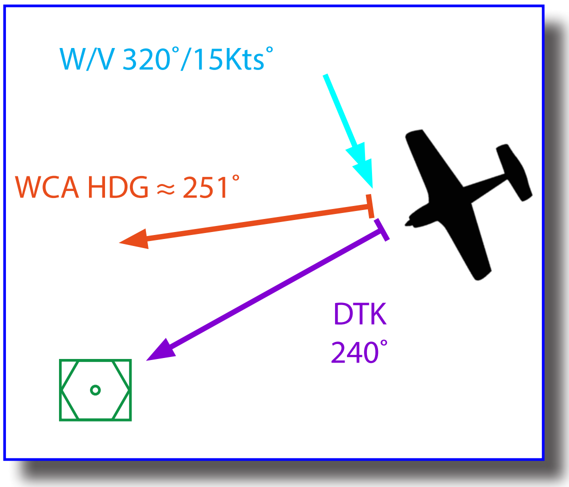
**WCA next:**
Track is 000˚, W/V is 025º, so 25˚ to the right of the nose.

Look at your watch, 25 is in the ½ Sector, so MDS of 15 x ½ ≈ 8˚, so
WCA is 360/000˚ + 8= 008˚ (as we need to steer to the right to counteract the wind)

So a Heading of 008˚will keep the aircraft Tracking to the Beacon on a DTK of 360˚. This is the Wind Corrected Angle WCA, or Single Drift if describing a Hold.

**Homework**
Get out your CRP-5. Put all the numbers above into the Wind Drift calculator. What is the WCA that the CRP-5 gives you? *

* 6˚ to the right, or HDG060˚




**Example B:**
An PA28 with a TAS of 105Kts has to track inbound to a VOR on a DTK of 240˚ estimated Wind is 320˚/ 15Kts

What is the WCA and HDG to steer to maintain the QDM of 240˚ to the VOR?

**MDS first:**
15Kts for Biplane, 8Kts for Seneca, so at 90Kts: 12Kts, so at 105, call it 11Kts.

**WCA next:** (use your HSI to calculate the wind difference)
Track is 240˚, W/V is 320º, so 80˚ to the right of the nose.
Look at your watch, 80 is above 60, so take all the drift of 11˚, so
WCA is 240˚ + 11= 251˚
*(as we need to steer to the right to counteract the wind from the right)*

So a Heading of 251˚will keep the aircraft Tracking to the Beacon on a DTK of 240˚. This the Wind Corrected Angle WCA and HDG to steer of 251˚.

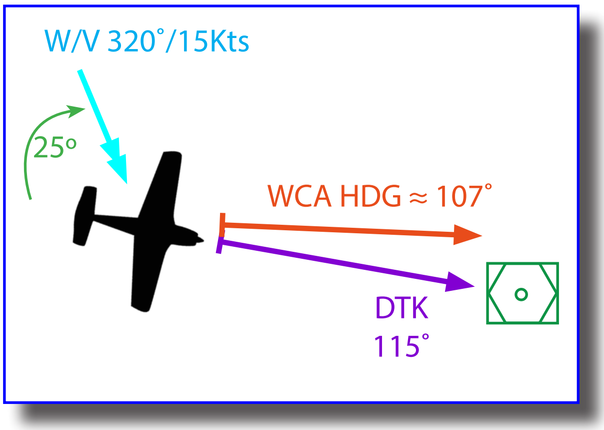
**Homework:** Now do this on CRP-5

**Example C:**
An C150 with a TAS of 80Kts has to track inbound to a VOR on a DTK/QDM of 115˚, estimated Wind is 320˚/ 15Kts

What is the WCA to steer to maintain the QDM of 115˚ to the VOR?

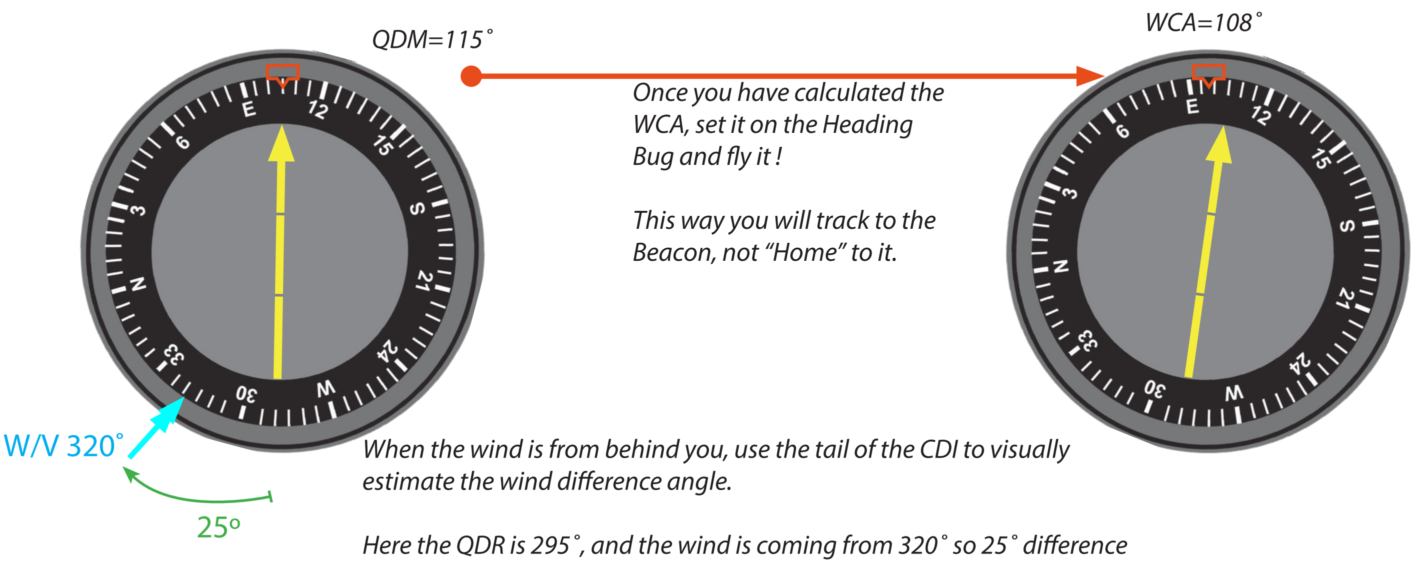
**MDS first:**
15Kts for Biplane, 8Kts for Seneca, so at 90Kts 12Kts, so at 80Kts, call it 13Kts.

**WCA next:**
Track is 115˚ (the QDM), the QDR is 295˚
W/V is 320º - 295˚ is 25˚ so wind is coming from 25˚ to the left of the tail.




Look at your watch, 25 is inside the ½ sector, so half of the drift of 13, gives a drift of ≈7˚ to the right, so steer 7˚ to the left to counteract it. Therefore WCA is 115˚ - 7= 108˚

So a Heading of 108˚will keep the aircraft Tracking to the Beacon on a DTK of 115˚. This the Wind Corrected Angle WCA and HDG to steer for 115˚. To finish off the correction, move the Heading bug on the HSI from 115˚ as shown on the diagram below to 108˚, then fly, *wait for it........* 108˚ and stay in the bug!




**Homework:** If you have calculated the WCA's for all three examples on a CRP-5, you will have discovered that the Mental calculations are within +/-3˚ of the CRP-5. Given you will struggle to fly +/-5˚ in anything other than smooth air, this is accurate enough for a Wind correction. Practice these calculations at home so that you become adept at them, and your Tracking will improve significantly and when planning for Holds you will gain significant and important mental capacity.

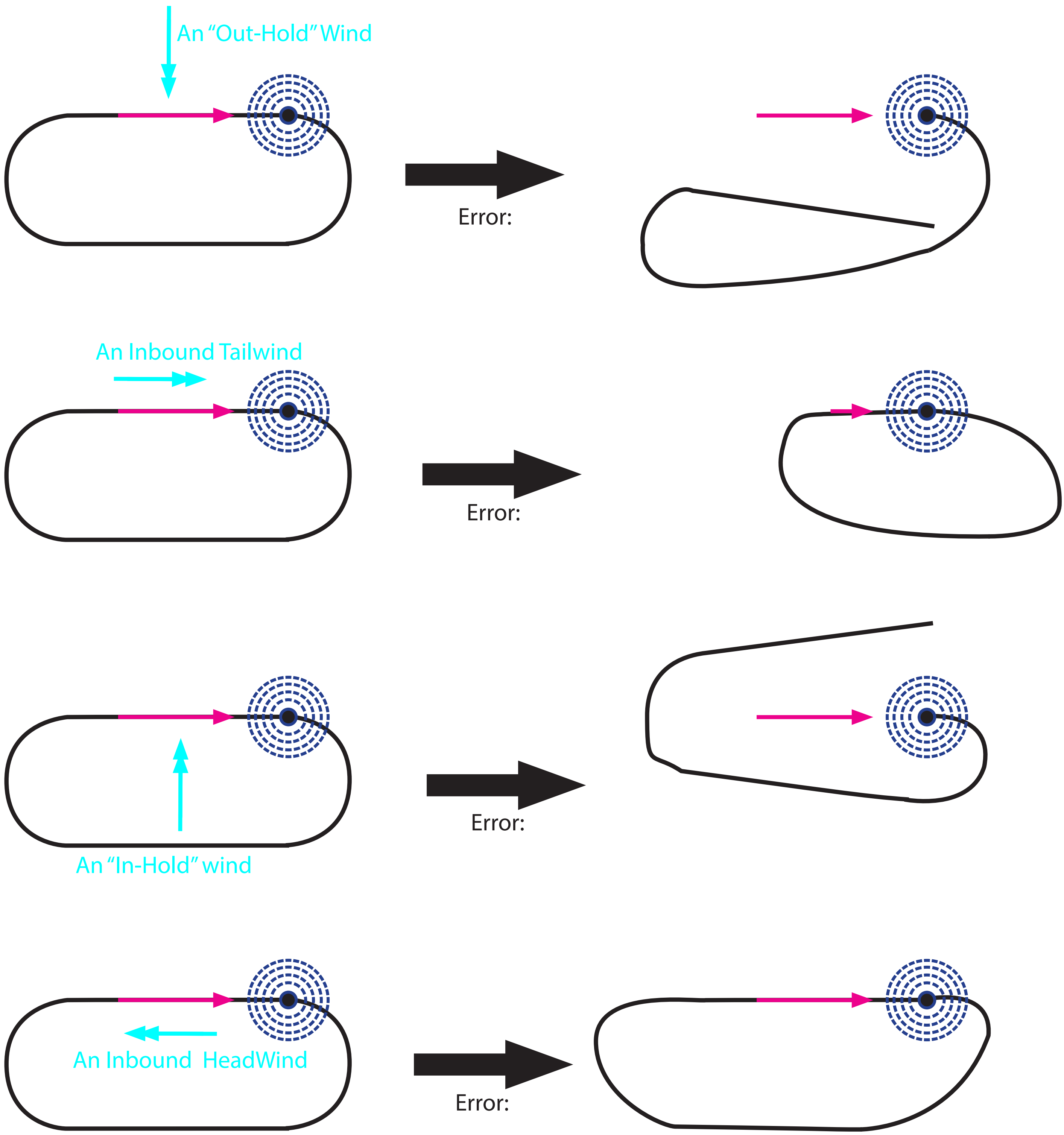
# Wind Correction in the Hold

Holds are rarely flown with zero wind, and as a result if no correction is made for the wind, then the tracks flown may outside of terrain and collision avoidance limits presenting a danger to the aircraft, or even other separation from other aircraft.

There are several steps you can take to compensate for wind drift in the hold to either completely compensate for the wind, or at worst, limit its effect.

Before we look at the mitigation, lets take a look at the effect of wind on the shape of a standard Hold. The diagram on the left is the standard hold shape with no wind applied, the diagram on the right is what happens when no wind correction is made for the wind shown.

The diagrams are exaggerated for clarity, but some students have in the past actually flown them like this !



## On-Axis Headwinds and Tailwinds

These are the easiest to deal with as there is a simple equation for correcting for the wind.

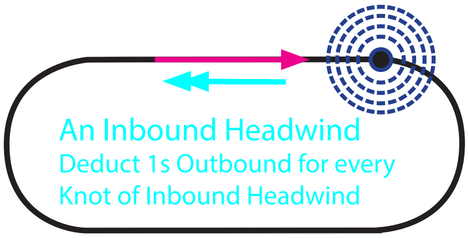
**1 Knot wind = 1second of correction**

The starting point to understanding this is that the Hold must be flown at constant speed and all turns must be flown at rate one.

That is 3˚per second or constant Bank Angle.
(TAS÷10) + 7) eg 120Kts -> 19˚ AoB

As both of the turns are rate one, that means a constant bank angle. Therefore you cannot correct for the wind in the turn.

By the time you have flown around the Inbound Turn, it too late to make any correction as you can't shorten the leg by speeding up, and you can't shorten by distance as you have to fly over the Beacon.


This means there is only one segment of the Hold where an adjustment can be made. This is the Outbound leg. The only solution is to fly the Outbound leg according to the correction.

**Example 1:** If there is an Outbound Headwind of 5Knots, extend the Outbound Leg for an extra 5seconds,

That is **60s + 5s = 65 seconds Outbound** before turning at the Gate to the Inbound Turn**.**

**Example 2:** Similarly, if there is an Outbound Tailwind, you can compensate by deducting the number of seconds equivalent to the Windspeed from the Outbound Leg, so using the same example above

That is **60s - 5s = 55 seconds Outbound** before turning at the Gate to the Inbound Turn

### Compensation for other Headwinds and Tailwinds

If the Headwind or Tailwind is not exactly aligned with the Hold axis, we must make an adjustment to the simple equation of 1KT = 1second.

This is where a variation of the Clock Code can come in. As with Wind Correction angle it is an approximation, but it is accurate enough for our purposes.

Start by the approximate number of degrees the wind is coming from **in relation to the heading of the aircraft**.

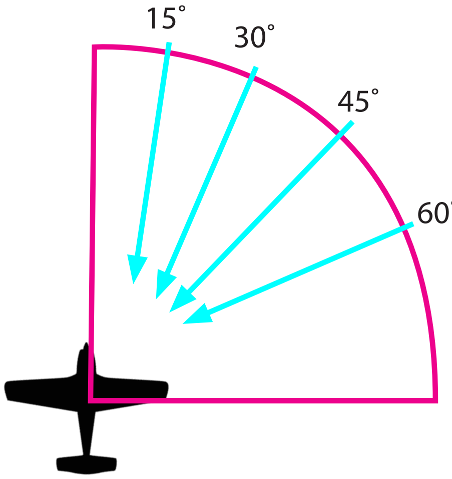
Now convert the number of degrees to the number of seconds around the Stopwatch face and break the face in sectors as we did with Maximum Drift Speed, except that this time, we work **ANTI-CLOCKWISE**:

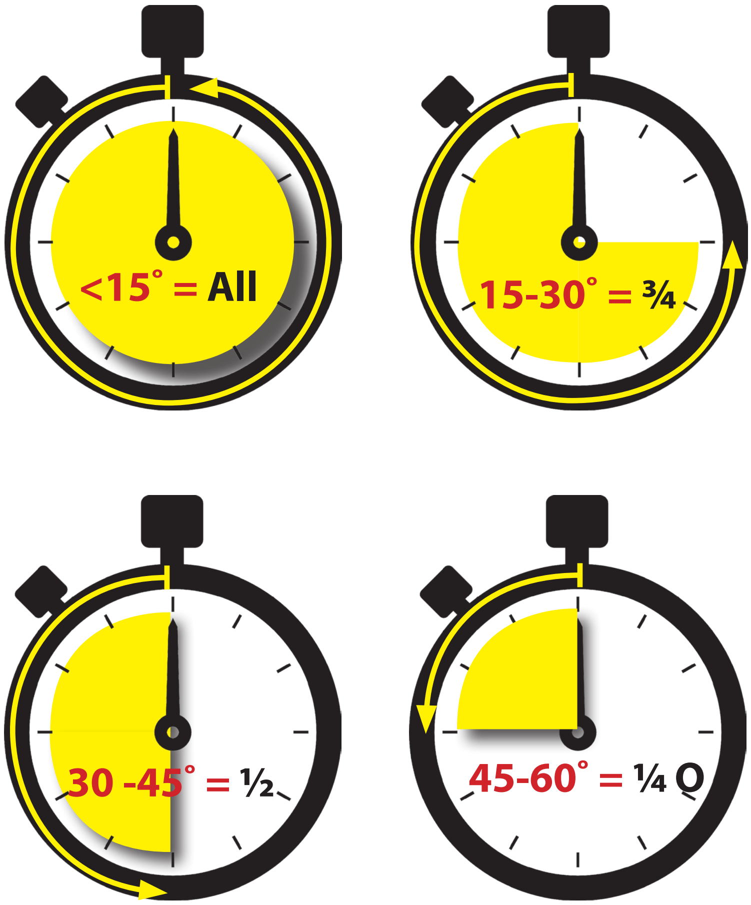
- 15˚ to 0˚, which is all of the way around the face, so this is the *"Full Sector"*
- 30˚ to 15˚, which is a ¾ of the way around the face, so this is the "*¾ Sector*".
- 45˚ to 30˚ is which is the first ½ of the face, so this is the "½ Sector"
- 60˚ to 45˚ is the first ¼ of the way around the face, so this is the "¼ Sector"

  and finally for 60˚and above to 90˚ we take zero correction for Headwind or Tailwind

Think of this way, between 0° and 15° either side of the Nose or Tail of the aircraft we take 100% of the Headwind and Tailwind and correct for that.

If the Head/Tailwind is between 15° and 30° of the nose or Tail of the aircraft, then we use ¾ of the Stopwatch face, so we take ¾ of the Headwind / Tailwind, and so on.




**Example I**
An aircraft is flying a Hold with a Inbound Track of 180°, the wind is 155°/15Kts.
What is the OutBound time Correction?

The Wind is an Inbound Headwind angle of 180 - 155 = 25°

25°is in the ¾ *Sector, so take*
*¾ x 15 Knots = 10 Knots*
**1Knot wind = 1second of correction**

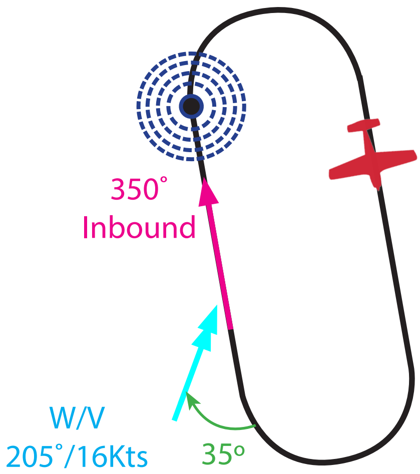
It is a Outbound TailWind so deduct 10 seconds to the Outbound Leg
60s -10s = **50 seconds on the Outbound Leg**

An aircraft is flying a Hold with a Inbound Track of 350°, the wind is 205°/16Kts. What is the OutBound time Correction?

350 -> 205 is 35° off the Inbound Track, so the ½ Sector, so 8° or 8 seconds
As it is an Outbound Headwind, then add 8s to 60, to get 68 seconds for the Outbound leg.

Remember this Plog Planner on the right? Now you can guess what the "Ot" means. Its is the calculated "Oubound time" for the hold, which here is filled in with the data for Example II

**Example II**
An aircraft is flying a Hold with a Inbound Track of 350˚, the wind is 205˚/16Kts. What is the OutBound time Correction?




350 -> 205 is 35˚ off the Inbound Track, which is in the ½ Sector, so:

16 x ½ = 8˚ or **8 seconds correction**

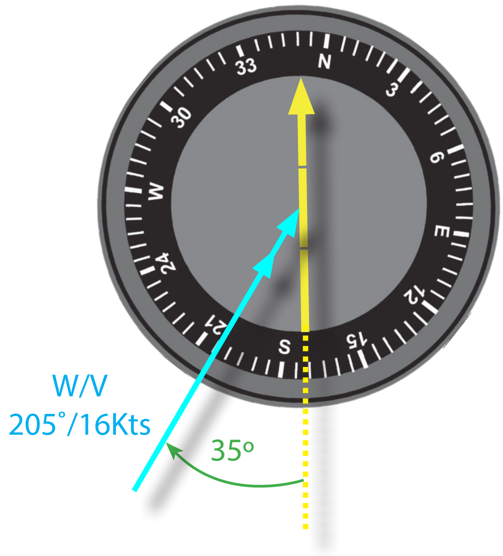
How do you quickly calculate the cross-wind angle between the Inbound track and the wind?

**Use the HSI.**
Once you have setup the CDI with the Inbound Leg (shown below as 350˚as in this Example II, then you can superimpose the wind coming from 205˚

It is then easy to see that the wind is an Inbound Tailwind of 35˚

As it is an Inbound Tailwind, it must by logic an Outbound Leg Headwind.

With an Outbound Headwind, we then must add 8s to 60, to get 68 seconds for the Outbound leg.




IT:202 - R
OT:022
Gt:359
Ab:292
OH:013
OT:68

Remember this Plog Planner on the left?

Now you can probably guess what the “OT” means.

It is the calculated “Outbound time” for the hold, which here is filled in with the above data for Example II of 68 seconds.

That just leaves the “OH” field to be filled in.

“OH” means Outbound Heading and is the heading to steer to correct for cross-Hold Winds

## Cross-Hold Wind Correction

As was stated earlier, Holds must be flown at constant speed and with rate-one turns. This means that there are potentially one two legs of a Hold where the wind drift for a cross-hold wind can be compensated for; namely the Outbound and Inbound leg.

Unfortunately as the Inbound leg must terminate with a passage over the fix within 5˚of the published Inbound leg, there is no opportunity to compensate on the Inbound leg.

This leaves only the Outbound leg where any compensation can be made for cross-Hold wind drift. So how to calculate the correction? We have already seen how to calculate Single Drift (or WCA) from a W/V and a Desired track (DTK), QDM or QDR.

How is this applied? Well we apply Single Drift to the Outbound leg, which is usually 60s long. So far so good. However we need to compensate for the drift in the Outbound turn.

As this is also 60s long (at rate-One turn of 3˚ per sec) we can compensate for the Outbound turn by adding it's drift to that of the Outbound leg, so we use twice as much Single-Drift in the Outbound leg.
But wait!, we also need to compensate for the Inbound turn, also Rate one for 180˚, so another 60s.

So add another Single drift to the Outbound leg to compensate for the Inbound turn and now we have a "Triple-Drift" on the Outbound leg to compensate for the Outbound leg itself and the two turns.

### In-Hold Wind

When the wind is blowing such that an aircraft would be blown "into" the hold when flying on the Outbound leg, this is known as an "In-Hold" wind. Looking at the diagram below, the nil-wind Outbound leg would normally be 270˚ for an Inbound track of 090˚

If we take a Single-Drift WCA of 10˚ from the South (in the diagram below), then the Outbound leg would have be flown 3x 10˚ = 30º to compensate for the wind from the south.

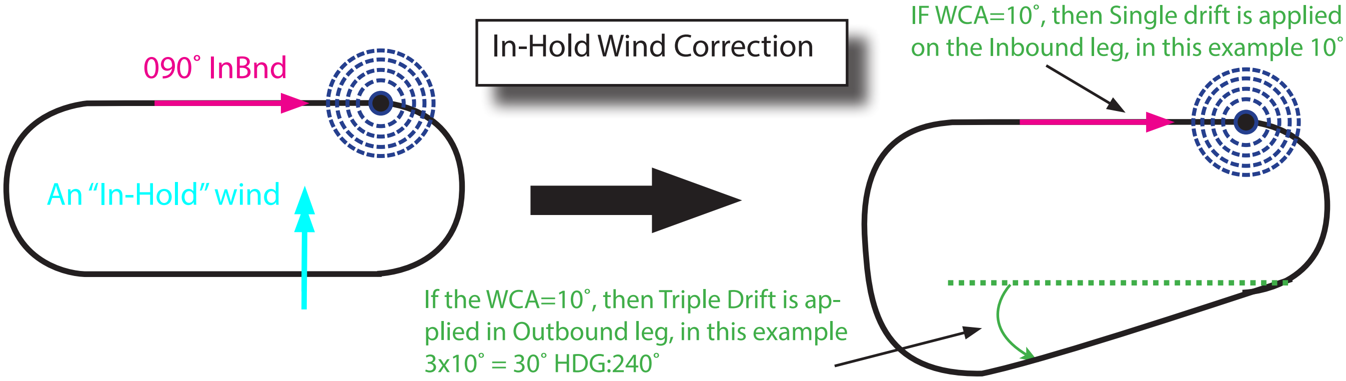
This means that the Hold must be flown as shown by the diagram on the right and the OutBound leg is flown on a Heading, not at 270˚, but at 240˚.

Remember "OH"on the Pilots PLOG? This is how you calculate it and record it in anticipation of arriving at the Hold and flying it correctly with compensation for the wind. eg OH:240˚

If the wind was stronger, or the aircraft slower and the Single-Drift for 270˚was 12˚, then the Outbound correction, would be

3x 12˚ = 36˚, so the leg in this example would be flown on a Heading of 234˚

It is therefore important that the airspeed of the aircraft is kept stable and constant, as it is this airspeed you will be using to calculate your WCA.



### Out-Hold Wind Correction

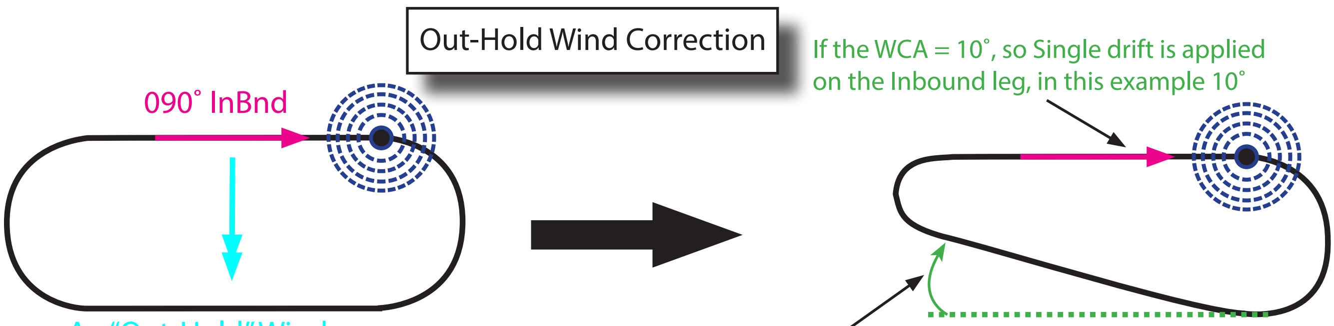
When the wind is blowing such that an aircraft would be blown "out" of the hold when flying the Outbound leg, this is known as an "Out-Hold" wind. As we have seen, we can compensate for this wind by applying triple-drift to the outbound leg to compensate for the Outbound leg and two turns.

The same calculations are used, exactly as previously, except that the WCA is applied in the opposite direction.

If we use the previous example and take a Single-Drift WCA of 10˚ but this time from the North to the South (in the diagram below), then the Outbound leg would have be flown 3x 10˚ = 30º to compensate for the wind from the north.

So instead of flying 270˚Outbound, flying it correctly with compensation for the wind, the Pilot would instead have to steer, 300˚ to compensate for the Out-Hold wind during the Outbound leg and two turns
The Pilots PLOG would have be updated thus: eg OH:*300˚*

Similarly, if the wind was weaker, or the aircraft faster and the Single-Drift for 270˚was 6˚, then the Outbound correction, would be: 3 x 6˚ = 18˚, so the leg in this example would be flown on a Heading of 288˚



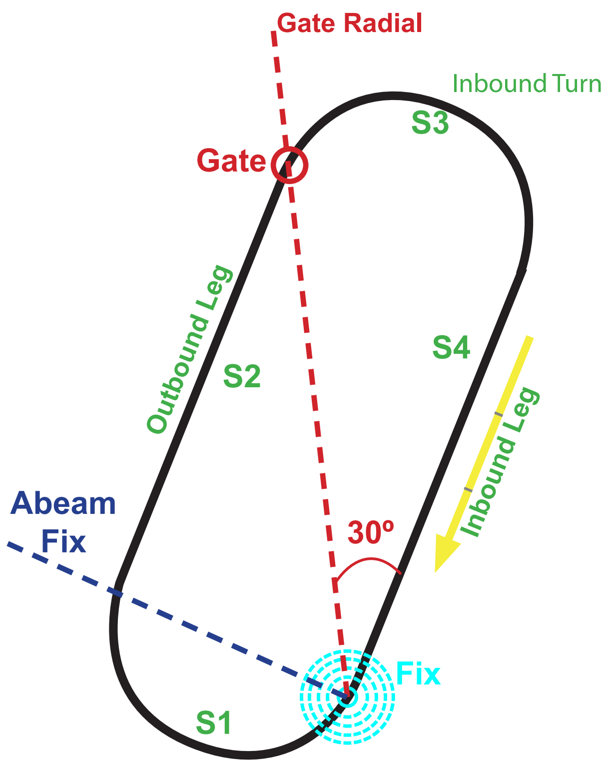

## Managing the Hold: Abeam Fix and The Gate

The Gate and Abeam Fix are two places that allow for the pilot to make adjustments to their position and /or timings when flying a Hold.

Although pilot error often accounts for deviation from the ideal flightpath, more often it is variations in wind direction and strength at various levels that cause such deviations. The Abeam Fix and the Gate can be used to assist the pilot in assessing their progress.

The Abeam Fix, marks the start of the Outbound leg and is a radial 90˚ from the Inbound Track. In the case of a right-hand hold, it is +90˚ and for a left-hand hold it is -90˚.

Therefore for a right-hand Hold of Inbound track 202˚, the Abeam Fix is the 292˚ radial. That is the QDR292.
For a left-hand hold of Inbound track 202˚, the Abeam fix is the 112˚ radial, or QDR112.

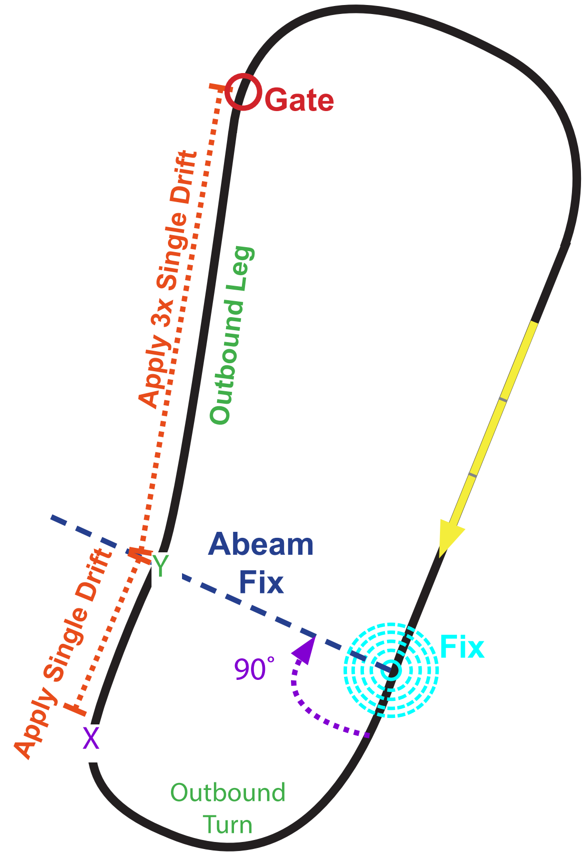


The Abeam Fix is used by the pilot to start the Outbound leg and by implication, the timing for the Outbound leg and also the start of any wind correction.

If the Pilot comes around the Outbound Turn, and finds themselves on the Outbound leg before reaching the Abeam Fix (point **X**), then they should fly Single-drift until the Abeam Fix  (shown right with orange line, point **Y**).

Once they have passed the Abeam Fix, they should then apply the calculated Triple Drift for the rest of the Outbound leg until they reach the Gate and turn to the Inbound Track.

By waiting for the Abeam Fix before apply the correction, this prevents over-compensation.




Hold Data
It:350 / R
Ot:170
Gt:140
Ab:040
Oh:155
Ot:68

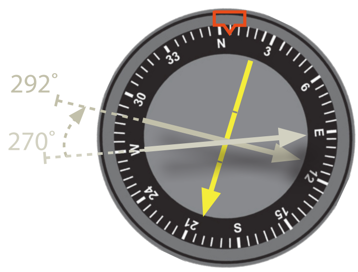
The second use of the Abeam Fix is for timing. Earlier we have seen that you may have to compensate in the Outbound leg for a Headwind or Tailwind.

If you look at the example Hold Data table on the left created by the pilot in-flight, we see they have calculated a triple drift of 15˚ (170˚->155˚) and an Outbound Timing of 68 seconds.

The point at which we start flying these two compensations is at the Abeam Fix, so for this Hold, before reaching the Abeam Fix, the pilots flies WCA 5˚=165˚ and on reaching the Abeam Fix the Pilot will turn onto 155˚ and restart their stopwatch to fly for 68 seconds.

## How to Detect the Abeam Fix

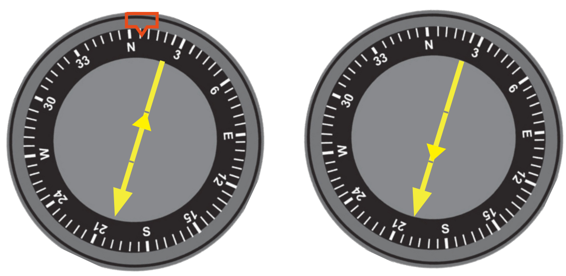
There are two methods for determining when you are passing/have passed the Abeam Fix. RMI, RBI and HSI/OBI.




In the case of the RMI, you can use the Tail of the Needle as this is giving the QDR reading from the Beacon.

Consider the diagram on the top right. The Pilot has used the CDI to "bug" the Inbound track of this Hold of 202˚. They have selected a Heading 005˚ for Single-Drift, and the RMI/RBI Needle starts roughly west (light-grey needle), but as they are flying north, they are "pulling the tail" of the RMI Needle north.

As the aircraft flies north the Tail of the RMI Needle reaches 292˚, (dark grey needle) and they have reached the Abeam Fix for this particular Hold.



Alternatively if the Fix is a VOR Beacon, then the To/From flag will switch from TO to FROM at the 90˚ position, the Abeam Fix

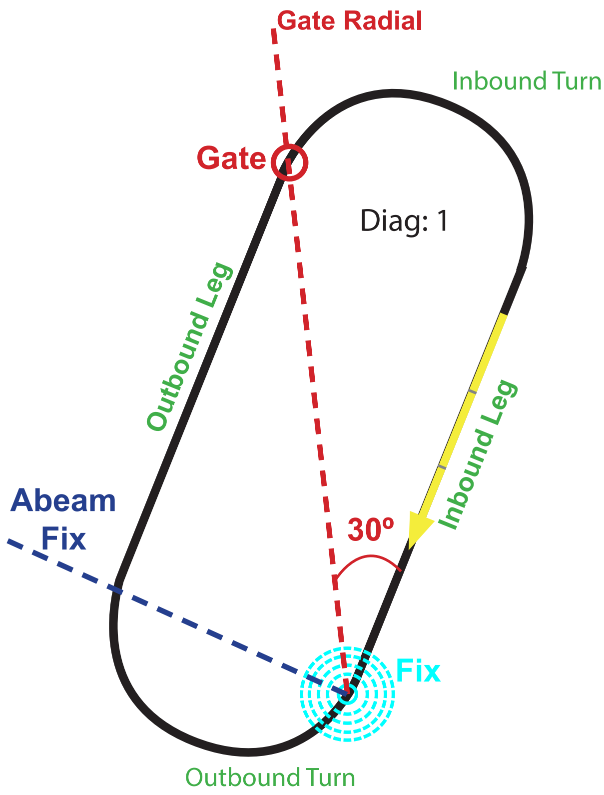
## The Gate

The Gate is ideally the position of the intersection of a radial 150˚ clockwise on a Right-hand Hold (or anti-clockwise on a left-hand) with the Outbound leg.

It is more commonly described and illustrated as being 30˚ from the Outbound Hold. Left of the Outbound leg on a right-hand Hold and vice versa on a Left hand hold.

The Gate is the point at which the Inbound Turn is commenced, but as hinted above is only "ideally" at 30˚.

This is because the Gate can be moved when a cross-wind correction is made, and in doing so can be used to correct for inaccuracies when flying the Hold.




### In-Hold Wind: Gate Correction

The Hold in Diag.1 shows a zero-wind idealised diagram of a Hold which you will have no doubt seen before.

However if there is an In-Hold wind, then this will force the pilot to make an correction of triple-drift as illustrated in Diag 2.

Due to the Triple-Drift correction in the Outbound Leg, if we are to use the Gate as point at which we initiate the Inbound Turn we need to "move the Gate back".

That is we need to move the Gate closer to the Abeam Fix. But by how much? Well as before, short of getting out a calculator and our Cosine tables, we make an approximation.

The approximation is equal to the value of Single-Drift.

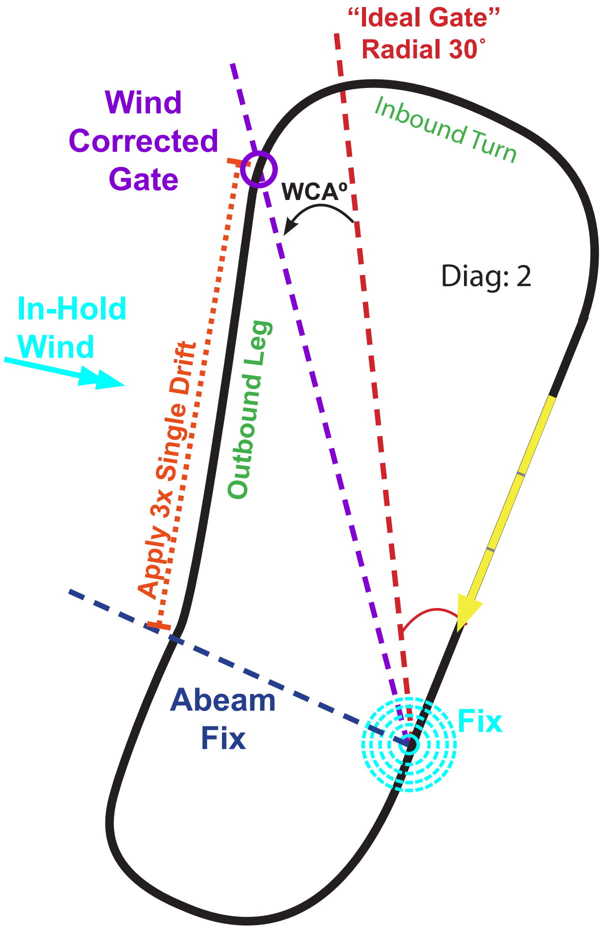
So for example if the Inbound Track of a Hold is 202˚, then the Outbound track is 022˚. 022-30˚ means a default "Ideal Gate" of 352˚. The picture in Diag:2 illustrates this.

If the Single Drift WCA is 10˚, then for an In-Hold wind we move the Gate back by 10˚, so 352-10 = 342˚

This is now our Wind-Corrected Gate and it is now at the Wind-Corrected Gate that we start the Inbound Turn.

If we have had to make a Wind-corrected timing because of a Head/Tailwind, then in theory we should arrive at the Wind-Corrected Gate at the same time as out Wind Corrected Timing.

Having gone to this effort, if however you arrive at the Wind-Corrected Gate early or late you can predict and adjust your flight to account for the impending error.



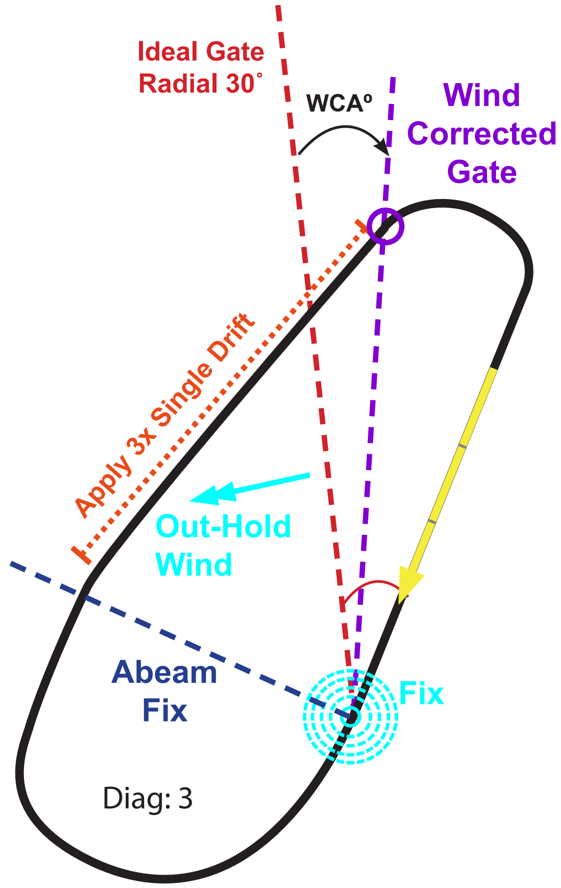
## Out Hold Wind: Gate Correction

In the case of an Out-Hold wind, as the Outbound Triple-Drift is applied in the opposite direction toward the centre of the Hold, we need to move the Wind-Corrected Gate "forward", that is away from the Abeam Fix.

Using the same example numbers as in Diag 2, the Idealised Gate should be 352˚, but if the WCA Single-Drift is 10˚, then we move the Gate to 352+10= 002˚

This is now our Wind-Corrected Gate and again at the Wind-Corrected Gate is where we start the Inbound Turn. We should arrive at the Wind-Corrected Gate at the same time as out Wind Corrected Timing.

Having gone to this effort, if however you arrive at the Wind-Corrected Gate early or late you can predict and adjust your flight to account for the error.




# Error Corrections in the Hold

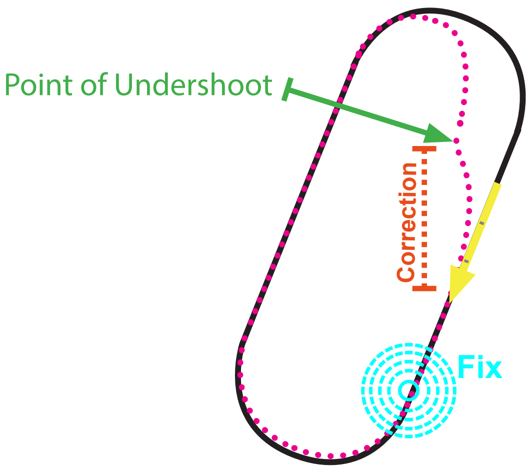
*To undershoot or overshoot, this is the question*

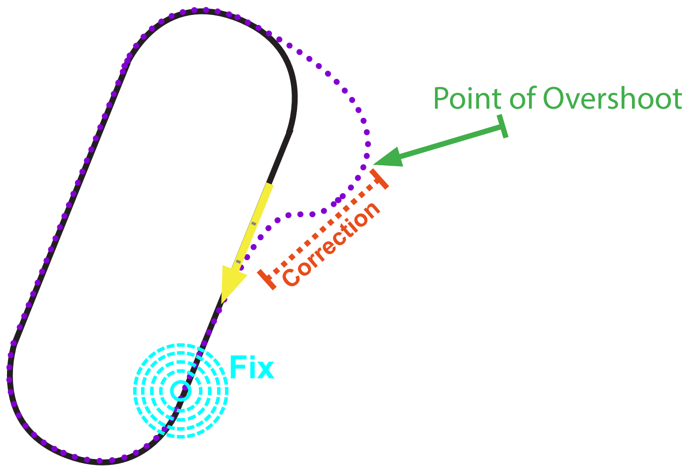
All of the equations, estimates and approximations we use to make our mental arithmetic easy in the air, are all just that: "Approximations".

Your instructor, ATC and even your examiner cannot and will not, expect perfection as the wind and weather will do what it likes and you can only compensate for these changes as they arise.

What you <u>can</u> do and <u>will</u> be expected to do is monitor your progress and make reasonable efforts to mitigate these errors and subsequently adjust your approximations in the face of new information. Failure to monitor and update, will be seen as failure of the lesson or worse your IR Exam.

Let us start with the Overshoot and the Undershoot and what they look like. Below on the left is an Undershoot, on the right an Overshoot. The names refer to the point of rolling out on the Inbound Heading, but not having achieved the Inbound QDM. In order to track correctly Inbound to the Fix, these errors must be corrected.



## Wind Corrected Gate: The Early Warning System

*Time before Gate, Undershoot, turn on time.*
*Gate before Time, Overshoot, turn towards Gate*

Learn the above "by heart" and you will save yourself a whole world of pain.

### Gate Before Time, Turn to Gate

**Correcting the Overshoot**

In Fig:1, The pilot has started their Stopwatch on reaching the Abeam Fix, however they either have a stronger In-Hold Wind, or their Triple-Drift calculation was too much.

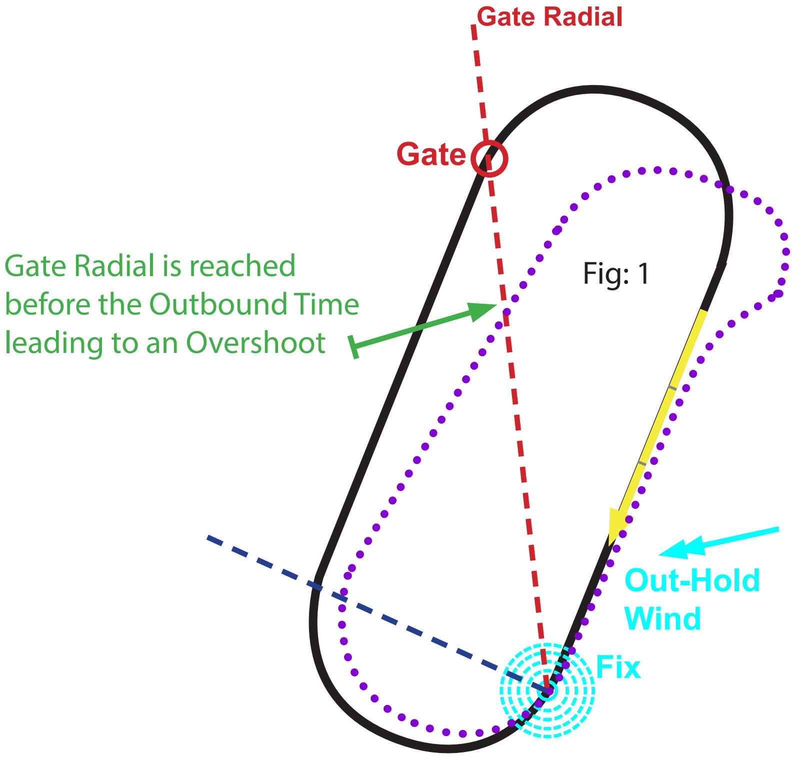
Either way, the Wind corrected Gate radial is reached before the Wind-Corrected time for the Outbound leg has been reached.

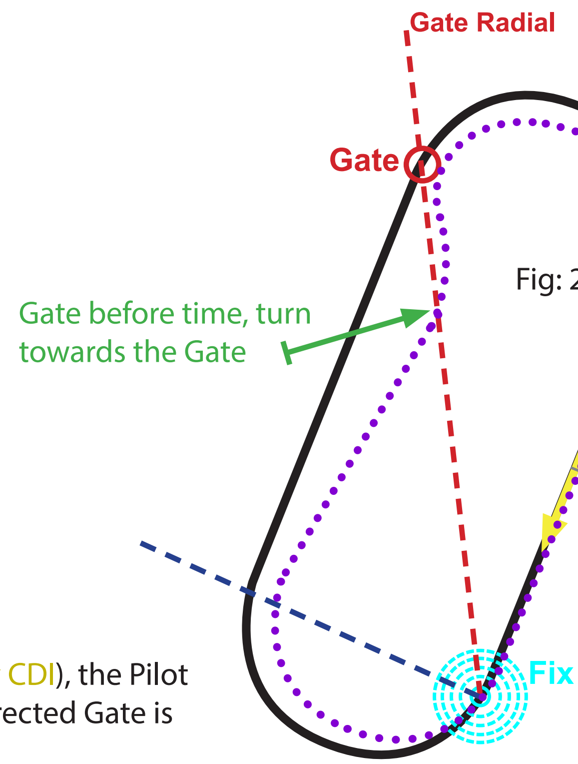
This will lead to an Overshoot.

The Pilot can at this stage make a correction for the Overshoot.

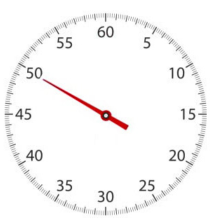
They are unlikely to completely eliminate it, but they can reduce it.

The solution; turn towards the Gate radial and fly along it until the Wind-Corrected time is completed. As can be seen by the Diag:2 this correction will reduce the Overshoot.








In this example the Inbound Track is 202˚ (yellow CDI), the Pilot is flying a Triple-Drift HDG of 030˚. The Wind corrected Gate is 350˚ & Wind Corrected time is 68s.

The Timer says 50 seconds, but the RMI/RBI tail of the orange needle already shows a QDR of 350˚. The Gate has been reached before time. So turn towards the Gate until 68s.

## Time Before Gate, Turn on Time

### Correcting the Undershoot

In Fig:3, The pilot has started their Stopwatch on reaching the Abeam Fix, however they either have a weaker In-Hold Wind, or their Triple-Drift calculation was too great.

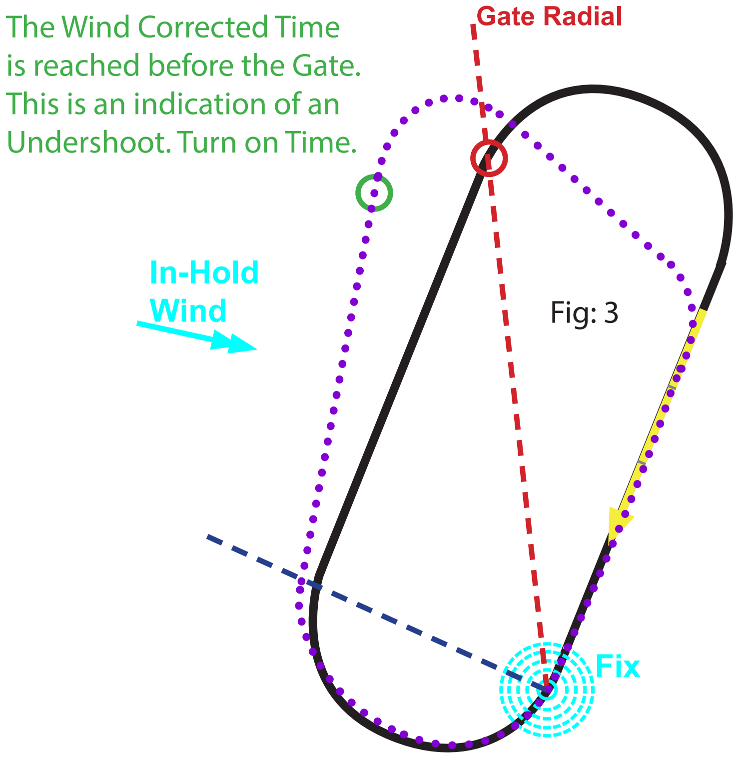
Either way, the Wind corrected Time is reached before the Wind-Corrected Gate has been reached.

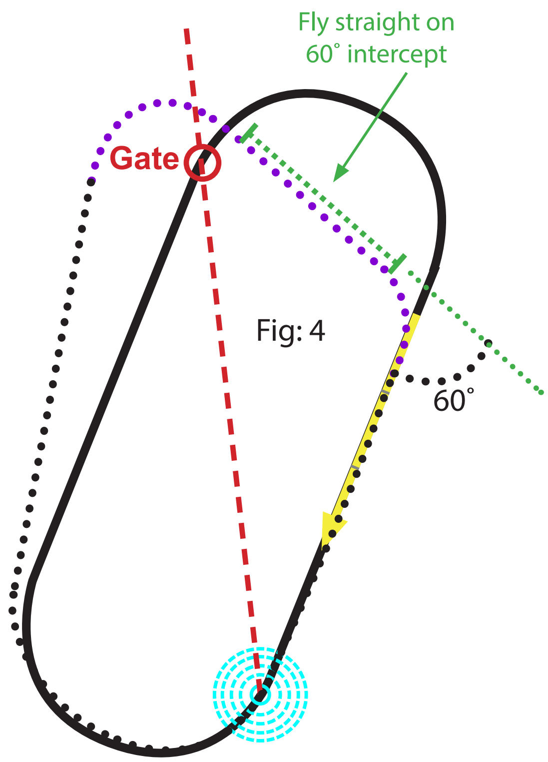
This will lead to an Undershoot.
("*Time before Gate*")

The Pilot can at this stage make a correction for the Undershoot.

They should turn towards the Inbound Track as normal in a Inbound Turn, but should roll level when 60˚ from the inbound Track QDM. Shown in Fig: 4 as the green line.

The pilot continues to fly straight to intercept the Inbound Track QDM to the Fix.



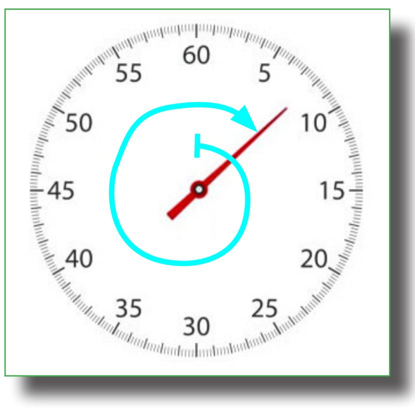





In this example the Inbound Track is 202˚ (yellow CDI), the Pilot is flying a Triple-Drift HDG of 340˚. The Wind corrected Gate is 325˚ & Wind Corrected time is 68s.

The Timer says 68 seconds, but the RMI/RBI tail of the orange needle only shows a QDR of 300˚ (not 345˚). The Time has been reached before the Gate. So turn towards the Inbound Track, but roll out when 60˚ from the Inbound QDM.

Continue to fly straight with an approximate 60˚ intercept angle of ~140˚ to then intercept the Inbound Track QDM of 202˚ to the Fix.



## Intercepting the Inbound Track

Whilst in the Inbound Turn, it is possible to predict if there will be an Undershoot or Overshoot.
This is another opportunity to judge the accuracy of the Hold, and that is at the 60˚-of-remaining-turn, point of the Inbound Turn.

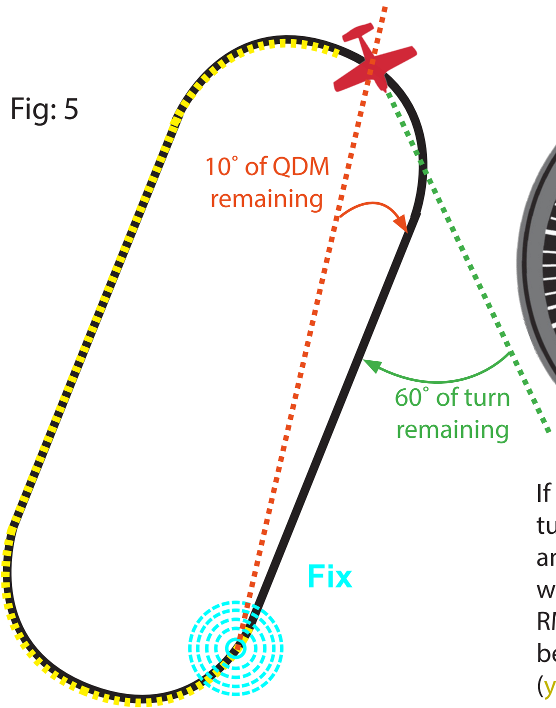
When the aircraft has a Heading that is approximately 60˚ of turn remaining (green line below) onto the Inbound QDM, the aircraft **should** have 10˚ of QDM remaining to intercept.

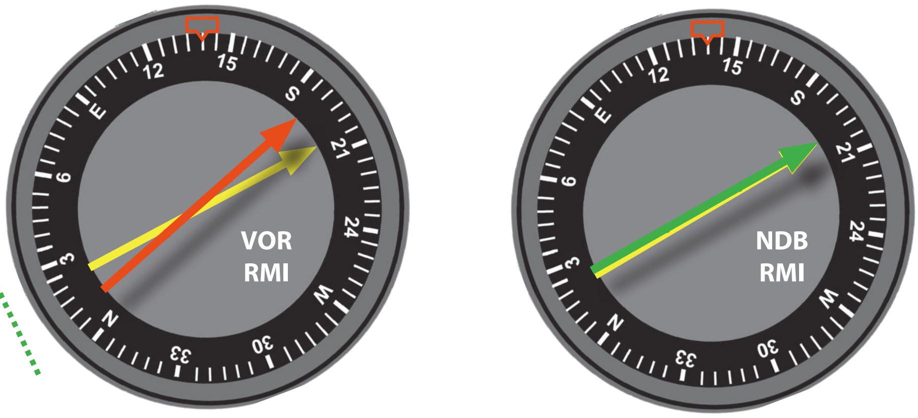
In Fig:5 below, the aircraft is turning in the Inbound Turn towards the Inbound Track of 202˚ to the Fix. The Aircraft has reached the 60º of turn remaining position, so therefore is on a heading of

202˚ - 60˚= ~140˚ (*note the HDG Bug position below*).

This is also 10˚ short of the QDM, so the Head of the Needle on a VOR-RMI instrument on the left (without Dip), should read 202 - 10 = ~190˚, but the NDB/ADF needle on the right instrument will suffer 10˚ of Dip meaning that QDM and the Needle position are the same. These are the ideal positions as shown in Fig. 5.

Fig: 5




If the aircraft reaches 60˚ of turn remaining (here 140˚) and if the Fix is a VOR or GNSS waypoint, then the Head of the RMI indicator (orange) should be 10˚ before the desired QDM. (yellow bugged needle)

If the Fix is an NDB then for the same position, the head of the ADF indicator (green)will be equal to the desired QDM as the -10˚ of QDM will be cancelled out by the +10˚ of NDB Dip, so long as a rate-one turn is maintained.

### Predicting an Undershoot

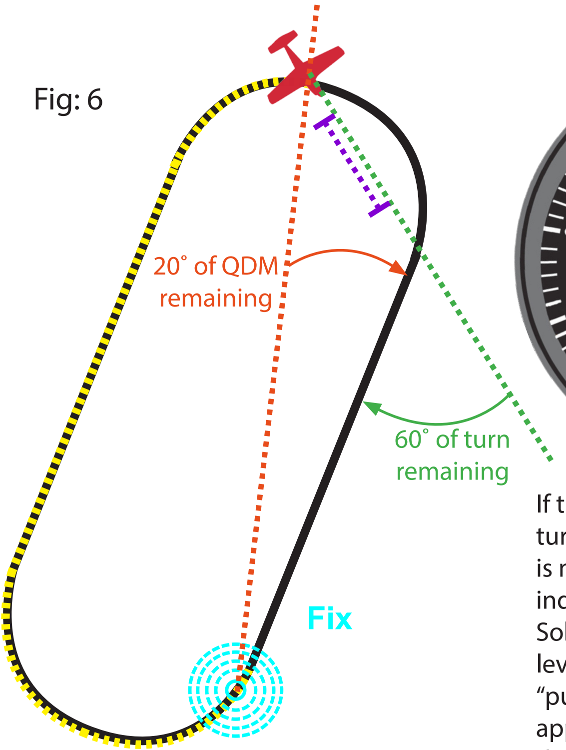
If the Aircraft gets to the 60˚-of-turn-remaining position and has more than 10˚of QDM to intercept, then this indicates an Undershoot (see Fig:6), here it is easier to visualise the effect of an undershoot and how to interpret the position with the RBI/RMI.

The solution is to roll the wings level, on the 60˚ intercept and *push the head* of the RBI/RMI needle towards the desired QDM. When the needle reads 10˚ of QDM re-commence the turn to intercept the Inbound Track.

**Note on NDB's.** If you are carrying out a reasonably accurate rate-one turn, then the ADF needle will be suffering from NDB-dip of aprox 10˚, but as soon as you roll wings-level the Dip will disappear.
What this means in reality is that if <say> at the 60˚ turn position you were actually 20˚short of QDM, then the ADF needle will show 10˚ QDM error in the turn (not 20˚), but once wings-level, the Dip will disappear and the needle will indicate 20˚ error. Now there is no Dip, the ADF can be trusted.

You should now fly accurately until the ADF reads QDM less 10˚ and then re-commence your Inbound Turn. The Dip will re-appear and the ADF needle should read exactly QDM (-10+10=0), but once the aircraft has intercepted the QDM, the ADF will read QDM + 10˚ (in this example 212˚) just before you roll out. As soon as you roll out and once the wings are level, Dip disappears again, then the ADF will read the QDM, as desired.

Fig: 6





If the aircraft reaches 60˚ of turn (here 140˚) but the QDM is more than 10˚, then this is an indication of an **Undershoot**. Solution: Roll wings level, fly level (the purple track in Fig:6) "push the Head" until the QDM approaches 10˚ then turn onto the QDM

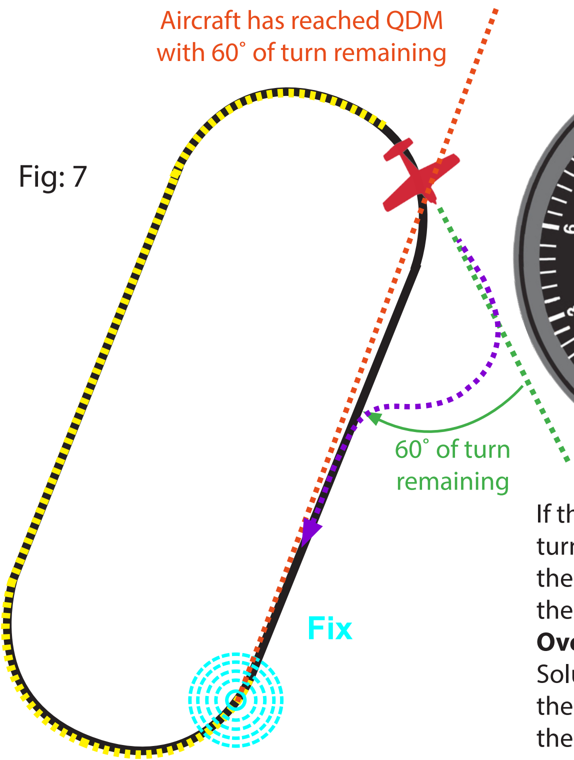

If the Fix is an NDB the head of the ADF indicator will read 10˚ below the desired QDM as the -20˚ of QDM will be cancelled out by +10˚ of NDB Dip. Roll wings level, but because the Dip now disappears wait until 10˚ below QDM before continuing the turn, at which point the needle Dip comes back and the needle will read 202˚

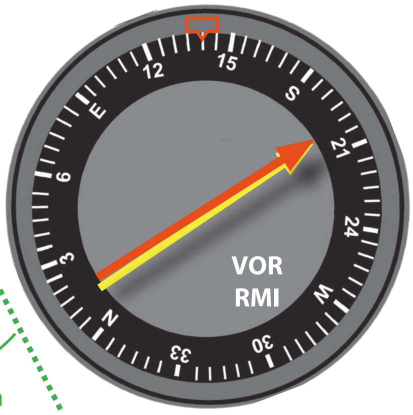
## Predicting an Overshoot

In the case of an Overshoot, if when you reach 60˚of turn remaining and the QDM is less than 10˚, then you have an overshoot scenario. The situation is illustrated below where the Heading is ~140˚, but the QDM is already 202˚, the desired Inbound Track. Here the aircraft has reached 140˚ (60˚ less than the Inbound track of 202˚), but the RMI/RBI is indicating that the Inbound QDM has been achieved.

This is an Overshoot situation. The solution is to continue turning until you have achieved a heading of QDM +30˚, which in this example would mean a heading of ~230˚. This will allow you to re-intercept the 202˚ QDM of the Inbound track.

Fig: 7




If the aircraft reaches 60˚ of turn (here 140˚) but the QDM is the same as the Inbound Track, then this is an indication of an **Overshoot**.
Solution: Continue truing past the Inbound track by ~30˚ and then re-intercept the Inbound Track


If the Fix is an NDB the head of the ADF indicator will be 10˚ beyond the desired Inbound Track.
Continue to turn past the QDM by aprox 40˚ of the indicated QDM. In the above example aprox 240˚.
Once within 10˚ QDM (~220) turn back towards the desired Inbound Track and you should intercept the QDM of 202˚.

## Undershoot, Overshoot Management

Managing the Hold is a matter of carrying out the monitoring at the correct time. If you miss the 60˚ Turn -remaining point, its not the end of the world, but you just made your job a whole lot harder.

In addition to a the ideal position at the 60˚turn point, you can also check at the 30˚-turn-remaining point. As with the 60˚point, at the 30˚ point you should be ~5˚ from the QDM, so another chance to check your progress and accuracy.

Below is a table which summarises the Turn position fixes and the respective QDM's.

**Inbound Turn Position Fix Table**

| Position Fix | VOR / GNSS Fix | NDB / ADF |
|---|---|---|
| 60˚ of turn remaining in turn | 10˚ QDM remaining indicated | 0˚ QDM |
| 60˚ of turn remaining wings level | 10˚ QDM remaining indicated | 10˚ QDM remaining indicated |
| 30˚ of turn remaining in turn | 5˚ QDM remaining indicated | 5˚ **over** QDM indicated |
| 30˚ of turn remaining wings level | 5˚ QDM remaining indicated | 5˚ QDM remaining indicated |
| No turn remaining, in turn | 0˚ QDM remaining indicated | 10˚ **over** QDM indicated |
| No turn remaining, wings level | 0˚ QDM remaining indicated | 0˚ QDM remaining indicated |

You need to learn the above table. It is not as difficult as it first may seem.
There are only 3 Fix positions to learn for VOR/GNSS, and that when the wings level they are identical to the ADF.

So of 12 items, this reduces to 3, and for the Fixes for the ADF when turning, that's just a case of "add 10˚", so in effect just 4 items to learn.

Dealing with an Undershoot is fairly straightforward, as you only need to roll the wings level, push-the-head and intercept the Inbound Track.

The Overshoot is a bit more tricky, and you should select an intercept no more than 30˚ beyond the QDM as anything greater than 30˚ will likely lead to you over-shooting again, and ending up with an Undershoot.

## NDB Dip Management

As stated earlier, the NDB Dip is a nuisance that cannot be eliminated, just managed, it is recommended that a thorough understanding of the limitations and errors of the ADF and associated Needle-Dip are understood before attempting a Hold based upon an NDB.

NDB Dip is caused by unavoidable errors in the sense antenna when banked. These are consistent and reproducible. For most metal light-aircraft the Dip is aprox 10˚ of Dip for 18˚-20˚ angle of Bank. It is therefore important that you maintain a constant speed to ensure that your Bank-angle remains constant to maintain your Rate-One turns.

Angle of Bank (Rate One, 3˚/Sec) is given by: (TAS÷10) + 7

You should therefore ensure good speed control and only fly Rate-One turns. If you reduce your angle of bank to <say> 10˚, then the Dip becomes unpredictable and the position Fix table above, cannot be used.

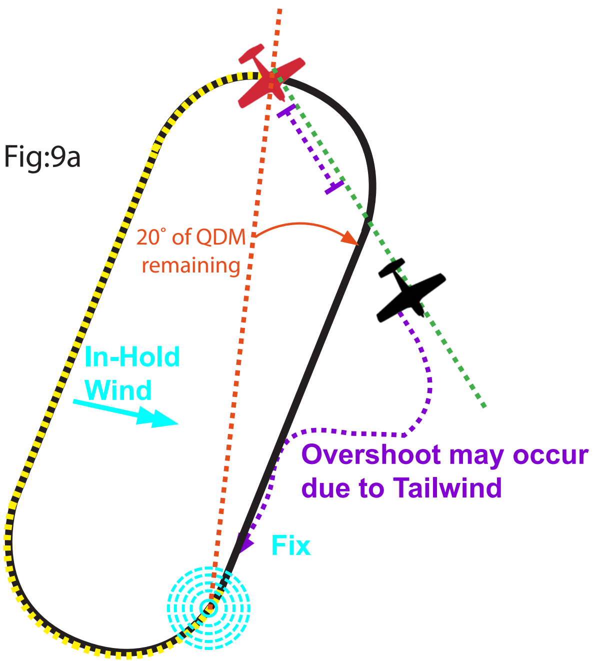
This means you will not be able to accurately judge your progress and accuracy through the Hold

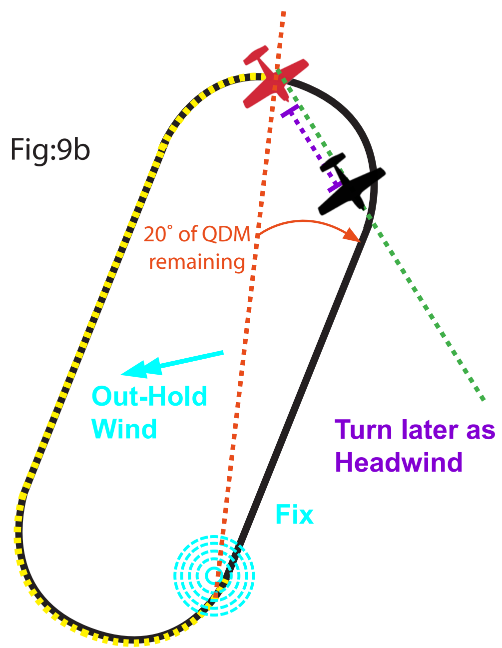
# Wind-Induced Undershoot and Overshoot

The previous Table states that in ideal conditions at 60˚ you should have 10˚ QDM remaining, however when rolling out onto the Inbound Track/ QDM to the Fix be careful if there is a strong In-Hold or Out-Hold wind in play as this may upset your intercept.

In Fig:9a, it can be seen that potentially an Undershoot could be turned into an Overshoot due to the fact there is a strong tailwind that is "pushing" the aircraft, which could lead to the aircraft overshooting the QDM (black aircraft position below)
Solution, turn earlier, or expect and plan for an Overshoot.

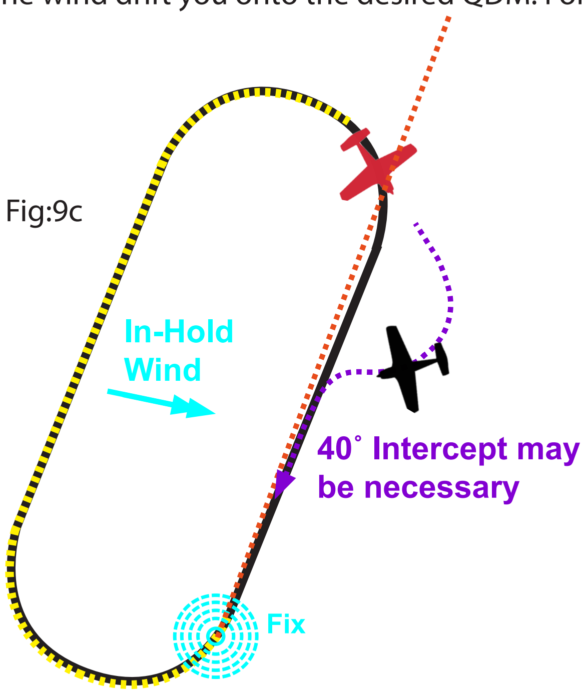
If there is a strong headwind, that is an Out-Hold wind (Fig:9b) turn slightly later, perhaps at the 5˚ QDM not the 10˚ QDM as is usual.

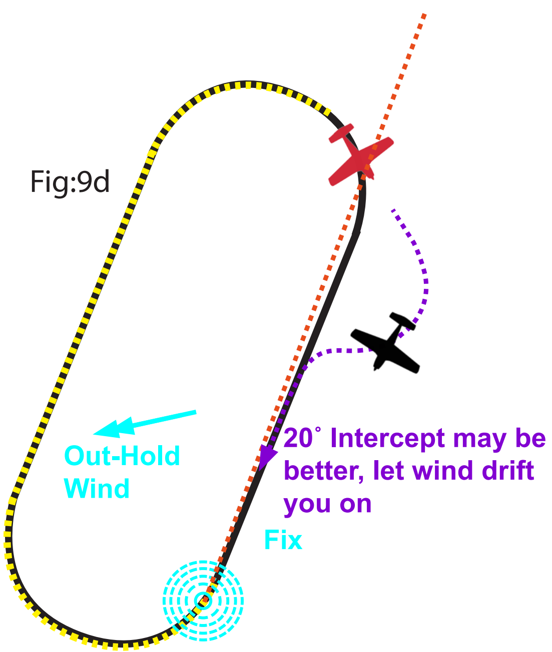



If you have Over-shot and you have a strong In-Hold wind (Fig:9c), then be prepared to use a 40˚ intercept (not 30˚ as previously recommended) or wait longer to re-intercept the Inbound Track.

However, if you have a Tailwind/Out-Hold wind, then you may need a lesser Intercept angle (~20˚) and let the wind drift you onto the desired QDM. For once the wind is your friend! (Fig:9d)



## Stephen's Little Cheats and Helpers

Having sat next to enough students over the past years and having flown my own holds, I have developed a number of "cheats" or helpers that will assist in helping you to fly an accurate Hold.

None of them are "textbook", but real-world flying never is. The wind is never what was predicted. ATC will have you holding at an altitude which you hadn't planned for, or even a place you were not expecting !!

Learn from me and they will help,

### Helper #1: Cone of Confusion

Within aprox 1nm of a Beacon the Cone of Confusion causes misalignment for the RBI/RMI needle and the actual QDM.

Solution, once established Inbound to the Fox on the correct QDM, get your WCA single-drift correction "Bugged-up", that is set on your Heading Bug. Then within 1NM just fly the Bug and trust it, not the needle. This will avoid you getting off course as you won't be "*chasing the needle*".

### Helper #2: Extending over the Fix: Abeam Fix.

This one is easy, when overflying a Beacon you will be inside the "Cone of Confusion", so don't trust the needle.

So simply continue on your Bugged heading until you have had "full beacon passage", this is when the RMI/RBI needle becomes stable and is fully pointing behind you.

Slowly and laconically reset the Timer, turn, talk and twist. All the time flying for an extra few seconds into wind ("Extend Here" in Fig:10) and away from the beacon.

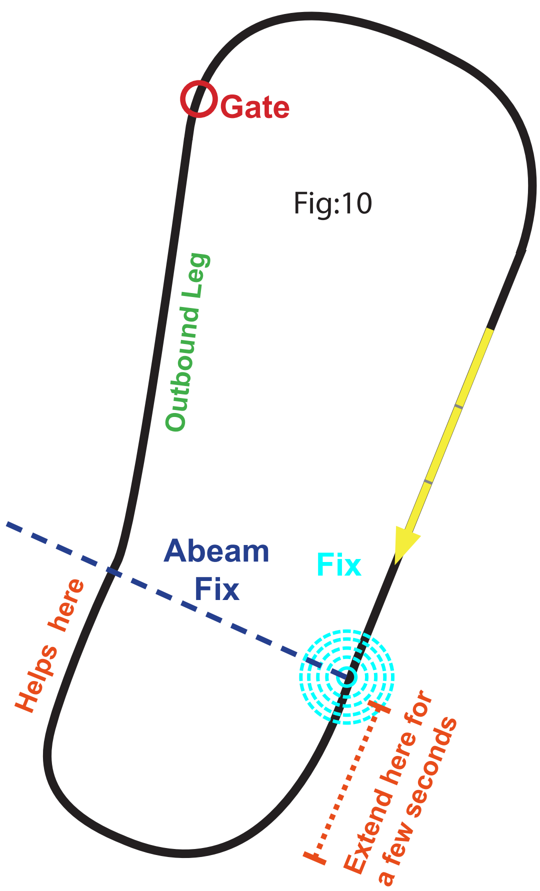
In just that extra 10s of complete Beacon passage you will have flown aprox' another 400m before you start your Outbound Turn.

Why is this important? Because it almost guarantees that you will get the wings level before reaching the Abeam Fix when on the Outbound Leg by about the same 400m or 10 seconds ("Helps Here")

It is difficult getting an Abeam Fix with a VOR/GNSS which does not suffer Turn-Dip.

Trying to get an Abeam Fix with an ADF whilst still turning and with 10˚ Dip is hard enough for advanced Pilots, let alone Students. So make life easy on yourself.

Get wings level for a few seconds before the Abeam Fix is due, and this will eliminate Needle Dip and give you a better Fix.

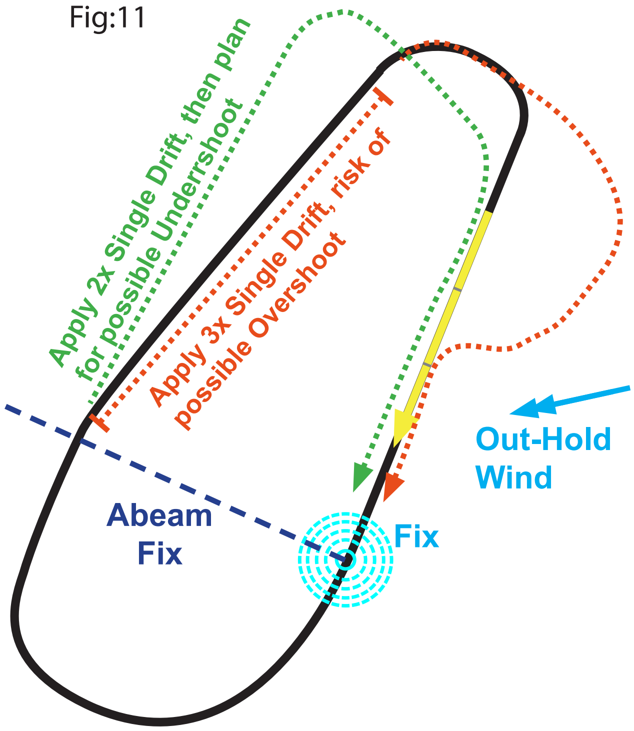


### Helper #3:  Double-Drift with Out-Hold Wind

The Textbook states that you should always apply 3x or triple drift in the Outbound Leg.  When you have an Out-Hold Wind, there is a very real risk of over-calculating the Single-Drift WCA and therefore flying too much correction with a consequential Overshoot. (Orange Track in Fig:11 below)

**Helper #3** suggests that when you have an Out-Hold wind that you limit the Outbound correction to double-drift (2x Single-Drift) and then expect a small Undershoot. (green track)

Fig:11




An Undershoot is very easy to fix as you just need to roll the wings level for a short time.

Undershoots, once you have practised them are much easier to manage and control than Overshoots.

Also Undershoots are safer than Overshoots as you remain on the "inside" of the Hold where the obstacle clearance separation heights are more favourable.

Although Fig:11 is exaggerated, it illustrates the point.

## How to Plan, Approach and Fly a Hold

*The six-P's: "Proper planning prevents p***-poor performance" HM-RN*

Proper planning indeed. It is not possible to plan for every eventuality on the ground as circumstances may and will change in-flight and you as an IR candidate must have the capacity to be able to re-plan and cope with changes mid-flight.

Therefore it is pointless planning every last detail prior to flight, and this is especially true of the Hold.

During an IR Skills test (and in reality) there is time to plan your Hold, Single-Drift and WCA, Hold Entry, Timing corrections, Gate correction, Outbound heading corrections and build some situational awareness of drift when turning Inbound to the Fix QDM.

So when to do it? Preferably once en-route and your terminal beacon is known. This will be as a result of listening to the ATIS at the destination Airport as soon as is practical.

> eg. at Sevilla, will you go to TENDU or ROTEX (based on runways 09 or 27 respectively)? What is their respective holds? Is it en-route or Beacon based??

Given that the ATIS transmission from 3000' has a propagation range of 60miles, you have at least 10 minutes to plan your hold. This is plenty of time if you are organised and in practice.

## Step 1: Get a Pilots PLOG

On your Kneeboard have some kind of Hold Planner space set aside for it. Below is one design that I suggest you consider. The Hold Data in black text (IT->Ab) are all just taken off the plate and will help with your calculations.

The calculated fields are the ones marked in red.

In this example the pilot has calculated a single drift WCA/Single Drift of 7˚ and westerly for their own situational awareness, from the wind strength and direction.

Outbound Heading is calculated off of the SD as being either triple or double-drift (see Helper #3).

Outbound Timing is calculated as preciously shown, and this indicates a slight tailwind of 4 Kts.

Finally the corrected Gate is calculated as being the Gate less single drift.
It all looks complicated at first, but it isn't really and with a little practice can be done quite quickly.

**Hold Example #1**

It: 202 - R
Ot: 022
Gt: 352
Ab: 292
SD: 7 (w)
Oh: 001
Ot: 56
Cg: 345

IT : The Inbound Track and Hold Direction (Right Hand Hold, Left Hand Hold) namely RHH and LHH *(taken from the plate)*
OT: The Outbound Track (180˚ from IT)
Gt: The Gate (-30 from OT [R], or +30 [L])
Ab: Abeam Fix: IT+90 (RH), -90 (LH)
SD: Single Drift WCA based on W/V & IT
OH: OT track corrected for wind (3x or 2x SD)
OT: Outbound Time based on Head/Tailwind
Cg: Corrected Gate (Gt-SD for In-Hold Wind RHH), (Gt + SD for OutHold Wind RHH), (Gt+SD for In-Hold Wind LHH), (Gt - SD for OutHold Wind LHH)

## Step 2: Time Turn Talk Twist

Every time, without fail, you go over or transit the beacon, you will **Time, Turn, Talk and Twist.**

**This is a must, not an option**. Failure to reset the Timer when over the beacon is an invitation to the Examiner to "partial you"

**TIME: *Reset the timer.*** Once at the Abeam Fix (assuming you get one) reset the timer again. If you forget to reset the timer at the Abeam fix, all is not lost, you can just deduct 60s for the Outbound turn (it's rate-one remember?) from your Outbound corrected timing.

If you forget to turn on at the Gate, then when you realise your mistake, looking at your Timer will tell you how far you have gone (in seconds) from the Beacon so you can make an estimate of how long you need to fly Inbound to the Beacon.

As you can now see, if you fail to reset the timer at the Beacon it becomes very difficult to accurately compensate for errors later on.

**TURN: *Turn onto the Outbound Time.*** That is not to say you can't wait for full beacon passage to occur before starting the turn. Helper #2. But be careful not to exaggerate.
5 seconds is usually ample, unless you have a strong Inbound Headwind, in which case expect that you wont get an Abeam Fix.

No Abeam Fix, no problem. If you have gone past the Abeam Fix whilst still in the Outbound turn due to the wind and before the wings became level, just leave the timer running when the wings become level and monitor the Gate and the time minus 60seconds from the Beacon.

**TALK: *Tell ATC you are taking up the Hold***
If the first time over the Beacon for a Direct Entry, call ATC and say "*CALLSIGN taking up the hold at <beacon>, altitude <xxxx'>, QHN1xxx*", this is a test requirement.

If the entry was Parallel or Offset, it is the second time over the Beacon/Fix when you call ATC.

If ATC are very busy, then don't bother them and wait until next time. They can still see you on their radar, so don't worry too much about it.

If ATC are still busy the Examiner has some latitude to ignore this, but what they won't want to hear is you talking over communications between ATC and commercial traffic. Once over the Beacon and you've proudly told ATC where you are, shut up and fly the Hold.

The next time you need to speak to them is when you are ready for the Approach, or to acknowledge that they need to kick you up to a higher altitude to enable a commercial arrival to fly underneath you!

**TWIST: *Twist your heading Bug onto your Outbound Heading*** (single-drift wind corrected heading).
This way you know where you are going in the Outbound Turn! If you end up coming wings level before the Abeam Fix, great just fly the Bug, then anticipate the 2x/3x Outbound Track correction.

Now try to remember Time,Turn Talk and Twist every time you go over the Beacon / Fix.

### Step 3: Monitor and Correct

If you only get to fly one Hold, then you are both lucky and unlucky. Lucky that if you flew it well, you don't have to repeat the exercise and you have passed the Holds part of the IR Skills test. If you didn't fly it well, you may not get a chance to prove that you can correct your mistakes.
Alternatively if you are held by ATC in the Hold, it means that you have to keep flying it well, but if you really are a sky-god, this is time to impress the Examiner and send them to sleep for the rest of the test with your prowess!

Less facetiously, if you find yourself having to do multiple Holds, impress the Examiner by stating if an Overshoot or Undershoot has occurred, and then stating what you intent to do. Recalculate and change the Outbound Wind corrected heading by a few degrees. (usually no more than 5˚)

You should arrive back at the beacon after 4 minutes. If not then take the difference, divide by 2 and try the new timing on the Outbound Track.

Example: For a wind corrected OutBound Track timing of 54 seconds, if you arrive back at the Fix at 3mins 50seconds, that is 10 seconds too soon. So add half (5s) to the Outbound Timing, so 54+5= 59s and try again.

The Same goes for the Outbound wind-corrected heading. If you Undershot, make a change to the 2x or 3x drift correction and move the corrected Gate Heading next time around the Hold to reduce it (5˚ is a good start). Same with an Overshoot, make a change to the Outbound.

What you are trying to demonstrate here to the Examiner is not that you are perfect (no-one is), but rather that you have correctly identified an error and made a sensible estimate of what needs to be done to correct it.

## Using the RBI in the Hold

One of the challenges of flying a Hold is when you need to use a RBI for the Beacon tracking.

The RBI suffers from two features that makes its' use more difficult, they are "Needle Dip" and Fixed Card. In the previous chapter the use and errors of the RBI are described in depth. Let us look at how those errors might affect our flying of a Hold.

**Abeam Fix**

Ensuring that you achieve an Abeam fix is important for timing on the Outbound leg. One way to achieve this is Steves' little cheat #2 where you fly throught the Cone of Confusion before turning Outbound.

This (hopefully) allows you to able to fly (even if it is for only 3-4 seconds) wings level before reaching the Abeam Fix. Getting the Wings level means that NDB Dip can be eliminated before reaching the Fix.

This means that if the Pilot successfully rolls wings-level before arriving at the Abeam Fix, then the RBI will indicate the Abeam transit with the needle being at the Easterly position, ie 090˚ Relative bearing for a Right-Hand Hold, or a Westerly position ie 270˚ Relative Bearing for a Left-Hand Hold.

**Gate QDR**

You need to know if you have reached or failed to reach the Corrected Gate in order for your wind corrections to work and for the prediction of a possible Undershoot or Overshoot.

I suggest you modify your Hold Plog Planner, to include a Relative Bearing for the Tail of the needle at the Wind Corrected Gate.

This is actually not as difficult as it may seem, as you deduct your Wind Corrected Gate QDR, "$C_G$" from your Wind Corrected Heading "$O_H$". Look at Example #2

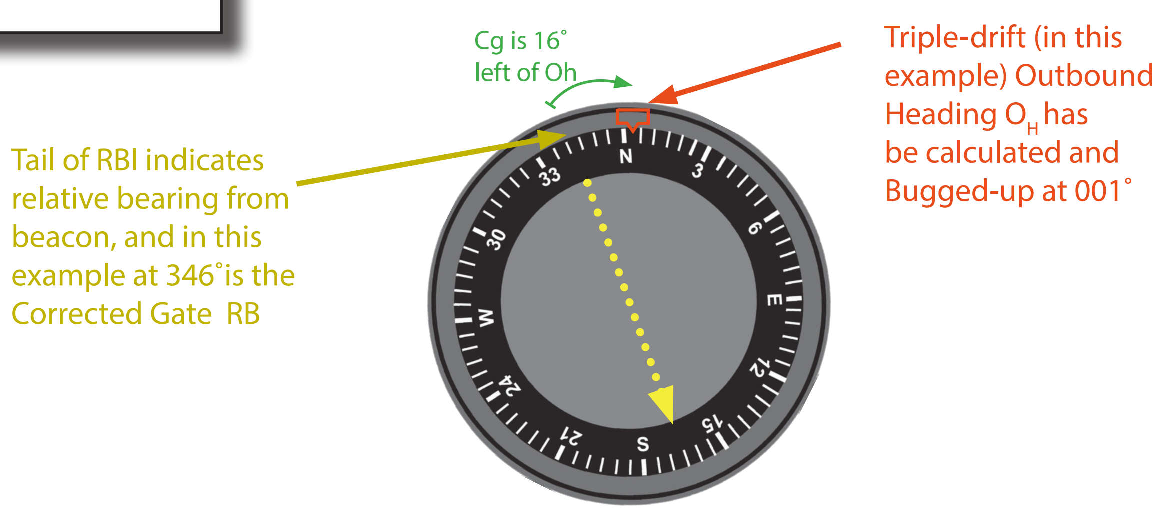
**HOLD EXAMPLE #2**

$I_T$: 202 - R
$O_T$: 022
$G_T$: 352
$A_B$: 292
SD: 7 (w)
$O_H$: 001
$O_T$: 56
$C_G$: 345
$G_{RB}$: 16

You will already have already worked out "$C_G$" and also your "$O_H$", so it is easy to calculate the Gate Relative Bearing ("$G_{RB}$")

001˚($O_H$) minus 345˚ ($C_G$)= 16˚ left of North
That is 344˚ to the left of the North/360º Relative Bearing

When the tail of the RBI needle reaches 16˚left of North, or an indicated bearing (on the fixed Compass Rose) of 344˚ (same thing), then this is the Corrected Gate bearing, and time to check the Timer.



## Inbound Turn Position Fix

Earlier we looked at the Inbound Turn Position Fix ("ITPF"), the point where, if you are on-track, then with 60˚ of turn remaining in the Inbound turn to the Inbound track, that your QDM is 10˚ less than the Inbound Track.

This is where you have to rely on your DI or Compass to check your 60˚ remaining turn position and the QDM. When using an RMI, this is relatively easy as the Compass Rose will rotate and if you have bugged your CDI, then the 60-turn-remaining Check point can be read off from the top lubber line of the RMI/HSI.

If your aircraft does not have an RMI/HSI, then add an extra line to your PLOG Hold Planner, and when in the turn to the Inbound Track, monitor the aircraft heading on either the Direction Indicator ("DI") or the Garmin.

**Hold Example #3**

$I_T$:202 - R
$O_T$:022
Gt:352
Ab:292
60˚:140
SD:7 (w)
OH:001
OT:56
CG:345
$G_{RB}$: 14 left

In the Example #3 on the right the extra line "*60˚*" has been added. (in purple on the right)

This is easily calculated (as in this example) as being

$(I_T)$ 202˚ - 60˚ ≈140˚

Do not try to get too clever with this, just round the number up or down to the nearest 5˚, so in this example, the 60˚intercept is actually 142˚, but 140˚ is more than close enough.

In the case of a Left Hand Hold add 60˚, so for example with an $I_T$ of 012˚, then

$(I_T)$ 012˚ + 60˚ ≈170˚

So for this Hold your Position Fix would be at approximately 170˚ and your QDM should ideally be 022˚

## NDB's and the Inbound Turn Position Fix

When using an NDB for the Hold, and when approaching the ITPF, if we are in a Rate-One banked turn, then in a Right Hand Hold we need to subtract 10˚ from the Needle reading for an accurate assessment of the progress of the Hold (and add 10˚ for a Left-Hand Hold).

From the previous section on the ITPF, we can use a table to assess the progress. One major error that Students make when flying a Hold is to relax the Rate One Turn in an Undershoot.

What happens is simple. The student recognises an Undershoot developing and rather than roll the wings level for a few moments, actually reduces the bank angle to reduce the rate of turn. When tracking inbound to a VOR, although not the correct way to fly a Hold, you wont fail for doing it.

On the other-hand, with an RBI/RMI - NDB combination, by rolling less than Rate-One, the Needle Dip becomes unpredictable and what normally happens now is an Undershoot is turned into an Overshoot, the Student then struggles to get onto the correct QDM and subsequently looses Situational Awareness, the scan breaks down and a situation that was under control becomes a battle to regain position and composure.

Lesson to Learn: Keep all turns Rate-One

## Undershoot & Overshoot Management

Earlier we looked at the type of error called an "Undershoot" (Fig. 6.), take a moment to revise this potential error. If your aircraft has an RMI (with an auto-slaving compass rose), then when an aircraft gets with 60˚of turn-remaining-to inbound, then the QDM to the Beacon can be directly read off of the instrument.

There is the added complication of NBD Dip on a ADF needle, but just deduct 10˚ when in a right-hand turn and add 10˚ to the needle position when in a left-hand turn.

When the aircraft does not have an RMI, then visually the situation becomes more challenging. There is some bad news and good news. The lack of direct readout of QDM, turbulence, induced needle wander and the general inaccuracy of an ADF on an RBI, means you just have to work just a little bit harder. That's the bad news.

The good news is that your Examiner will equally have the same issue as you, and therefore will have difficult definitively reading off your exact QDM to the Beacon. Add to that, that the RBI is often on the far left-hand side of the Instrument panel, they will be suffering from extreme parallax error and will have great difficulty reading your QDM +/-10˚. This doesn't just apply to the Hold, but any ADF single-needle tracking.

Take the example below, this is a classic Undershoot setup.

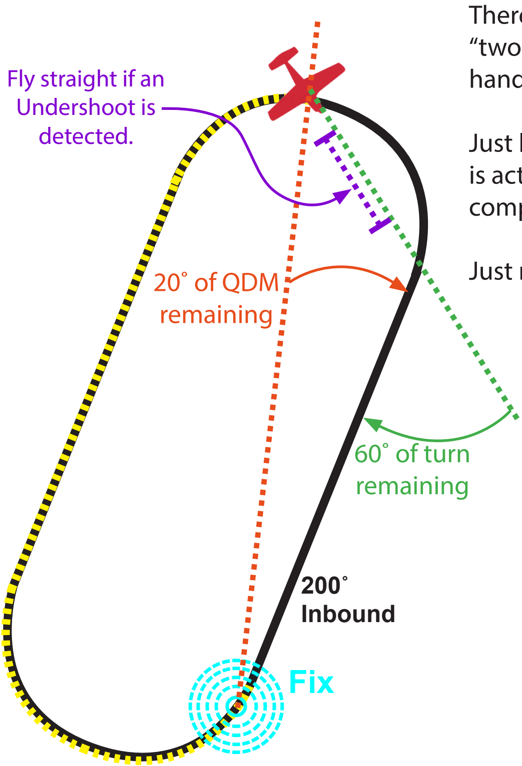
**G5 with GPS Hdg**


**HSI with Mag Hdg**


Firstly you will need a Heading source.
A Garmin G5 with magnetometer will give you Magnetic track. If not, then a GPS track readout , but with European Mag Deviation being +/-3˚, this can be effectively ignored.

Alternatively, your aircraft may be fitted with a HSI, which is auto slaving, or maybe you have a Compass and Direction Indicator. On the left, all three are reading ~140˚, the 60˚ of turn-to-go.

Whichever you have, you know when you are approaching the 60˚-to-go fix.




Have you realised yet that the "big numbers" on a Compass rose are at 30˚intervals? Therefore to visualise your "QDM-to-go", just look at the RBI to see if the needle is "two-big numbers" to the right of the top of the RBI (in a RH Hand turn, left in a left-hand hold).

Just look at the example below, you can see that the ADF needle (green arrow below) is actually pointing at 40˚, when it should be at 60˚. No maths required don't over complicate the problem.

Just roll out level, then fly straight to push the head towards 60˚on the RBI.


Now in the example shown here and if you have been paying attention, then you will realise that as soon as the wings go level, NDB Dip will disappear and the ADF needle will (in this case) point at 30˚

This is correct as the QDM is 140˚ + 30˚ = 170˚ when it should be 200˚. This is an Undershoot.

Just fly straight, "push the head" until the needle reads 60 to the right (light blue needle) and then continue the turn onto the Inbound Track

## Undershoot and Overshoot Management

Earlier we looked at the type of error called an "Overshoot" (Fig. 7.), take a moment to revise this potential error. If your aircraft has an RMI (with an auto-slaving compass rose), then when an aircraft gets with 60˚of turn-remaining-to inbound, then the QDM to the Beacon can be directly read off of the instrument.

There is the added complication of NBD Dip on a ADF needle, but just deduct 10˚ when in a right-hand turn and add 10˚ to the needle position when in a left-hand turn.

Take the example below, this is a classic Overshoot setup.


As in the previous example

The 60˚ turn-to-go fix is at ~140˚

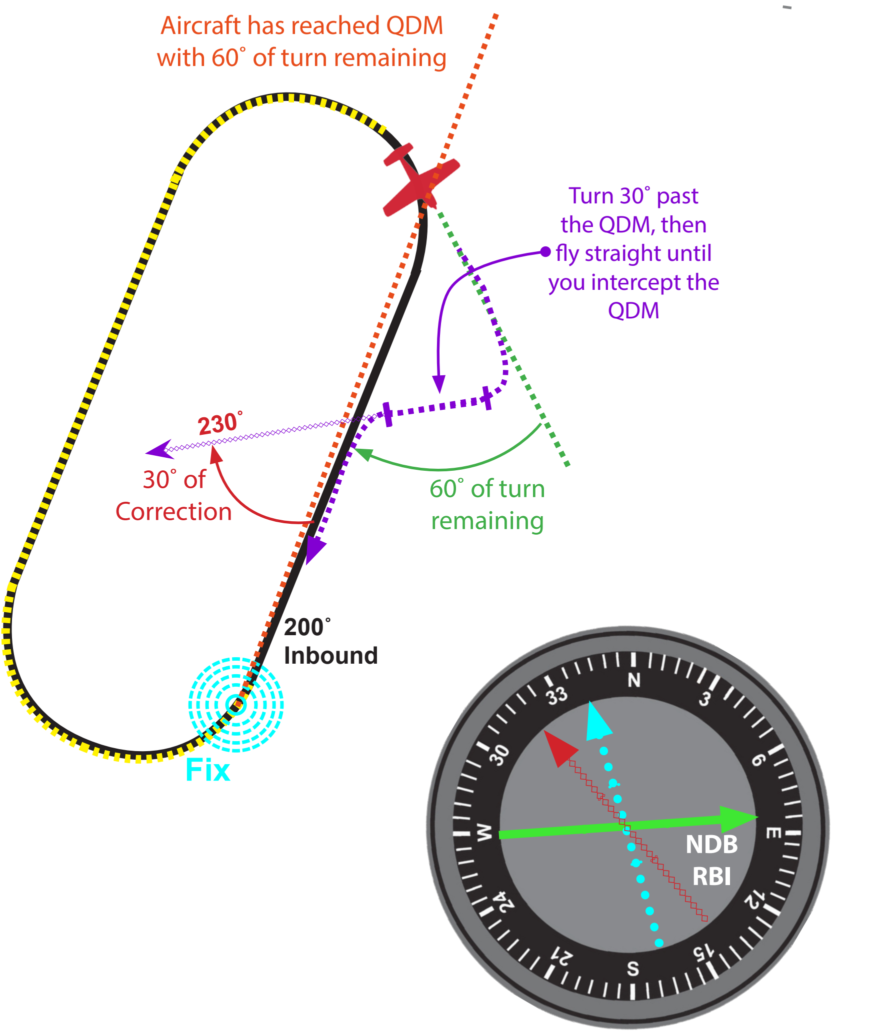
Just look at the example below, you can see that the ADF needle (green arrow below) is actually pointing at 80˚, when it should be at 60˚.

In this scenario you are going to fly through the Inbound QDM onto the "unprotected" side of the Hold.

Therefore, continue the rate-1 turn until you have a heading that is approximately 30˚ past the inbound Heading.

In the example below, the Inbound QDM is 200˚, therefore 200+30 = 230˚

Roll out on 230˚ which will push the head of the needle, back towards the 200˚ QDM, but how?
Well, from an initial heading of 150˚ (remember the 60˚-to-go-fix) around to 230˚is an 80˚ turn.




As a result of your turn, the ADF will have rotated and now point approximately 20-30˚ to the left (blue needle) depending of course on how far you Overshot by.

Let us assume the overshoot was 20˚

You are now intercepting the QDM at 30˚ so by doing so you are pushing the Head from 340˚ (blue needle) towards 330˚, which represents our 30˚ of intercept angle.

**But WAIT!**

The needle suffers Dip, so we need to actually fly an extra 10˚ to 320˚ to get to a Relative Bearing of 30˚ .

As soon as the needle reaches 320˚, start to turn left back onto the heading of 200˚ and you should have intercepted the Inbound QDM.

This is visualised on the right by the position of the red needle, just prior to turning left onto the Inbound track.

If this doesn't make sense, practise it in RANT XL, as it is a repeat of the Intercept exercise.

Ahh...... the lights go on !!

## Garmin Systems

*Purple Bugs and The Pursuit of Happyness*

The Garmin G5 has a built-in GPS. It is therefore able to give you GPS Track information. This is your Track over Ground, or TOG, which has been mentioned before. It does not matter what the wind is doing, how strong it is or in which direction, this is your actual flightpath over the planet as defined by WGS84.

The Garmin G5, also has an inbuilt electronic Compass, that can work independently of any Flux-Gate in the aircraft's wing, that may or may not been fitted. Not all G5's have this feature enabled, so check before flying. However, if you do fly behind a Garmin G5 and the Compass is enabled, your life just got a whole lot easier! *The following discussion assumes that the Compass feature is enabled.*


This is a typical G5, configured as an Attitude Indicator. The G5 is TSO 'd and can be used to directly to replace a vacuum-driven Attitude indicator, but also comes with extra features as can be seen from the display.

One of those features, which is part of the Compass ticker-tape along the top of the display is your magnetic heading, in the left-hand example, reading "225", or 225˚ Magnetic heading.

If this is the case, then you must realise that you now effectively have an electronic Direction Indicator, which is auto-aligning. *Light-bulb moment!*

Note, that there is a small magenta diamond to the right of the Compass ticker-tape at the 212˚ position. This is the Tracking Bug, it is indicating the track-over-ground as determined by the GPS receiver.

Second light-bulb moment! If we have a magnetic Heading of 225˚ and we have a TOG of 212˚, then by deduction we must have a wind drift of 13˚. What this means is that when flying in any given direction you can now read off the actual (*not a "guestimated"*) wind drift, <u>in real time</u>!

This can be used to much more accurately to create triple-drift calculations as the Single-drift WCA is actually straight in front of you. A GPS-derived TOG also gives you Ground-speed. This is displayed in the bottom left-hand corner of the display. Need Headwind/Tailwind calculations for any given heading? Just deduct the GS from the ASI number.

In this photo, AS is 149Kts, GS is 150Kts, so a 1Kt tailwind.

This is where we find out who is paying attention, because wait, if we have a GPS-derived TOG, then we must also have a fully corrected wind angle? Indeed we do, and better than that, the GPS receiver is updated once per second, so this is the ideal tool for tracking a QDM, or QDR perfectly!

Quite simply, if you have a desired track to a Beacon (its desired QDM), then all you have to do is to turn the aircraft so that you match this QDM to the GPS-TOG, and you will fly directly to the beacon.

If you think about it, we normally start with a Heading, then Wind correct it for track, and the correction is always an estimate and we don't know if that estimate works until we have flown for a few minutes and re-assessed the progress.

Now we can bypass all of that. We decide what QDM we need, and turn the aircraft until that GPS magenta track bug matches the desired QDM. Then set the Heading bug to whatever heading is on the Compass display, and then fly this heading. QDR's are just the same, just set the magenta bug to the reciprocal of the desired QDR.
*If you don't now have a grin from ear to ear, its probably because you don't understand the implications of this piece of equipment. A suggestion....... go back to the top and read this page again!*




### Garmin Systems (contd.)

Where an Attitude Indicator is removed and replaced by a Garmin G5, then that usually only leaves the Direction Indicator as the remaining vacuum-driven instrument. *(For reasons of single-point failure resilience, Turn Co-ordinators and Turn Indicators should be electric.)*

For this reason it is common that if the AI is replaced then the DI is removed at the same time. This saves not just 2x Kgs of instrument weight, but also the removal of the vacuum pump (1.5Kgs plus associated plumbing) and sometimes an electrical auxiliary vacuum pump as well. (another 3 Kgs).

The smart move is to fit a second G5 slaved to the top unit so they can share common information and a data bus.

The Navigation unit, can be configured to act as a GNSS RNAV unit, a VOR OBI, a VOR RMI, an ILS LOC/GS or even an RNP display.

The actual capability will depend on the avionics fit of your particular aircraft, so take some time to research what is fitted.

The radio-nav information can be turned off (see bottom left) so that the display only offers an auto- aligning compass rose.

Here you can see more clearly the GPS-TOG track and bug (dotted white line, magenta triangle). The set Heading Bug (cyan) and ground speed (GS KT).

The G5 is a very powerful piece of equipment. There are simulator programs available to enable you to train on the ground how to use them. Ask your instructor where you can do this and don't forget to buy them a coffee.

## Test Limits

In the IR skills test, the Hold Section has a number of limits, which if flight occurs outside of these limits, invites at best the increased scrutiny of the Examiner, or worse the application of a "partial" or if particularly unsafe, a Fail.

If you think your instructor is nagging you in your lessons, then that is probably for a reason, so stop arguing with them and learn what you have done wrong.

### Single-Needle Tracking: Inbound QDM #1

Most of the IR test is like a well-choreographed dance, with certain things happening at predictable times.

Not so the Single-Needle tracking. This creeps up on the student when not expecting it, and usually takes the form of an ATC request "route direct to XXX". At this point the student tunes, idents, selects the correct mode and turns towards the Beacon or fix. IF test specifications state that Tracking must be achieved to an accuracy of +/-5˚.

Without you knowing it, the Examiner will wait until you have gone wings-level towards the Beacon, pauses for a few seconds then notes down the inbound QDM.

This is now the target QDM that you must maintain +/-5˚ all the way to the beacon.

Do not home towards it, but track with a wind corrected heading.

A Garmin G5 will help you with this, if having gone wings-level, and set up a WCA, properly bugged it, you casually mention the fact that you have "*selected a WCA to account for the wind for a QDM of xxx to the beacon zzz*" , you will send the Examiner back to sleep as they now know you are wise to their monitoring of you.

Monitor the Head of the Needle, and remember "***push the head, pull the tail***".

If the needle Head starts to move away from your heading, and therefore your desired QDM, then you may be applying too much "push", so turn towards the Head, and reduce the "push" angle. If the Head moves off of the desired QDM towards your heading, then turn away, and increase the Push-angle to push the Head back.

Conversely, if on a QDR, the tail moves away off of the QDR and away from your Heading, turn away from the tail to "Pull" it more back towards the QDR.
If the Tail starts to move towards your Heading, then turn towards it, in other words reduce the angle of "Pull" so you are not "pulling" it so hard.

## Inbound Planning

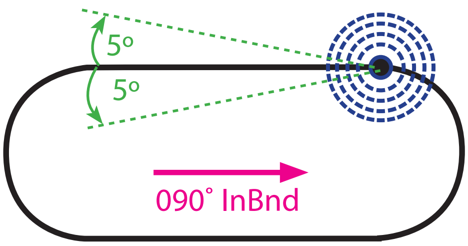
There is a good chance that the Beacon you are single-needle tracking to is also the Hold Fix, which can also double-up as the Intermediate Approach Fix ("IAF") for an Approach.
Not necessarily a pass/fail item this, but if whilst Inbound to the Beacon/Fix, with a good 10minutes before reaching the fix, start on planning the Hold, using the actual wind you are getting in-flight.

This will do three things.

1. Prepare you for the Hold
2. Act as a reminder of what you about to do, and refresh your memory of the Hold
3. Demonstrate to the Examiner that you are planning ahead, so they can relax and go back to looking out the window and not on your progress (*or perhaps that QDM you were supposed by tracking by +/-5˚ that has now become 10˚!*)

## Entering the Hold: Inbound QDM #2

The Inbound track to the Hold must be flown to within 5˚of the QDM if a Beacon or DTK if it is a Fix.
This is number, so it is not open to interpretation by the Examiner.




Work at it. When entering the Hold, or when coming back round the Inbound turn, deal with any Under/Overshoot and get back with +/-5˚ QDM before passing the Beacon

## Platforms

At some stage in the Hold, if it is an Intermediate Fix, then you may be told to descend to the Platform altitude for the Approach served by the Beacon. Platforms are there for a reason, to provide minimum obstacle clearance. Treat them with respect and don't bust below them.

***Platforms are made of concrete!***

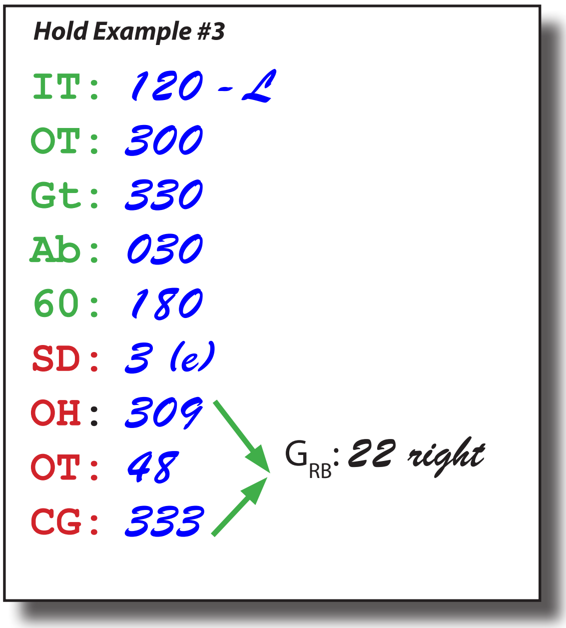
So fly 50-60' above them and never get below them. So, for a Platform of 1800', fly at 1850'.
Bust a Platform once the Examiner takes notice. Bust it again and don't do anything, its a partial. Bust it a third time or at anytime by more than 100' its a fail. No "if's, no "but's" and no argument.

# Fully Worked Example

Lets have a look at a fully worked example of a Hold plan, start to finish.

**Exercise**

You need to hold at the EVA on 329Khz, which is a **left-hand Hold**, Inbound is 120°, the predicted W/V is 100/18, Aircraft TAS=105Kts. Heading is 035° towards the Beacon. Plan the Hold and Entry.




Start by filling in the Green data, **I**nbound **T**rack, **IT,** is 120 - L(eft)
**O**utbound **T**rack is 120+200=>320 - 20 =>300, so **OT** = 300
**G**a**t**e is 300 + 30 (its a left hand hold!), so **Gt** = 330
**Ab**eam Fix is **IT** - 90 (again for a left hand), so 120-90=030°, therefore Ab = 30
60° Inbound Turn Fix will be 120 + 60 (left hand again), so 180°

So far so good, just simple arithmetic.

MDS is again easy...
60=18, 120=9, so 90=12, so for 105Kts call it 11°

Single Drift Inbound, W/V is 100, IT=20, so clock code 1/3rd, 1/3rd of 11 is about 3°. So Single Drift correction is 3° East. Put that next to **SD.**

The wind is blowing the aircraft into the hold, so In-Hold wind, so use triple-drift. 3x 3° = 9°, so **O**utbound **H**eading, **OH**, is OT+9°, so 300+9 = 309.

Write down 309 next to OH, so your Outbound, wind corrected heading will be 309°

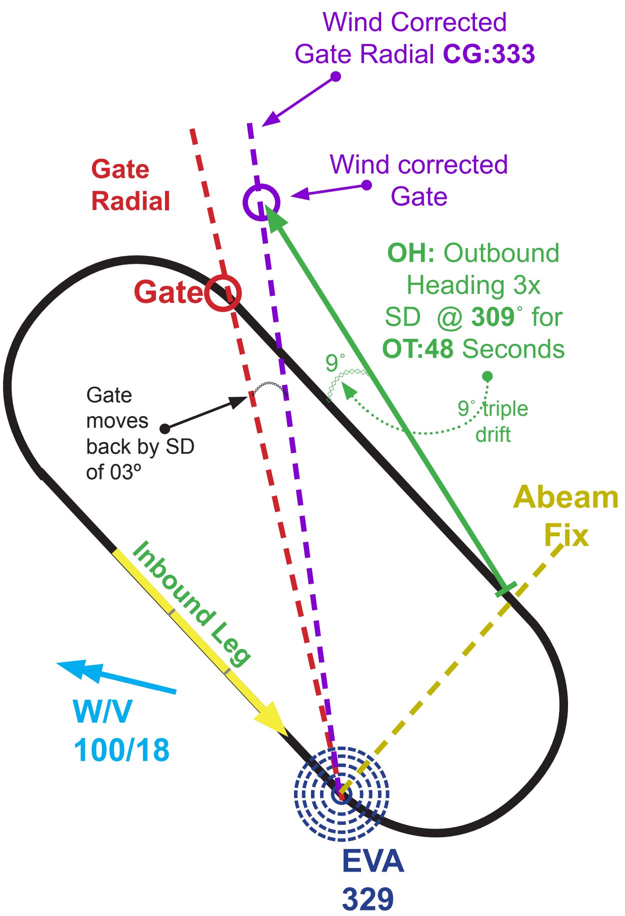
Timing. When on the Outbound, the wind will be 20° from behind you at 18Kts.

Starting from 12 o'clock, work anticlockwise to 20mins, this is in the 3/4 quadrant, therefore 3/4 x 18 = 12Kts of tailwind.

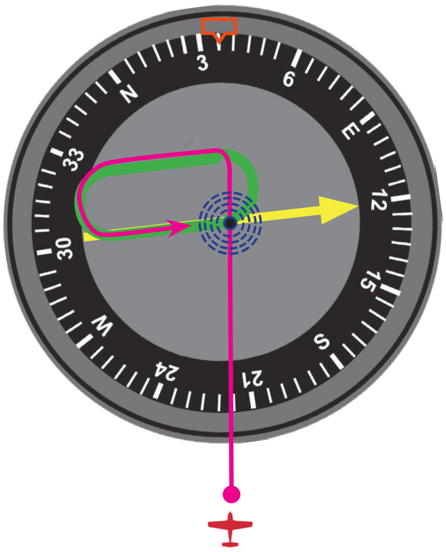
So instead of a 60second outbound track, take off 12 seconds, so **O**utbound **T**ime is
60-12 = 48 seconds. So for **OT**, write 48.

It is an In-Hold wind, so bring the Gate back by Single Drift (SD), already calculated, so Gate is now 330 + 3, as it is a Left-hand Hold, so **C**orrected **G**ate, **CG** is 333.

Finally if you are using an RBI, then the **G**ate Corrected **R**elative **B**earing, $\mathbf{G_{RB}}$ will be OH - CG, 309-333=>-22, so 22° to the right of the top of the RBI. $\mathbf{G_{RB}}$ = 22° right




*The above illustration shows the approximate corrections to be made. Angles have been exaggerated for clarity*



## Fully Worked Example (contd.)

The top image illustrates what you would see in the cockpit on the instruments as you approach the hold on a QDM of 035˚ with the CDI "bugged" onto the Inbound radial of the Hold of 120˚.

Even though you may have already completed the Hold calculations, to help you visualise what is going on, try to imagine the Hold.

The lower image shows how by overlaying an imaginary beacon and the hold onto the face of the HSI, how easy it is to visualise the Entry and to act as gross-error check on your calculations.

In this example, you can see that the entry will be a Direct >90˚ but less than 180˚

You can also visually check the calculated Corrected Gate and the wind-corrected Outbound Heading, making it less likely you have made any major mistakes.

## Practice & Revision

The example above, requires a fair bit of thought the first time you do it. However the more you practice the faster it will become and more intuitive. Eventually you will be able to "see" the Hold floating on top of your Instruments and the calculations will become almost automatic.

To get there though, requires practice. A lot of it!

For every hour in the SIM, you should spend at least an additional hour on revision and homework.

There is a piece of software called RANT XL. Buy it! It will cost you £80 if you buy direct and will save you a lot more money later on. It will allow you practice exactly this type of scenario, for a fraction of the cost of a Simulator lesson, and also at your convenience.

RANT XL is a procedural trainer. Unlike MS Flight Simulator or X-Plane where the emphasis is on handling skills, RANT is about learning how to Intercept, Track and fly Holds. Turning climbing and descending are done with single keyboard presses, so you can concentrate on the "radio picture".

As an aspiring IR candidate, you should budget at least 40 minutes per day on RANT XL, mastering the various skills of Applied IF.

Once you have got to the stage of learning Holds, the best exercise you can "fly" is the "*random-wind, random position, random beacon, intercept and fly a hold*" exercise.

Think of it this way. If over the course of your IR course if you can save 10 minutes of flying in the Seneca as a result of using RANT XL, it will have paid for itself. If you save one extra SIM lesson of thirty minutes it has paid for itself.

Ask your Instructor for a demonstration, and you will understand not only what is expected of you, but the accuracy and speed needed to be successful. You now owe your IR instructor a small case of beer!
Money well spent.

# Conducting the Hold

A Hold will usually (hopefully?) terminate with an Approach. However before you start an approach and leave the safety and comfort of the Hold, you need to prepare for the Approach. Given that this preparation will be done whilst flying the Hold, we are including it here.

## The Approach Ban (EASA)

> " The commander or the pilot to whom conduct of the flight has been delegated may commence an instrument approach regardless of the reported RVR/VIS.
> If the reported RVR/VIS is less than the applicable minimum the approach shall not be continued: (1) below 1 000 ft above the aerodrome; or
> (2) into the final approach segment in the case where the DA/H or MDA/H is more than 1 000 ft above the aerodrome.
> d) If, after passing 1 000 ft above the aerodrome, the reported RVR/VIS falls below the applicable minimum, the approach may be continued to DA/H or MDA/

In normal flight operations one would not volunteer to fly a Hold, but fly radar vectors or a procedural STAR, straight to the appropriate Approach. However as you are "on-test", you will be asking to take up a hold for the purposes of the test. As a result, you will be asked by ATC to "*report when ready for the Approach*".

Before you can ask for an Approach, you need to demonstrate that you have considered the possibility of an Approach Ban and have briefed yourself on the weather conditions at the Airport.

Before we start, it is worth noting that it is considered poor airmanship to make an approach when the reported cloudbase and visibility for the airport are below the minimas.

Ryanair with a coupled approach autopilot, multi-pilot crew and automated TOGO capability, may elect to "give it a go". But not us, not single-pilot, with no autopilot-coupling, manually flown with manual power.

For us we have the Approach Ban as a safety feature, and for Jerez it can be summed up as this:

- The Airport altitude is 93' AMSL
- Add 1000' to this and round it up to the nearest 100', so 1000 +93 =>**1100'**
- If the reported RVR is below minimas for the approach, you cannot descend below 1100' on the Approach and must initiate a Go-Around (and presumably return to the Beacon for a Hold)
- If however, the RVR is reported as being better than minimas on reaching 1100', you can continue the Approach below 1100'
- **But** ,if after passing below 1100' , the RVR reduces below minimas, then you may continue the Approach to DA/MDA.

**RVR Minimas**
The RVR for an Approach is given on the Approach Plate and will always be the highest of the most limiting factor.

**Standard** STRAIGHT-IN LANDING RWY 20

| | ILS<br>DA(H) A: 317'(224') C: 337'(244')<br>B: 329'(236') D: 348'(255') | | LOC (GS out)<br>CDFA<br>DA/MDA(H) 660'(567') | |
|---|---|---|---|---|
| | FULL | ALS out | | ALS out |
| A | RVR 550m [1] | RVR 1200m | RVR 1500m | |
| B | | | | |
| C | | RVR 1300m | RVR 1900m | RVR 2400m |
| D | RVR 600m [1] | | | |

[1] RVR 750m when a Flight Director or Autopilot or HUD to DA is not used.
[2] Or higher Straight-In minimums.

*For Example #1 ILS Z Approach RW20 LEJR (right)*
Cat A/B?C: With Flight Director/Auto Pilot 550m
Cat A/B: No Flight Director / AutoPilot 750m
All Cats: Single Pilot Ops, no coupled Autopilot 800m (*this limit applies to all airports*)

Therefore flying without coupled Autopilot, in a Single-Pilot operation the RVR Minima is 800m

## Conducting the Hold (contd.)

*Example #2 VOR Approach RW20 LEJR*

| | |
|---|---|
| Cat A/B: No equip. concessions granted | 1500m |
| All Cats: Single Pilot Ops, no coupled Autopilot | 800m |

Therefore the absolute RVR minima for the RW20 VOR App is 1500m.

## Planning the Approach

Working backwards, you cannot start an Approach unless above limits, therefore you cannot ask ATC that you are ready to start an Approach if you can't fly it.

You can't make that decision without knowing the current RVR, so the first thing you must do before asking to leave the Hold is to **get some fresh ATIS** !

The ATIS will tell you what the Cloudbase is, so you can decide if the cloudbase is above DA/MDA.

The ATIS will report the RVR, so you can decide if it is above the limits from the Approach Plate.

Now you can make a decision, inform the Examiner that "*Cloudbase and RVR are above limits, no Approach Ban in place*" then push the PTT and tell ATC that you are ready for the approach.

At the same time, if you are really "on the ball" why not check your Missed Approach Instructions?

So be efficient and make a single full call to ATC something like this:

> "*Sherry 63, ready for the Approach, ILS Y RW20 at Jerez, request missed Approach instructions, QHN1xxx*"

This tells them you are ready to go, that no Approach Ban is in place and it prompts ATC to give you your M/App instructions.

If ATC forget to give you instructions (they sometimes do), then brief yourself on and be prepared to fly the standard M/App Proc, whilst also getting a thumbs-up from your examiner for asking.

In some busy environments, it is not unusual that once you are established on the Approach and have been asked to contact the Tower, that it is the Tower that passes the M/App instructions to you, so be ready for this.

## Conclusion and Further Resources

### RANT XL

RANT XL can be downloaded from www.oddsoft.com . There is a trial version available, the full version (*at time of writing)* is £80. The author can get a discount for Students, ask before making a full purchase.

The author of this manual has also successfully installed RANT XL on a Macintosh (Intel) without needing to install a windows Virtual Machine and accompanying Windows OS. Approach the Author if your flavour of fruit is Apple.

### Approach Plates

All of the official Approach Plates are available from the AIP of the relevant country.

For Spain they are available from Enaire. Here for example, are the plates for LEJR (Jerez):

https://aip.enaire.es/AIP/AIP-en.html#LEJR

Download and print the plates you are most likely to use and study them.

Do not memorise them as they get changed regularly and the data will change. By studying them, I mean understand every piece of information on the Plate.

If you don't know what something means, go look it up. Be a "*miner for truth*" and prepare yourself for using them in anger, by analysing and understanding what they are telling you.

### Other Resources

The author runs his own web site with more support manuals for practical Applied IF flying from this series.

http://www.evansabove.us

for more information, including an IR PLOG, setup with all the information and check-lists to keep you on-track just log on and take a look.

# Final Approach & the Drop-In

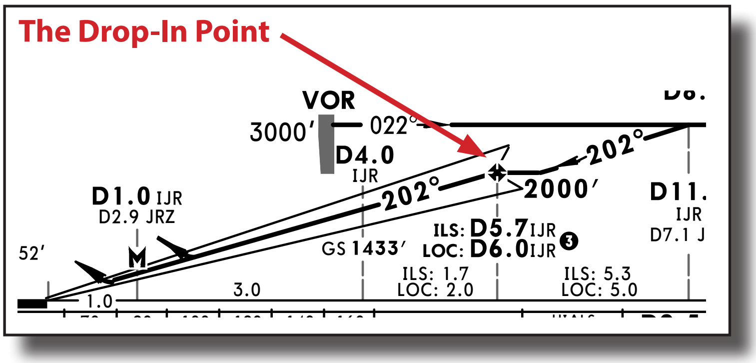
*"Do not allow a trend to become an error"*

## Introduction:

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

The Drop-In is the transition from level flight at the procedure "Platform" altitude onto the Glideslope, at the Final Approach Fix ("FAF"). This applies to both Precision (ILS) and non-precision Approaches.




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.

Throughout 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 / Track 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 me quick!**


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 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 3º 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 that the difference between a GS of 80Kts and 120Kts is only 200′/min. This is a **VERY** narrow range of vertical speeds, for a wide variation in airspeed. This tells us two things.

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

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 on a Glideslope 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 should consider **only changing 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 this is a pitch change of 3˚, not 3˚ down. Therefore, if for example, your AI was set when 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 achieve an approximately power setting of: 2000RPM (PA28/C172), 20" 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 a sensible reduction of power.

**Whilst still looking at the AI**, and without taking your eyes off it, whilst maintaining the pitch down pressure on the stick, 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 move, re-trim with feel only, without taking your eyes off the AI.

Having now set *approximately* the correct thrust, and the *approximate* trim, the aircraft should now without any further input *approximately* continue on the 3° 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* flying 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 complete reversal of your very first lessons for "Straight and Level" flight, we are now going to apply a different set of rules for flying, namely: "**Power for Speed, Pitch for Rate of Descend**".

If for example, 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 0.5° 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 in small increments of aproximately  100RPM, or 1"MAP or 5% Power, 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 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.

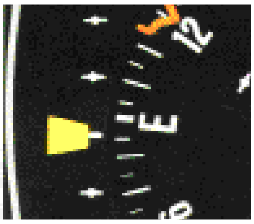

This equates to a groundspeed change of 10Kts, and anything greater could lead you to either overshooting or undershooting the target Glideslope.

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.

# Constant Descent Profile Approaches

*"Opinions are like ar**holes, everybody's got one!"*

Different schools and instructors preach different methods for teaching how to fly a constant decent profile approach such as an ILS or a CDFA on a non-precision approach.



Opinions vary widely, often dogmatically on the best method to use. I have been taught different ones myself at various stages of my career, and I have my experience of which works best for me.
Without wanting to become as bad as the others, let me simply share with you my technique that seems to work well for my students and gives consistently good results.

### VSI as a Command Instrument

This technique which I have alluded to previous sections, sets the VSI as being the Command Instrument for any CDFA or ILS approach. When flying on an ILS or RNP approach, then the Glideslope indicator is the secondary instrument that confirms an accurate glideslope path.

The Pilot, having worked out the Rate of Descent from the Groundspeed, focusses on maintaining an accurate RoD +/- 50 feet per minute after the Drop-In. If the approach is non-precision with lateral guidance-only (VOR / NDB / LLZ or RNP) this will ensure at the very least a stable flightpath. Checking every 1nm against the Approach Plate Alt/Dist table confirms the accuracy, or indicates a deviation accordingly.

In the case of ILS or PBN with vertical guidance, then the GLideslope Indicator is used to monitor the accuracy and developing trend of any error in the RoD on the VSI.

# Adjustments for Wind.

Descending from cruise/platform altitude to ground-level, there is likely to be significant vertical 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.

In-land it is more often the case that the wind, "backs and slacks" during the descent. In northern Europe that means predominantly a westerly wind.

However this can be reversed at coastal airports due to Sea breezes, Katabatic winds in mountainous regions or for Jerez, the influence of the "Levante", where this wind strengthens and backs as you descend.

The Levante by way of example can reach upwards of 40Kts at sea level, but be almost zero knots at 5000' from where you start your approach from the Hold. It can be a challenge!

# Flying the ILS

There are various different methods used for configuring aircraft with regards to flaps, undercarriage and power settings before starting a CDFA-style approach. What follows are my recommendations, but usually they are school-specific, so look at the SOP's for your establishment..

## 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** Drop-In technique.

The Seneca, when you lower the Gear will naturally want to drop 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 / LLZ

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 is to limit your heading corrections to the width of the Bug.

Bank the aircraft and turn so your heading is now on the edge of the bug. Roll 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 verbalise "*staying within the <new> Bug*".

### Glideslope

To recap on what has been said earlier, most students will start their ILS Approaches staring at and fixating 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 knows 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 Gauge/ 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 1**: 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.

**Solution 2:** Don't' take your eyes off of the AI until you have some gross trim to maintain 3˚ pitch-down.

**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 (that's 1100 Kg or 1.1 metric tonnes) , a DA42 is aprox 1.7 mTonnes and the mighty PA34 Seneca with 6 cylinders, 6-seats, 6-pack and 6-levers weights in at over 2.0 metric tons !

Say that again slowly and do not be surprised that 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 Groundspeed by no more than 10Kts at a time, then wait and monitor for ~1nm/30seconds . If after ~1nm, if a further change is necessary, then change again by no more than 50'/min or 5Kts.

Look carefully at the width of the "dot" on a mechanical AI. It is aprox 3˚ high, therefore limit your pitch changes to +/- half the width of the Dot, that is +/-1.5˚ and "*stay in the bug*" for heading.

## 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 a working wind-corrected heading "bugged-up", with the flaps/gear where you want them and your RoD calculated **BEFORE** you get to the Drop-In.

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 from 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 and then have added some patience, the Final Approach will become much easier.

# Preparing for the IR Skills Test

*"Plan the Dive, then dive the plan"*

## Planning is Everything

You have already been introduced to the Royal Navy's "6-P's", and the equally poignant motto of the British Sub-Aqua Club (BSAC); *"Plan the Dive, then dive the Plan"*, or perhaps even heard of Benjamin Franklin's *"A Failure to plan is a plan for failure"* .

Which ever you prefer take your pick, but if you fail to plan for your IR Skills test and it all goes horribly wrong because of a lack of planning, then you have nobody to blame but yourself.


Part of the reason for writing this final section of my Series on the Instrument Rating course is actually quite selfish. This document is available to every Examiner who tests my Students, and it is, in my own way, my own "*get out of Jail-free card".*

You see, by making sure my Students get a copy of this document, they cannot later claim to their Examiner or *bitch* to the Head of Training that "*my instructor never told me about this.....*".

Unfortunately having now invited you to read this Study Guide, that excuse will no longer wash, and I am, my friends, off the hook and *outta jail* !

## The Authority and the Examiner

### Myths

Contrary to popular belief, if you have been put forward for the Skills Test, there is the presumption by the Examiner (and the Authority) that you have already demonstrated the skills necessary to pass the test and therefore, by extension, you already have.

Your Examiner wants you to pass, they believe that you have already passed. My own IR Examiner went so far as to sign my IR Skills test sheet as a "Pass" before we had even taxied out of the apron with these immortal words:

> *"If John O**. *says you're ready for test, you must be; so if I die of a heart attack on the flight, you can just fill in the paperwork yourself when you get back*" (*John O. was my instructor)

What he really intended to do was to put me at ease, so that he could get the best out of me during the skills test. What it also means is that you don't really ***pass*** the skills test, you only stand to ***fail*** it.

In other words, you have already passed it, so you can only stand to get a "fail" or a "partial" by making some serious mistakes along the way.

### License / Rating Issue Forms

Fly In Spain, is fairly unique in offering training for both UK CAA and EASA licenses.

Each issuing authority has its own forms for issue of a class rating, licence or revalidation. Your examiner does not keep copies of all of the forms from all of the different authorities for all the different requirements.

Therefore go to the web-site of your state of license issue ("SOLI") and download all the relevant forms necessary for the examiner to complete on your behalf what it is you are applying for.

You are a Commercial Pilot (or at least training to be one), this is your responsibility, so take it seriously and be prepared with the correct paperwork. If you are training with FIS and your SOLI is Austria/Spain/UK or Malta, then the Ladies in Admin have these forms or can obtain them for you. For anywhere else, its for you to go to the Web site of the national authority.

### Test Notification

Check the available of your Examiner before booking the Exam.
Most SOLI Authorities require that they are informed in advance of any planned test.

This can range from 4 hours notification time up to 14 days! Check the SOLI AIP or even eMail the Licensing department for Notification requirements beforehand. One student I know had to retake their CPL skills test for this reason. NEVER assume that the Examiner has notified the Authority, as some are quite disorganised (sad to say!) and may forget. Ultimately it is your responsibility.

Check the web site of your SOLI for notification requirements and make your **Instructor** aware of any such requirement BEFORE you book your Flight Test, Exam or revalidation flight. Your Instructor does not carry around in their head the differing requirements of every EASA authority, so as a Commercial Pilot, you need to do this research yourself. Think 6-P's !

### Examiner Fees

Most Examiners are self-employed and will therefore need to be paid directly for the Test.

You should discuss with your Examiner their fees, and be prepared to pay the examiner in cash, in full, on the day, no excuses, no second chances. So make sure that you have their fees with you on the day of test.

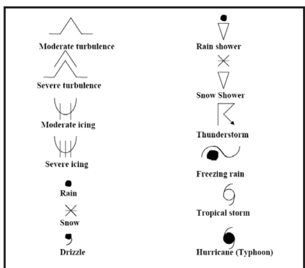
If you are unable to pay the Examiner, do not expect your paperwork to be processed.

### Examiner: Official Sources of Data

Before presenting yourself for Test, you will need to prepare a "Briefing Pack" of documents for the Examiner to inspect. The full list of documents can be found at the end of this document.

You must use official Web sites run by either the Government or an official Aviation Authority (eg Eurocontrol) and print off the raw data. By all means use other web-sites for convenience, but give the Examiner official printouts.

By this I mean, for example, print off the raw NOTAMS and be prepared to interpret them into English. You should print off the raw TAF's and METAR's for the relevant airports and be able to decode these as well. Significant weather chart symbols relevant to your flight should be highlighted.




In particular relevance to an IR Skills test are the Freezing Level (0˚c) and any forecast Freezing Rain and / or turbulence. Know your Symbols !

## Briefing Pack

Although legally speaking the ME-IR test is not *per-se* a Commercial-Pilot operation (*the CB-IR and En-Route IR for PPL's is a good example of this exception*), you should nevertheless approach the ME-IR as is it were a commercial operation and prepare for it as such. More information on how to actually accomplish this is given later.

The bottom line is that you should (*must if you are one of my Students*) prepare a "Briefing Pack" for the Examiner.

Flight Planning is a testable component of the IR-skills test. If you present a pack of properly-formatted preflight calculations, a prepared Pilots Log, Met, Performance charts and NOTAMs; your Examiner will be assured that you have prepared for the Exam.

This will be your first "tick in the box √" and you will have made a good start to the Exam. 

## The Test Profile

### The Story

One of the things that never ceases to amaze me is the complete lack of understanding of the IR Skills Test Profile. This is not necessarily all of the fault of the Students, some Instructors don't grasp it either, or fail to pass it on.

So like any good story, we shall start at the beginning with a modern-day Fairly Tale of the young Pilot (*the brave Knight*) saving the Princess (*a photographer*) from the inevitable Dragon (*bad weather*) with two Donkeys (*engines*) to help him *[1].

So here is the story.....

> *The pilot (you) is working as an Air-Taxi driver, who has been hired to take a photographer on an assignment from departure airport **A**, to a destination airport **B**. The weather en-route is particularly bad with icing forecast above 3000', snow and fog forecast but not currently present at airport **B**. Cloud is overcast at about 800' AGL at both **A** and **B**, RVR is marginal at 900m.*
>
> *You have planned an alternate landing airport **C**, which you can reach if the weather deteriorates at airport **B** below minimums. You will depart with a SID from **A**, arrive at **B** (preferably with a STAR, but if not Radar Vectors) and attempt an ILS Approach.*
>
> *Unfortunately at DA, the cloudbase is lower than the DA so you must go-around. Once the undercarriage is up, the flaps are up and you are above aprox 700' AGL one of the "Donkeys" will quit and you will have to carry out an EFATO exercise and safely secure the aircraft and recovery asymmetric.*
>
> *You will then divert to your Alternate Airport, enter the Hold as the weather has temporarily closed-in and RVR is less than 700m. One, maybe 2 holds later, the RVR rises to 900m and you carry out a non-precision approach, which again will be below Cloudbase limits at MDA, so you need to initiate an Asymmetric Go-around.*
>
> *At which point the weather will miraculously clear up to VFR, and you will be invited to carry out a visual circuit to land whilst Asymmetric.*

** If this is starting to sound like a script for the next Shrek movie, you're not far wrong!*

## In More Detail

In one respect, the ME-IR skills test is like a well choreographed dance between you, the Examiner and Air Traffic Control. Much of the Exam will follow set-piece manoeuvres, yet you will also be expected to be able to offer some "free-style" flying that makes this "dance" more of a "Tango" rather than a "Foxtrot".

In order to get the best from you when you are still "fresh" the Examiner will usually try and arrange for the first Approach to be the Precision Approach (ILS), with the Hold and Non-Prec approach being the second at the "alternate" Airport.

For operational reasons this may not always be possible (*ATC restrictions usually being the main reason, change of runway, availability of Beacons etc being the others*), but in any case be prepared for change, have the full set of Plates available on your kneeboard and have the capacity to be flexible in the air.

One of the main reasons for me not signing-off my Students as "ready for test" is their incapacity to deal with changing circumstances.

If as a student you can only cope with a single flight profile like:

EGSL -> EGMC -> Radar Vectors ILS -> SND -> NDB App -> EGSL

because that is all you know, then you are **not** ready for test. So with that all said...

Let us now go over this "Dance" in more detail.

## The Examiner

The Examiner is prevented from intervening in the safe conduct of the flight, because if they have to, it is an automatic "fail".

The Pass / Fail criteria for a Skills Test are well documented, published and enforced. However there is some latitude on how they conduct the test.

Some Examiners will brief you that they should be considered to be like an 80-year person, unable to assist or participate in any meaningful way in the conduct of the flight.

Some Examiners offer that they can be treated as a "helpful passenger". That does not mean you have to start a long conversation with them, but asking them to check for ice on the wings or possible bad weather is acceptable.

If you lack an Autopilot and you need to briefly (and I mean briefly) hand over the controls to them whilst you re-arrange some Approach Plates or pick up a dropped pencil, they may consider this acceptable.

However make it clear what you are doing first with a "*You have control/ I have control*" handover and make sure you have briefed them first.

However NEVER assume you have a "helpful passenger" next to you, and if its not offered, then pretend you have a deaf, dumb and blind old lady of 90 sat next to you, who will only notice your mistakes.

Play it safe..!

## The Standard Instrument Departure ("SID")

The first stage is the SID from your departure Airport , which is procedural flying and you are being tested on the ability to interpret and fly a procedural departure. This will be followed by an en-route section.

If your airfield does not have a published SID (e.g. it is uncontrolled), then a visual departure will be made with a IF clearance to remain outside of Controlled Airspace with a suitable limit on Altitude and position.

If this is the case, then on leaving the ATZ of your departure, you will call Regional ATC for further clearance.

The Examiner may elect to put you "under the hood" at this stage, in which case they are then responsible for collision avoidance.

In northern Europe, the en-route section may actually be on Airways, in but in southern Spain, there are few suitable Airways and the test routes too short to warrant them.

So plan your flight (include it in the Flight Plan) to get to a Flight Level on Standard Baro (1013.2), this will satisfy the Authority that you have at least attempted to fly something close to an Airway Standard.

Your Examiner has some latitude on this subject and will not penalise you if an Airways clearance is not available from ATC.

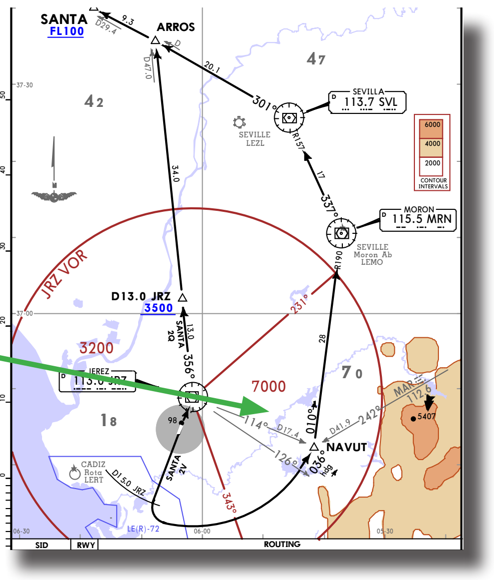
Check the Semi-Circular rule for your country (which at the time of writing), the UK, France and Germany use an North-South split of the country, but Spain and Italy it is East-West.

So for headings in Spain of 270˚->090˚ (heading northerly) you fly under IFR on "Evens" (6000', FL080, FL100 etc) and if flying southerly (090˚->270˚) then you need to fly "Odds" (5000', 7000', FL090, FL110 etc).

By way of example take a look at the SANTA 2V departure from Jerez on the right. Although the initial track is South, the actual complete SID is actually Northerly, it is only the first section until you reach the the DME Arc that is in a Southerly direction.

Therefore you should select the first available Flight Level above the MSA, which at NAVUT is 7000', so on a Northerly track that means FL080.

So file your flight plan for FL080.




In an SEP (PA28 / C172) you can expect to take about 15 minutes getting to FL080, but at 90Kts you will not cover too much ground.

In a MEP (DA42/PA34) you can expect to arrive at FL080 in less than 10 minutes, so why not?

Either way, by filing for a Flight Level you will satisfy the Airways section of the test, and as Turbo-charged engines are more efficient at altitude and the climb-rate in an MEP is not prohibitive, this is a "commercial preference".

Another tick √ in the box 

# En Route

## Top of Climb ("ToC")

The ToC is often (not always) the point of transition from the SID to the En-route section of the test.

This is especially true if no official SID exists (non-controlled Airfields) or direct injection into an Airway occurs. Either way it is a good place to clean up the aircraft and prepare for the en-route section of the test, but Safety-First, check the MSA.

# MSA

At ToC, one of the most important checks is to confirm the achievement of Minimum Safe Altitude ("MSA").

MSA achievement can be checked in four main ways:

- SID Sector
- Radar Sectors
- En-Route
- Grid

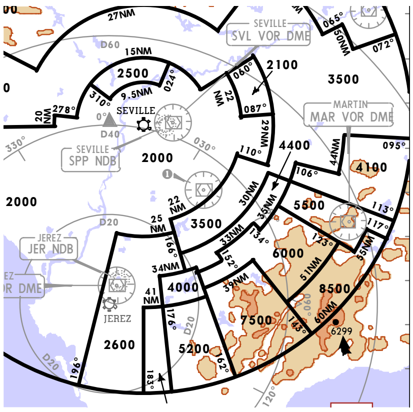
### *SID SECTOR*

In the SID previously discussed (SANTA2V), the MSA for the SID is given by "safety sectors" and their accompanying radials from a beacon (in this case JRZ). The RMI/OBI can be setup to indicate passage across the sector boundaries as a QDM to a Beacon.

For example in the case of the SANTA2V, the passage of QDM 343˚indicates entry into the 7000' Sector whilst the DME Arc is being followed. This is a smart use of the avionics and indicates to the Examiner superior understanding and use of the equipment.

### RADAR SECTOR

The Air Traffic Controllers when giving Radar Vectors rely on a Radar Sectors chart similar to the one shown left for Sevilla that is based upon the SVL VOR Beacon.




By way of example, if you know your radial and DME distance from the SVL then you can monitor the changing MSA along your route.

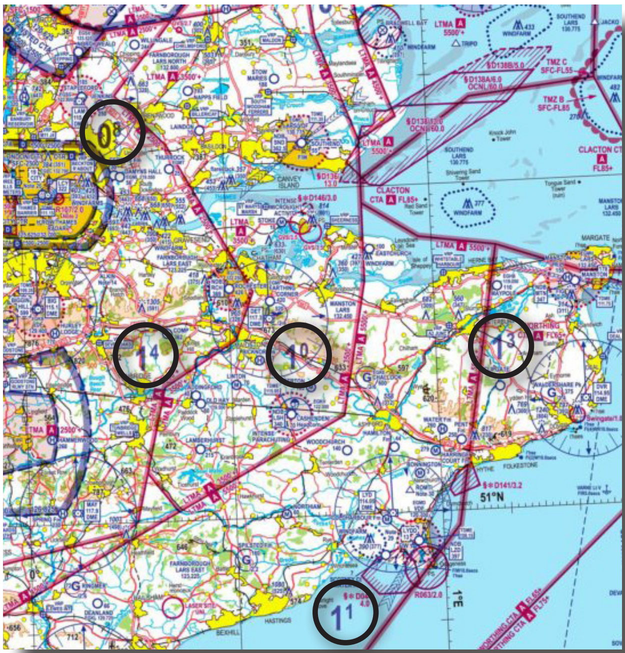
If you take the time to superimpose your SID on a Radar Sector chart prior to flight, then this method offers one of the least restrictive MSA's to you.

### *ROUTE MSA*

If your climb-rate is compromised (high density altitude, full fuel-load, carrying an extra passenger, flying a SEP) you may not achieve Sector MSA. If this is the case then a course MSA can be used, which will be likely to be the least restrictive route as it will cover a smaller area than the SID sector and possibly exclude some other obstacles or terrain.

For this you will have needed (some time before the flight) to have superimposed the SID on a topographical aeronautical chart (half-mil is perfect). Then for an area 10nm either side of the track, look at the highest terrain/obstacles, add 1000' (2000' in mountainous region or above 5000') for a "Route MSA".

This is the same as the technique to be used for Off-Airways navigation (see next section).



### *GRID-SECTOR*

Lastly, and most restrictive are "Grid-MORA's".

These are derived from the grid-VFR minimum altitudes designed for VFR flight that can be found on a "Half-Mil" topographical VFR Chart.

They are shown here on the UK CAA half-mil chart on the left inside the black circles for each Grid.

As with a Route-MSA, you need to add 1000' to the Grid safety altitude (2000' in mountainous regions).

This is the least desirable method because it generates the highest MSA of all of the methods and you might be icing-limited, but when off-Airways it can be the quickest solution.

## ToC, Engines and Clean Up

At ToC you will need to "clean-up" the aircraft. This will include setting Cruise Power, checking T's & P's, updating your PLOG, checking engines and looking out the Window.

Depending on the Aircraft this could also mean closing Cowl Flaps, leaning the Mixture or checking and engaging the Autopilot.

Finally note the time in the ToC section of the PLOG and update (if necessary) the next ETA.

So why *looking out the window*?

Well depending on the actual weather when you test, you may be forced to take your test when there is the risk of light icing or predicted towering cumulus (TCU). None of which may necessarily give cause for postponement of the test as such.

However in such circumstances check for icing, if in clear air or stratified cloud, look for Cumulonimbus (CuNb) clouds that have developed from the TCU.

If scattered thunderstorms (TS) were predicted and there might be one in your path, be prepared to divert. If widespread embedded-CB's are predicted it is probably better to postpone the Exam, but if they are isolated then an Exam can still go ahead, just keep your eyes open.

Remember your Examiner is supposed to be a "helpful-passenger". Every so often ask them to check for Ice and clouds. If in CAVOK conditions they will soon tell you it is unnecessary and that you don't need to keep asking and its another "tick √ in the box".

Of course if you do find yourself in icing conditions (you will have predicted this from your Met planning) and your aircraft can cope with light icing, and a descent is imminent, then continue. If MSA requires further climb or if in ANY doubt of the aircraft anti-icing capability, be safe and discuss this with the Examiner.

If MSA allows a descent below the icing level and ATC allow it and the Examiner agrees, again then carry on. Otherwise divert back to base and cancel the Exam. Think good airmanship.

## Off-Airways Navigation

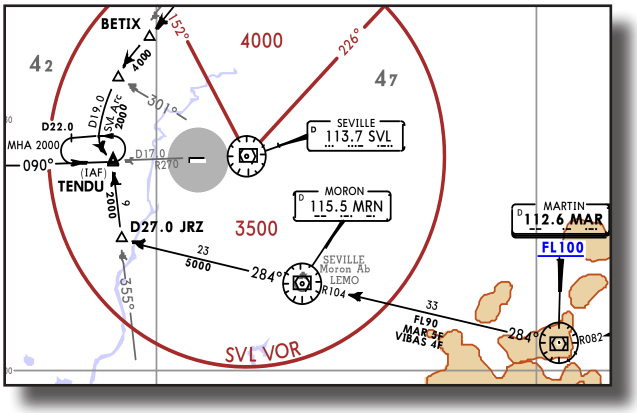
At some stage you will leave the SID for either a STAR (*highly unlikely given the truncated nature of the Skills Test*) or more likely directly towards a Beacon/Fix for the Intermediate Approach Fix (IAF). This is known as the Off-Airways Navigation section of the Exam.

There are two "gotchas" waiting to trip you up, namely "MSA" and "Single-needle" tracking.

### MSA

As with the Top of Climb section, the Off-Airways section needs attention to the MSA. There are four ways you can do this:

- STAR Sector
- Radar Sectors
- En-Route
- Grid




The STAR Sector method uses Sector MSA's just like a SID sector does, so the same technique can be used.

As can be seen on the right (the **MARTIN5F** STAR to LEZL) if routing to the IAF at TENDU from the Martin VOR (MAR), once you have reached the MRN VOR at Moron, then the MSA becomes 3500'.

The beauty of this technique is that whether you fly to TENDU direct, or via the JRZ355/27D fix, you can be assured that the MSA is 3500'.

If you do not have a convenient STAR you can use, then for the Off-Airways section, you can use a Radar Sector chart, or prepare a Route MSA before the flight or calculate a GRID MSA as explained in the previous section.

If your SID Sector chart overlaps the STAR Sector Chart, your planning job just got a whole lot easier !

### Single-Needle Tracking

If at the end of the SID / Off-Airways navigation you are routed direct to a Beacon, then Single Needle tracking skills will be tested, if a Fix then your GPS mastery and knowledge of your GNSS equipment will be examined.

The Single-Needle tracking exercise (unlike the well-choreographed dance that is the EFATO) is never official announced and can creep up on you when you are least expecting it.

It usually starts with an innocent-sounding request from ATC like "*Dingbat69T, route direct to EVA*"

If EVA is a VOR or an NDB, look at the QDM and turn towards it. Whilst in the turn think about where the wind is coming from and make an initial, sensible correction for wind-corrected heading using Single-drift and Clock Code (see "Holds" for an explanation of this).

Once you have rolled out, you can expect the Examiner to lean over and make a note of the QDM. You need to do the same, write it down and maybe even verbalise the fact.

Now you have to track towards that beacon +/-5˚of QDM all the way there. Do not Home to the Beacon, but try to quickly establish a Wind-Corrected heading that maintains the QDM.

### Single-Needle Tracking (contd.)

When you get to within 3-5miles of the Beacon the Examiner will lean over again and look at the current QDM to see how accurate you were. This is a testable standard with a number attached to it (+/-5˚) so if you end up 30˚ off QDM it is technically a fail!

### RBI's and ADF's

The ADF on an RBI is a notoriously difficult instrument to use. They are usually poorly damped and suffer from hysteresis. Add to that NDB Antenna "Dip" and a bit of turbulence and you have a job on your hands to accurately fly them.

This is the bad news. The good news is that the Examiner will have an equally difficult time reading the instrument as you, plus that they also have to cope with a parallax error from their right-hand seat.

That said, if you make sensible and proportionate modifications in the correct direction, you can expect some latitude from the Examiner. The key here is to monitor your progress every 2-3 minutes and if starting to drift and get off-QDM, do something positive to correct it.

If, for example, the needle is falling to the left (rotating "anti-clockwise"), then say "*needle falling left, turning more left to counteract*". Even if it is turbulent and the ADF is unstable, it indicates to the Examiner you have noticed the drift and at least know what you are supposed to do, even if your are struggling to achieve it.

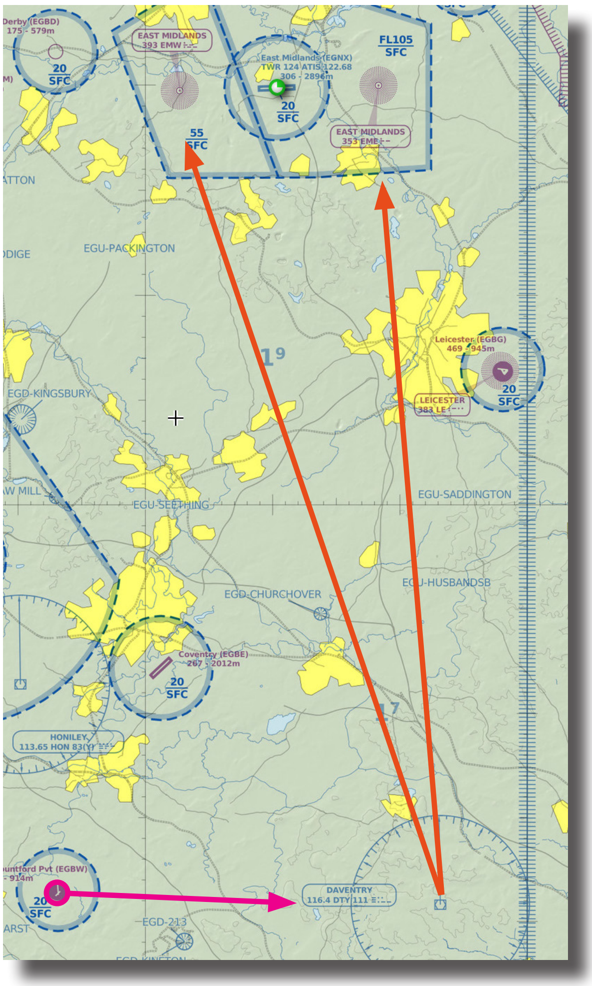
Say nothing, do nothing or give the impression you haven't notice a drift off of QDM and the Examiner will assume you don't know what you are doing. Not good.

## Planning the Descent and IAF

### Which Route ?

Before you complete the En-route section, you will need to know which runway is in use at your Destination. If the wind is light and variable, or at 90˚ to the main runway, then either runway could be in use.

Seen on the right is the Chart for southern England and a possible route to East Midlands Airport (EGNX) from Wellesborne (EGBW, bottom left) via the Daventry VOR (DTY).




The issue is, East Midlands Airport is serviced by two NDB's, "EME" for RW27 and "EMW" for runway RW09. On reaching DTY, which one do you fly to?

The answer is ATIS, so in advance of reaching DTY, you need to get the latest ATIS from EGNX and plan the route from DTY to the airport .

If you are really smart, you will have anticipated this on your PLOG with two route-rows, one for the route DTY->EME and another row for DTY->EMW. This is shown later in "PLOGs".

Then it is a simple matter to use the one that is pertinent and ignore the other. The end of the Off-Airways Section is usually the Intermediate Approach Fix ("IAF") and then a Precision Approach.

### IAF and Hold

If there is a lot of Commercial traffic going into the Airport they will be given priority and you can expect to be held at least 3000' above their approach height beneath you.

If you have to pre-book your Approach (many UK Airports require this), then although you won't get priority over a A320 that is late or early on an Approach, ATC should otherwise offer you a "clear slot" when you book the Approach (usually by telephone to the Tower).

This enables them to be accommodating and potentially offer a Radar Vectored, straight-in approach and in doing so significantly reduce your workload. They should, if they are really helpful respect the "Tango" (test) Callsign and be "kind" to you and offer an expedient Approach.

That means you need to plan a descent from your en-route altitude down to the IAF / Hold altitude. So best practice is when cleared direct to the Beacon/Fix/IAF ask ATC for a descent earlier rather than later.

If the descent platform you are given is above MSA for this section of the flight, you only need to comment on it. If not, then plan for it.

Either way, once you have been you given your descent platform, plan a descent rate that gets you to this platform altitude, so that you arrive about 1nm/1 min before the Fix/Beacon all of the time remaining above MSA.

There are various methods used for calculating Descent rate, your instructor will teach you their favourite, but constant RoD and time is mostly intuitive. Constant RoD and Distance is the other.

> **Example (Rate & Time):** When cruising at FL080 and cleared to 4000' with a descent rate of 500'/min, you will need (8 - 4) x 2 minutes {8 minutes} to descend. If you have 12 minutes to run to the IAF, then start your descent in 4 minutes. No wait!, Remember you need to arrive at platform about 1nm before the Fix, so deduct another minute for simplicity. So start the descent in 3 minutes from <u>now</u>.

## Intermediate Approach Fix & The Hold

The end of the Off-Airways Section is usually the Intermediate Approach Fix ("IAF").

Expect to be able to go straight to the ILS, but be prepared to enter the Hold at the Fix/Beacon and plan for it. Planning is everything, so at least 10 mins before the fix work out the Max Drift, Single Drift, Outbound Drift and Gate position BEFORE YOU GET THERE!

When you are in the Descent or Hold, check the ATIS, make a decision on the Approach Ban and call for the Approach from ATC when <u>**you**</u> are ready, not them! Remember and respect Altitude clearances +/- 80' and treat Procedural platforms as if they are made of concrete. That is -0' / +100'.

The ILS should be straightforward with the "BUMF" checks carried out in the Procedure Turn / Racetrack / Final Vector.

Remember for Applied IF, the "U" in BUMF is for "U-Turn", that is the Missed Approach procedure. Don't assume it is "standard", it rarely is due to commercial considerations, so ask with plenty of time at your convenience and when you have "capacity".

## Intermediate Approach Fix & The Hold (contd.)

If you forget to ask for the M/App instructions a good controller will be helpful and give them to you, but "Murphy's Law" usually dictates they call you when you are least expecting it and when you are not ready to scribble them down.
If so, just suck it up and deal with it if that happens. If not ask for the M/App-Procs if you don't get them.

Very occasionally you will not be given the standard M/App Proc, or even a default one, but actually a SID. So make sure you have the SID's for the approach runway available for this eventuality.

## ILS, Drop-In and EFATO

The standard form of the Dance is for the first approach to be a Precision ILS with both engines. It doesn't have to be, but usually is. This is done to try and get the best from you.

Remember your SOE's for the aircraft you are flying, calculate the GlideSlope (GS) descent rate from the groundspeed (i.e. RoD = groundspeed x 5) and concentrate on getting a clean and accurate Drop-In.

Before the flight check the PoH, is there a PEC applied to the Altimeter? If so apply it to the Decision Altitude (DA), but mention the fact either during the Approach (*not the best place*) or during the pre-test briefing (*much better*). Then stick to it. Bust your DA and expect a fail. Go around 100' before DA, expect a partial.

Just before the DA (~50'), look up, say "*nothing seen, going around*", this ensures that the "Decision" is made **at** the Decision Altitude.

Apply power and pitch simultaneously, such that maximum thrust is achieved as the nose of the aircraft / dot on the AI, crosses the horizon and then continue to pitch up for aprox 10˚.

## ETAFO

The EFATO should really be called an EFAGA (its a Go Around not a Take-Off !) but either way this routine should be carried out from memory and will occur after the Missed Approach from your first Approach mentioned in the previous section.

Due to your proximity to the ground and other safety factors, your Examiner will not cover the throttles and "fail" an engine until the undercarriage is safely up, flaps retracted and you have climbed above 700' AGL.

So take your time to get the aircraft settled into the climb, on heading, correctly configured and at climb speed before you raise the last stage of flaps as you know what is coming next !

The Examiners kneeboard will come out, the throttles will be covered and one of your "*donkeys*" will die.

You will have practiced this exercise many times before. In the Sim, in the aircraft, lying in the bath, lazing on the beach, in fact anytime you have free time.

So having got the Engine Failure checks firmly embedded in your cerebellum, don't rush the checks, but equally don't look hesitant, and before presenting for test, absolutely practice, practice, practice this manoeuvre in your head, on the drive home, on the train or bus, so that it is SLICK !

If ATC start talking to you whilst you, the brave Knight, is trying to stabilise and secure your half-failed flying steed, just say "Standby".

## ETAFO (contd.)

You have a "Tango" call-sign on test, so a good ATC should probably guess you are dealing with an engine failure on the Go-around, certainly UK Controllers are well used to the test profile and will usually be extra-helpful to the "Tango's" and keep quiet until you talk to them.

Remember, Aviate, Navigate and Communicate in that order. Control the Pitch, Roll and Yaw. Stay inside your Heading Bug for Obstacle clearance and the speed at the Blue line (Vyse) for safety above Vmca and best rate of climb.

**Maintaining control of YOUR Aircraft** exceeds all other priorities, so if you are feeling overwhelmed, and you are getting bullied by an impatient ATC; be firm, un-flustered and commander-like whilst remaining in control, this will impress the Examiner.

The M/App-Proc will likely result in the controller getting you as far away from his much-more-important commercial traffic as quickly as possible, so do not be surprised to be given radar vectors that are 90˚ from the runway heading. Also expect a routing direct to a fix or beacon, so its back to Single needle tracking again.

Remember everything is a touch drill.

Once you have identified the failed engine, the Examiner will likely give you full power on both engines to enable a sensible climb rate up the cleared altitude that ATC gave you.

## En-Route Diversion Section

Having failed to land at your destination, you are now going to fly to your Diversion Airport.

"T*he Lord giveth and the Lord taketh away*", so expect the Examiner to set "failed power" to simulate a feathered propeller once you have reached Top of Climb. Therefore be careful with using the Rudder trim, and don't over-compensate.

According to the Fairy Tale, you should now carry out a diversion to your Diversion Airport "C", in reality this is very uncommon unless it is very close to your departure Airport or your departure does not have an official approach. If your home base is itself an Airport, the diversion will normally be back to your Home base ("A"). Either way plan for a Hold and a non-precision, Asymmetric Approach and go-around.

Non-precision will most likely mean either a Localiser-DME, VOR, NDB or a PBN/RNP approach. If its an RNP Approach, you just hit the Jackpot and so long as you pass it, you will not have to carry out a separate PBN endorsement later in the Simulator, saving you some money and time.

On the route to the Fix/Beacon, you are usually flying Off-Airways, so know what your location is and have a Topographical chart or Radar Vectors Sector map available to check (and comment on) your MSA en-route. This is no different to the previous Off-Airways section.

Use as much power on the live engine as it takes to maintain Altitude. With only one engine you will have lost aprox 80% of your climb capability, so it is much harder to regain height if you lose it, than it is to maintain it.

If Single-Needle tracking, expect the Examiner to lean over and check your QDM as they did before. If you made a "hash" of your first attempt at Single-Needle tracking, this is an opportunity to put that right and fly a much better track.

If the first tracking exercise was good, don't let your guard down and make a *hash* of this one . Work out your wind-drift, apply it and then Track +/-5˚ to the Beacon and maintain this QDM all the way to the Beacon.

If there is Hold coming, plan for it and get prepared.

## Limited Panel & General Handling

### Limited Panel

The General Handling stage of the test usually takes place after the first approach and during the transit back to base, in other words it breaks up the "En-Route Diversion Section".

If taking a MEP-IR Skills test then depending on a number of factors:

- Have you passed your Single-Engine IR with the same Examiner in the last few weeks?
- Have you also passed your MEP Class Rating Exam in the last few weeks ?
- You are flying like a true "sky-god" up until this stage of the Exam ?

Then you may get lucky and not be asked by the Examiner to carry out some General Handling.

Otherwise if you hear the Examiner talk to ATC and say something like "*XXX Control, Dingbat69T wishes to cancel IFR for 10 minutes"*, then you will be expected to carry out some general handling under the Hood.

The first exercise is **Limited Panel** work which simulates a Vacuum-pump failure for a 6-Pack analogue display, so the AI and DI cannot be used usually with the use of suction cups to blank out the two instruments. Flight is maintained by use of Power/ASI/VSI and TurnCoordinator/Compass.

If in a DA42 with a G1000 or similar, the whole PDF is covered up with a panel that is velcro'ed into place with sole reference to the standby analogue instruments.

What will follow are the Limited Panel exercises you covered at the beginning of your IF Course, namely

- Climbing and Descending
- Timed and Compass Turns
- Unusual Attitude Recovery (*General Handling*)

There is nothing unusual about the Exam requirements and is a simply a repeat of the exercises your Instructor took you through during your early Applied IF lessons.

Once the Limited Panel and General Handling are out of the way, it is back to "En-Route Diversion" for the Second Approach.

## Second Approach

Once at Airport "B"'s Beacon, if you flew a good Hold at the previous Airport, the Examiner will not, unnecessarily, want to torture you with another for reasons of time and expediency. If however you had a straight-in Approach at your first Airport you will certainly get one Hold for the second Approach.

If a previous Hold was sub-standard and the rest of the flight is of a good standard, the Examiner may be kind and give you the opportunity to redeem yourself and get it right this time by flying a second hold .

Alternatively ATC may have other ideas about you carrying out a "straight-in approach" as they might have Ryanair on a 150-mile final and they get priority. As always, plan for the worst, and hope for the best. Either way just deal with it and fly it well.

Carry out all the BUMF and Approach checks as before and don't skip anything. Get the M/App-Proc, but don't be surprised to hear your Examiner talk to ATC for a revised visual circuit to land.

When you are cleared for the second Approach (having checked the ATIS, checked the Approach ban etc) you will need to factor in that you have less power to overcome the drag of Gear, Flaps and possibly Cowl flaps, so follow the SoP for your plane, or the notes in the Appendix of these Student Notes for when to "dirty-down" the aeroplane.

### Asymmetric Approach

The Asymmetric Approach will not feel very much different from a Symmetric one as you will be using low power settings so the asymmetric differential will be less.

This is why I suggest you are prudent with the use of Rudder trim en-route, as now with low power and too much trim, you might find yourself pushing with the "wrong" leg as you may have over-compensated with the rudder trim in the cruise.

If you are carrying out a CDFA-style approach on a non-precision Approach, check the plate to see if the MDA is modified for CDFA approaches. If not, then if using CDFA, then your MDA just became a DA.

Mention this to the Examiner. As before you are going around at MDA/DA (even if CAVOK) into an Asymmetric Go-Around.

### Asymmetric Go-Around

The Asymmetric Go-Around is a opportunity to really mess things up, so follow the drill to the letter, apply power and pitch simultaneously, such that maximum thrust is achieved as the nose of the aircraft passes the horizon.

Maintain horizontal and get the Gear and flaps up immediately, don't over-boost the live engine and keep your heading inside the Heading Bug and speed at the Blue line. Don't forget 5˚ of bank towards the live engine.

As the drag is reduced from the retraction of the undercarriage and flaps, the aircraft will start to accelerate above the Blue Line (Vyse), but don't let it.

Gently pitch upwards to maintain Vyse and the aircraft will settle (most likely) at approximately 5˚ pitch up with a  positive rate of climb.

## Asymmetric Landing and ACA Checks

What follows next is most likely a visual circuit to land, whilst Asymmetric.

Many students feel a great sense of relief when they "go visual" and forget they are still under test and this circuit is still being examined.

Do not "let your guard down", stay focussed, as it will all be over soon.

Fly an Asymmetric circuit, if flying a 6-Lever craft, verbalise the "Red's/Blues/Greens" on Base and remember to verbalise on Final and at above approximately 600' AGL, the Asymmetric Committal Checks:

> **"Stable - Gear - Clearance - Clear"**

Assuming of course that your approach **is** Stable, the Gear **is** down, you do actually have **3x Greens**, the Tower **has** given you a Clearance to Land and the Runway **is** clear of obstacles, then...... you will land.

Sometimes once you have called out the "ACA Checks" the Examiner may take control and land the aircraft.

Don't be concerned. You already have an MEP rating so this has already been tested and as far as I know, is actually outside the scope of the IR Skills test.

Its not a problem, its just that so many Examiners spend their time watching other people fly, they like to gets some "hands-on" of their own and this is the only opportunity they get to the fly the plane.

So take pity on them and enjoy the landing !

### Taxiing In

When off the runway, stop at the Hold, carry out the after-landing checks and if you have passed, your Examiner should lean over and shake your hand and congratulate you.

Then just make sure you don't mess it up and hit something on the Taxiway on the way back in all the excitement !!

> *The brave Knight finally delivered the Princess, has beaten the Dragon, even handled a dead-donkey and after the paperwork was completed, they all lived happily ever after.**

### Proper Planning Prevents..........

Before any of this flying could take place there was some significant amount of planning carried out.

This is the subject of our next section.

** For those who would prefer it, we do also have a woke version where the brave Princess Pilot rescues an ambidextrous one-parent family from a misogynist politician whilst handling a expired whale. Who said we are not inclusive?*

# Flight Planning

## Logic is Everything

The more planning you do, the faster, more accurate and better you will become.
Therefore plan a full route with M&B , Performance etc, even if your are just flying a Simulator session.

A structured logical approach to planning will save time and reduce errors. Some of the planning can be recycled, so is not wasted time.

Good planning will also "upload" to your subconscious the task in hand , which will assist later when you fly the route as you will be familiar with it. Its like pre-loading "deja-vu".

If you follow the following logical approach, it will improve your situational awareness and increase your capacity for the unexpected on test. Most importantly the familiarity of Planning will de-stress you as you will have done the planning at least 6 times before presenting yourself for test (more if you practice during your SEP-IR phase).

The starting point for your planning is the route. Your examiner will usually tell you the route one or two days before the Exam, or will choose a "standard" route. You should always have at least 24 hours before the exam to prepare your plan.

### The Route

Start with a 500,000:1 ("half-mil") VFR Chart and plot out the SID, en-route and possible arrivals. This should not take too long as transferring a SID can be done by using the Radials/Distances from the VOR's marked on the chart, and even DME Arcs can be quickly approximated. SIDs & STARs are not to scale, so drawing out the tracks will give you a better sense of the length of the route and the times between legs.

As a Commercial Pilot on an Air Taxi service would you do this? Absolutely not, its unnecessary, but as an inexperienced IR-applicant anything you can do to give you better situational awareness that is not explicitly banned, is fair game! If you are performance and MSA limited this effort may give you a better Route MSA, which as mentioned earlier is the least restrictive.

For your first Destination Airport #1 it may have two beacons that serve different Runways (eg *VOR1 for RW04 and NDB2 for RW22*.) These will be the Intermediate Approach Fixes ("IAF") for their respective runways.

So draw two lines from the last guaranteed, immovable fix (probably a RNAV waypoint or VOR on an airway or SID) to both of these IAF's.

From a planning point of view you want to include fuel, distance and time calculations for both Approaches to RW04 and RW22, but obviously one will become redundant on the day of your flight.

Of course you cannot know which one is redundant until you know what the wind is for the day of your test. In a worse-case scenario the wind might be light and variable at your destination and the runway may change due to commercial operations (think Sevilla). Therefore the earliest you may know which Approach/ Runway is in use, is in the cruise, by obtaining the ATIS at the destination.

Failure to plan has caused many a "partial" as the Student under test becomes overly stressed at trying to re-plan for RW09 when they were absolutely certain it was going to be RW27! They then miss an ATC descent call, fail to arrive at the platform they were told to be at, or worse still cause a re-direct of another aircraft.

The Examiner may strongly hint at the progressing mess of a situation, but may not intervene.

As a  candidate for the Instrument Rating you are expected to be able to cope with the unexpected. You are certainly not expected to plan for EVERY possible contingency, but what you certainly can do is plan for some likely or semi-expected changes.

Follow this advice and you will at least have some spare capacity for a change in the Arrival.

This way, the only planning you need to do on the day of the test, is Ground-speed and Wind-Corrected heading for the Wind and the altitude you will actually fly on the day.

Now you need to repeat the above from Destination Airport #1 to Alternate Airport #1 and from Dest #1 to Alternate #2.  You now have a Route Plan.

## Meteorlogical Planning

Having planned the route, the next step is to get the Met for the flight.

This can be done with relative certainty the night before the test. The Authority will want to give you the best chance of passing the Exam, and therefore you will not be  expected to fly in severely turbulence or moderate icing. Any prediction of Cumulo-Nimbus en-route will be considered reasonable grounds for delaying the Exam to another day and will show good airmanship.

Many light-twins have anti-icing / de-icing, but depending on the individual aircraft may not be fully operative. Where the aircraft does have full icing capability, do not plan to enter anything other than light icing and only then for short periods.

### Forecast Met for the Route

Create an area brief for the whole of the triangular route you may intend to fly (including diversions). You will need to obtain Lower and Upper winds and significant weather, together with trends +/- 1 Hour either side of the Exam start and finish.

### Spanish Met

In Spain, for example, go to to: `https://ama.aemet.es/generacion-de-ruta` to create a Route plan.

- For Fly In Spain students, enter the departure (eg: "***LEJR***") destination and alternate.
- Select "***Peninsula Iberico, Baleares Y Mellila***" information to show, select "***All***"
- Click the checkboxs "***SIGWX charts***" and "***Wind and temperature***".

In the selection menu, use the Control key to multi-select the "***FL020-spain***", "***FL050***" (and if expecting a routing above FL080, then the FL100 option as well). In the "***Schedules***" area, enter the take-off time in the "***UTC Time of departure***"  -1Hour (less one hour) in UTC of course, and in the "***UTC Time of Arrival***", put in your estimated time of arrival +1Hr.

Once you have generated your route, go to the "All" tab and just below it is an icon with the Adobe PDF symbol in it. Click on this and a downloadable PDF is generated from which you can print a weather briefing pack.

Another tick √ in the box. 

Do not assume you will always be Holding at 3000',  if, for example, you are in the Hold at JER for Jerez and Commercial traffic is inbound to RW20, ATC will often force you to climb to 6000' for separation, they really don't trust us you see!

For this reason you need the winds aloft for the most likely altitudes, so for a test profile that will be 2000', 5000' and possibly (but rarely) FL100 for a Hold at 8000' (it has been known).

## TAFs and METARs

You will need to obtain TAF's and METARs for all your relevant Airports, so print them out.

You need to be able to interpret raw TAF's and METARS. For example can you decode this?:

```
TAF EGSS 130502Z 1306/1412 24010KT 9999 FEW030
TEMPO 1310/1318 25015G25KT
TEMPO 1402/1408 7000
PROB30 1403/1406 3000 MIFG BR
```

Your Examiner may ask you to interpret raw data, so practice!

Another tick √ in the box. 

## OGIMET

Go to **www.ogimet.com** to create a "Gramet Aero". In the Selection Box list the Airports in order of arrival.

For example ***Jerez->Sevilla->Granada*** (the diversion) is entered thus: "lejr_lezl_legr"

The Gramet will include the freezing level, cloud-bottoms and tops in the diagram and the terrain.

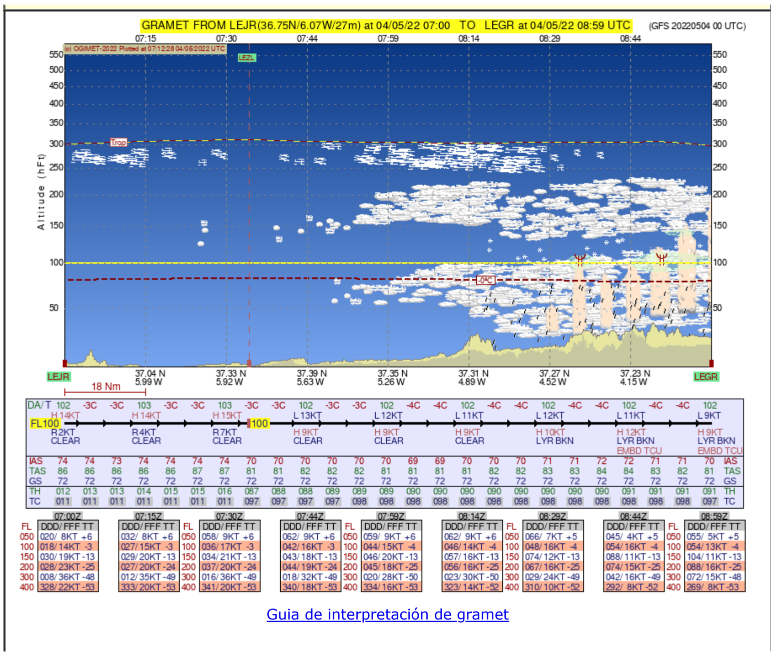
Print it and bring the Freezing Level to the attention of your Examiner and comment on its relevance or impact to your flight.

Another tick √ in the box. 

In the example given here, a diversion to Granada at FL090 will be above the Freezing Level (red dotted line), which is between FL070 and FL080.

With a cold-soaked airframe and descent into towering cumulus with rain, this could mean icing conditions, especially if you are placed in the Hold at the "GDA" VOR at Granada at 7500'.

Brief your examiner about such conditions and what mitigations you might plan (TEM ?) for such an eventuality and you will start to sound like a professional pilot; another tick √ in the box.




## WINDY

For a dynamic and easy synoptic representation of winds and general weather, "Windy" is useful.

**https://windy.com**

Windy has the ability to predict Winds and weather into the future. However, be aware that Windy is based upon different computer models, so take care that you look at all of them and compare them to each other.

Where the predictions diverge, extreme care must be taken and compared with official sources. Where they converge on the same prediction, a higher degree of certainty can be assured.

## NOTAMS

Obtaining and adhering to NOTAMs is part of Professional flying. You should not have to spend a lot of time on the day of test sifting through the relevant NOTAMS as they can be obtained several days in advance. Filter out those NOTAMs that will or could affect the flight. Then on the actual day of the test it is a simple job to get fresh NOTAMS and quickly check to see that no new ones have been issued overnight.

Create a Narrow Route Brief for the planned route. Include diversions, so if a LEJR->LEZL flight with LEGR as the Diversion, then include Granada (LEGR) in the route (from LEZL).

For Spain, there are 2 official sources of NOTAMs; **Eurocontrol** and **Insignia** (from AESA).

### Eurocontrol

`https://www.ead.eurocontrol.int`

Log into to Eurocontrol, and select "Route PIB", select "INT" and "MIL" from "Briefing Type", set "IFR/VFR" rules under "Flight Rules"

- Enter Departure, Destination and Alternate (eg dep:LEJR, dest: LEZL and alt: LEGR)
- Under FIR's click "Get Default FIR", should come up with "LECM" and "MADRID FIR"
- Enter your likely flight levels (eg. lower "000", upper: "100" for FL100)
- Enter the departure time, minus one hour (in UTC) and arrival at alternate (assuming it is longer flight than destination) +1Hour.

This produces a purely text-based NOTAM that must be read in full for the relevant and pertinent information. Print off the NOTAM's as these will become part of your "Examiner Briefing Pack"

Read through them and use a highlighter pen to mark NOTAMs that may affect you. This will make it easier for you to bring to the attention of your Examiner pertinent NOTAMs for your flight.

In reality as soon as the Examiner sees you have gone to the effort of highlighting NOTAMs they probably won't read through them all, as they will (correctly) assume you have read them all.

Another tick √ in the box. 

### Insignia

Alternatively, a graphical representation of NOTAMS can be obtained from the Spanish authority, here:
`https://insignia.enaire.es`

Once the map has been displayed, click on the floating button on the left hand side called "Layers".

Select "NOTAM", and to declutter the display, turn off the other airspace displays.

The NOTAM'ed areas are highlighted in light yellow, and the details of the NOTAM are revealed in a floating window when you click on the area highlighted or the warning triangle if it is a point NOTAM.

### NOTAMinfo

Unofficially, NOTAMs can be obtained graphically using the "NOTAMinfo" website.
This site has several sub-pages for each of the major countries including Spain and the UK. It is concise and easy to read , but cannot be officially used for planning.

Use the Website as a sanity check to make sure you haven't missed any NOTAMs from Eurocontrol/Insignia.
For Spain use: `https://notaminfo.com/spainmap`

## Fuel Planning

Now you have a route and the Winds aloft, you can start planning the fuel burn, contingency, Diversion Fuel, Hold and Approach fuel requirements.

In reality most Students will take off with full tanks as there is only going to be two people on board the aircraft, with minimal luggage for an aircraft likely built for 3-6 people plus baggage.

The exam should be limited to about 2.5 hours maximum and thus is well within the capacity of any light twin built within the last 50 years with the typical payload for the Exam.

However, take the time to calculate the fuel burn for each leg of the Route you previously planned. Where there are two leg alternatives (as in the previous example of VOR1 and NDB1) take the worse-case scenario and use that.

The ability to create a Fuel Plan is part of the MEP-IR test, so it must be correct or you might fail before even walking out to the aircraft. Again this kind of planning can be done in advance.

In real life, at a busy school, you may get lessons where someone has already flown your aircraft before you and has flown for 1.5 Hours, so you need to do the calculations. When the tank capacity is nominally 4 Hours and you need to fly a full test-profile of 2.5 hours, do you have enough fuel with contingency? Again do the numbers.

Your Instructor (if they are good) will make you work this calculation through, so as to force you to carry out full fuel calculations. Do not take it as a chore, relish it as a good exercise.

Remember you are a CPL. You will be expected to behave like one and flying with minimum (but legal) fuel is good commercial practice. Think of it this way, your passengers are paying to be ferried, any excess fuel you are carrying is therefore getting a free ride!

## Mass & Balance

Now you have worked out the fuel requirements for the flight, you can work out the Mass and Balance.

Your examiner will tell you their weight, or if you know the examiner works regularly at your School, you can probably get it from a previous test-Student or previous M&B calculation.

With the use of spreadsheets or "Apps", M&B calculations are now an utterly trivial affair, so why not produce two?

The first one with full tanks (most likely) and another one with the minimum fuel load that complies with the Exam route profile that you worked out earlier. This way on the day of the test, you already will have your M&B worked out. One less thing to worry about, and some more de-stressing!

At FIS, there is a Web-Site that has the M&B calculations for the whole of their fleet. This has the advantage that the actual, real weights and lever-arm of the Aircraft at their last compulsory re-weighing is used in the Calculators.

Again, more simplicity.

# Performance

Following the logic of calculating Mass and Balance, the next stage is the Performance Calculations.

For the PA34 Seneca at FIS, these are reproduced in the Pilot Checklist. Other aircraft will have them in the Pilot Operating Handbook ("POH").

Carry out the Take-Off performance using the real weights for each and every flight and the fuel load carried. This practice will make your planning ultimately easier.

> It is very tempting to work out the Take-Off Distance Required (TODR) for the worse-case scenario of 30˚c at Max All Up Weight with a 10Kt tailwind and come up with a figure of 2300' when you have a runway length of 5000' and say to yourself :
>
> "*I don't have to do this calculation again, as I will always have enough runway at Jerez*".

Technically that may be true, but if you do the proper calculations and present it to the Examiner, it shows that you have the skills and diligence to carry out the calculation and it is a big "tick in the box" on the Examination Sheet under "Planning".

Do not panic and expect to do all the calculations in the 1.5 hours before being "Off-Blocks" (though it helps if you can), but plan the night before the Exam. The same is true of the LDA's for the Destination and Alternate.

The weather forecast (TAFs') will give you forecast temperatures, pressures and wind directions for your Departure, Destination #1, Alternate #1 and Alternate#2.

You can then work out the night before the Exam the following Performance Calculations:

| | |
|---|---|
| Departure Airport: | TODR |
| Departure Airport: | Climb Performance |
| Departure SID: | Time, Fuel and Distance to Climb |
| En-Route: | Speed (TAS) and Power |
| Destination Airport: | Landing Distance Required (LDR), against runway Landing Distance Available (LDA) |
| Alternate #1: | LDR against available runway LDA (*remember to factor in consumed fuel, you weigh less!*) |
| Alternate #2: | LDR against available runway LDA |

So you are thinking "its a lot of work"? But actually, no it isn't once you have done a few of them.

However they will form part of your "Briefing Pack".

So, another tick √ in the box.

## Putting it all Together

By the time you have got this far, you will have spent approximately four hours of preparation on what will be a two-hour flight.

Do not worry, this is normal! As most of the preparation can be done the evening before the Exam, there is much less to do on the actual day. This will de-stress you and will prepare you mentally.

Prepare a "**Briefing Pack"** of printed documents to demonstrate your planning. They are:

| | |
|---|---|
| Weather Charts: | Significant Weather, Winds & Temperatures |
| OGIMET: | Print off with Icing/Terrain |
| TAFs & METARs: | Raw (and interpreted) |
| NOTAMS: | Raw (and highlighted) |
| Mass & Balance: | For the actual Fuel and passenger load |
| Departure Airport: | TODR |
| Departure SID: | Time, Fuel and Distance to Climb to ToC |
| En-Route: | Speed (TAS), Power & Time |
| Destination Airport: | Landing Distance Required (LDR), against available runway L/D Available (LDA) |
| Alternate #1: | LDR against available runway LDA<br>(*remember to factor in consumed fuel, you weight less!*) |
| Alternate #2: | LDR against available runway LDA |
| Prepare the Pilots PLOG: | According to the Data above |
| Flight Plan: | The IFR flight plan relevant for the flight |

And last but not least, have all your Plates printed and up-to-date.

## Timing

On the day of your test, turn up with plenty of time to prepare the Briefing Pack with all the documents that could not be completed the night before.

Shown below is an example of a Time Planner used at my School (Fly-In-Spain, Jerez) for both lessons and the Exam. If you fly with us, then here you go, if not, then you can take this example and modify it to your own needs.

**Lesson / Exam Time Planning**

| | | |
|---|---|---|
| **Brakes Off**<br>*As filed in your Flight Plan: EOBT* | **Off Blocks Time —–>>** | |
| **Taxi & IFR Clearance Reqst. [ -3]** | T -3 | |
| **Captains Brief [ -1]** | T -4 | |
| **Avionics Test & Setup [ -8]** | T -12 | |
| **Take-Of Checks & ATIS [ -2]** | T -14 | |
| **Power Checks [ -2]** | T -16 | |
| **Request Engine Start [ -1]** | T -17 | |
| **A-Check & Cockpit Chx, ATIS [ -13]** | T -30 | |
| **Walkaround & Security [ -15]** | T -45 | |
| **Walk-Out [ -15]** | **-45 Mins —->>>** | |
| **Instructor / Examiner Brief [ -20]** | T -65 | |
| **Met / W&B / Performance [ -15]** | T -80 | |
| **File Flight Plan, book Approaches [-10]** | T -90 | |
| **Time to Report at Test Centre** | **-90 Mins —->** | |

Either way, get into the habit of planning your lessons and arrival time at the school or flight centre based on working backwards from your planned Off-Blocks time, that is the EOBT in the Flight Plan.

Much like a NASA rocket launch, Start with the EOBT at the top, calculate your "T-minus" Walk-Out time (blue) and Reporting time (green), then stick to it! Instructors and Examiners do not like to be made late.

As you can see here, you need to be walking in the front-door of your flight centre about 1.5 Hours before you are meant to be Off-Blocks.

Even so, this does not give much contingency for any problems you might face such as the printer out of toner, the Internet is down or catastrophes of catastrophes, the coffee machine is broken !

# PLOG & Record Keeping

*"Captains Log Stardate 21367; en route to the Teran System....."*

Captain Kirk, you may not be, but keeping a Pilots Log ("PLOG") is an integral part of the planning and record keeping of the IR Exam. It performs three functions. The first is to act as a planner, the second as a reminder of the checks, laid out in a logical order and lastly to act as record for the conduct of the Exam.

The PLOG should be detailed enough that the flight can be reconstructed from the notes and clearances you received during the flight. When you first start your IF training in the SIM you will be under enough pressure just to fly the aircraft and have little excess capacity for Log-Keeping.

When you start on Routes you will start on PLOGs and eventually you will slowly gain the capacity to complete the PLOG and as you will later discover, it will keep you out of trouble.

Oh for a Beer every-time one of my students didn't look at their PLOG and forgot a vital check / action / setting and/or route change, who then kicked themselves afterwards!

Don't worry about it, everybody does it once, then the annoyance of completing the PLOG will evaporate with the realisation that the PLOG has just become a life-saver, well exam-saver at least !

## Worked Example

Take a look at the next page for a PLOG created for a pseudo-flight.

The Departure Airport is LEZZ with a QUARK 2V SID terminating at JENKN.
The Destination is LEYY which is served by two Beacons, one for each runway, namely EVA and EVB.

Note that two routes have been planned from JENKN to EVA and EVB respectively, though once ATIS is obtained at ToC, then it will be obvious which one to fly.

These two alternate routes are marked thus: //

For clarity, the planning has been done in blue ink, written thus. This can all be done the night before, or at the latest in the morning before the Exam.

Once in the aircraft, I personally switch to using a (propelling) pencil in the air, as I can amend mistakes if I make them rather than create a "spiders nest" of ink rubbing-outs. See the first article in this series for my suggestion on propelling pencils.

As can be seen from the example PLOG, I have **filled out the in-aircraft PLOG in pencil thus**.

If you were to come back from an exam with a PLOG filled out with this accuracy, most people will be impressed, as you can see that the flight could be reconstructed from the detail. Most of the PLOG should be self-explanatory, but just a few points to note.

## Clearances

Apart from the Departure Clearance, which has its own dedicated Box, en-route clearances should be recorded in the Notes table, then read back.

As you can see it is totally acceptable, even encouraged, to use "short-hand" to make notes, such as "*ATIS indicating that runway 27 is in use at LEYY, therefore fly to the EVB beacon on reaching JENKN*".

## ATIS / WEATHER

| AIRPORT | LEZZ | LEYY | LEXX |
|---|---|---|---|
| INFORMATION | A | H | S |
| UTC | 10.20 | 11.10 | 11=50 |
| R/W | 20 | 25 | 19 |
| W/V | 210 / 12 | 230 / 9 | 220/8g15 |
| VIZ | 1900m | 1200m | 1800m |
| CLOUD | bkn 900 | ovc900 | sct200 |
| CLOUD | ovc 1200 | | ovc800 |
| TEMP | 12 | 13 | 14 |
| Dew Pt | 10 | 12 | 14 |
| QNH | 1009 | 1008 | 1009 |

## WINDS & TEMPS

| ALT | W/V | TEMP |
|---|---|---|
| 10000 | 255/30 | -3 |
| 5000 | 250 / 25 | 2 |
| 2000 | 230 / 20 | 10 |
| 1000 | 220 / 15 | 12 |

## FREEZING LEVEL

| | |
|---|---|
| Dept. | FL080 |
| Dest. | FL090 |
| Altern. | FL070 |

## FLIGHT PLANNING

| | |
|---|---|
| Date | 13/09/2022 |
| Callsign | DINGBAT69T |
| NAV Db | Oct 22 |
| Student | John Smith |
| Instructor | Exam (T. Jones) |
| Aircraft Reg. | I-RTST |
| Lesson | ME-IR Skills Test |

## DEPARTURE PLANNING

| | |
|---|---|
| Start Eng. Time | 09=40 |
| Est Off-Blocks (Eng. Start +25 mins) | 10=10 |
| Off Blocks | 10=15 |
| Take Off | 10=20 |
| Landing | 12=25 |
| On-Blocks | 12=3[illegible] |

Fly-in Spain

Pilot IFR PLOG

(c) Stephen R.S. Evans 2022 www.evansabove.us

## DEPARTURE CLEARANCE

| | |
|---|---|
| Runway / Hold | 02 / E3 |
| QNH | 1009 |
| ON TRACK / SID | QUARK 2V |
| LIMIT (ROCAS?) | EVA |
| INITIAL HDG | 210 |
| ALTITUDE | FL080 |
| SQWK | 4233 |

## SANITY CHECK

**NAV1**: T.I.M.S. & HSI set
**NAV2**: T.I.M.S. & OBI set
**DME**: Nav1
**Comms**: Now & Next
**F/Plan**: Programmed
**RNAV**: Set Mode - Chk RAIM

## LINE-UP CHECKS

Fuel: On, Mixture Rich
Altimeters: Set, X-Chk
Transponder: Set to ALT
Pitot: On (if temp <3˚)
Landing Light: On

## TOP of CLIMB CHECKS

Fuel Contents: Flow & Chk
Eng T's & P's: Chk
Cowl Flaps: Closed
HSI / Compass: Slaving & Synch
CO Detector: Chk
Mixture: Lean
Altimeters: Set, X-Chk, STD Baro?
Vacuum Pump: Check
MSA Achieved: SID, MORA, RadarChart
Location: Check

## HOLD PLANNING

| | |
|---|---|
| InBnd Track | 200 |
| OutBnd Track | 020 |
| Gate | 350 |
| 60˚ Turn Fix | 140 |
| Single Drift | +3 (east) |
| OutBnd Heading | 011 (-9) |
| OutBdn Time | 55 secs |
| Corrected Gate | 347 |
| Crctd. Gate QDR | 359 |

## Pre-DESCENT CHECKS

ATIS: Obtain
Altimeters: Set, X-Chk
Safety Altitude: Chk
Plan Desc.Rate: RoD & Start
Ice / Clouds: ~1000' in Descent
Approach Brief: Plan & Brief
- Plate & Date
- Navaids Set & ID
- Brief Minimas
- Brief Std M/App

Hold Entry: Plan
Comms: Tower & Next
App Beacon: Tune & ID, RAIM

## DESCENT PLANNING

| Altitude to Lose | 5000 |
|---|---|
| Time @ 500'/Min RoD (Alt' to lose x2 Mins) | |
| Time @ 750'/Min RoD (Alt' to lose x1.5 Mins) | 8 min |
| Dist.145Kt@500'/m RoD (Alt' to lose x 5nm) | |
| Dist.130Kt@750'/m RoD (Alt' to lose x 3nm) | 15nm |

## PRE-APPROACH CHECKS

ATIS: Get latest
Wx Minimas: Check
*Cloudbase-* *Above Minimas*
*RVR-* *Above Minimas*
Approach Ban: Decide? (Go / No-Go)
Comms: Request App & M/App
Nav: Set M/App Bcn. / RNAV

## PRE-LANDING CHECKS

**Brakes**: Pressure Felt
Handbrake Off
Heels on Floor
**U-TURN**: M/App Procedure
M/App Nav Aids Set
**Minimas**: Platform
DA / MDA
Viz / RVR in limits
**Propellors**: Fully Fine
**Fuel**: Sufficient for M/App
**Instruments**: T's & P's
Idents / RAIM
Altimeter X-Chk
Bug Appr for wind
**Cowl Flaps**: Open
**Comms**: Tower & Next
**Hatchs & Harn**: Secure
**Landing**: Light On

TAKE OFF FUEL: 93 USG

| WPT | WPT | MSA | ALT/FL | TRK | HDG | DIST | TAS | TIME | ETA / ATA | | FUEL (USG) | | | | NOTES / CLEARANCES / M-App Proc's |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LEZZ | ToC | 2000 | FL080 | 200 | 205 | 25 | 120 | 13 | ETA | 33 | Planned | 12 | REM. | | clrd dct JENKN pass 4000 |
| | | | | | | | | | ATA | 34 | Used | 13 | | 80 | |
| ToC | JENKN | 6000 | FL080 | 030 | 025 | 15 | 145 | 5 | ETA | 39 | Planned | 12 | REM. | | ATIS @ LEYY RW27, dct to EVB |
| | | | | | | | | | ATA | 40 | Used | 13 | | 67 | |
| JENKN | EVA | 4000 | 5000 | 340 | 335 | 25 | 145 | 10 | ETA | 50 | Planned | 5 | REM. | | |
| | | | | | | | | | ATA | | Used | | | | |
| JENKN | EVB | 3500 | 4000 | 020 | 015 | 15 | 145 | 6 | ETA | 56 | Planned | 2 | REM. | | desc 5000' q1008 hold @ EVB 4000 |
| | | | | | | | | | ATA | 55 | Used | 2 | | 65 | |
| LEYY | VCT | 3000 | 3500 | 180 | 185 | 20 | 105 | 14 | ETA | 09 | Planned | 6 | REM. | | MAPP clrd rw hdg 3000' left 180 to 5000' then dct VCT |
| | | | | | | | | | ATA | 10 | Used | 4 | | 61 | |
| VCT | LEXX | 2000 | 3500 | 200 | 205 | 5 | 105 | 3 | ETA | 13 | Planned | 1 | REM. | | hold VCT @ 3000 |
| | | | | | | | | | ATA | 13 | Used | 1 | | 60 | |
| LEXX | LEZZ | 2000 | 2500 | 110 | 114 | 15 | 105 | 9 | ETA | 21 | Planned | 3 | REM. | | MAPP turn right climb 3000 bck to bcn |
| | | | | | | | | | ATA | 22 | Used | 2 | | 58 | |

### Route PLOG

The TAKE-OFF time {10.20} is added to the first leg TIME {13} to generate the Estimated Time of Arrival (ETA), at the end of the first leg (or start of the next leg) which here is {"33"}.

The Actual Time of Arrival (ATA) you take from your clock when you arrive. Note we only bother with Minutes, hence "33" not "10:33" for expediency.

From your ATA, your next Leg TIME is used to generate the next ETA. So here in our example an ATA of 34 + 5 creates a next ETA of "39".

### Fuel PLOG

As part of the planning, the Route fuel can be pre-calculated (hence the blue ink), however once in the air, an unexpected en-route Hold, or stronger than forecast winds may mean that the actual fuel usage is different from that planned.

For reasons of safety, we calculate the Used fuel based upon the actual time for each leg at the standard burn rate (assuming leaning etc). This is deducted from the TAKE-Off fuel load (usually full tanks minus some Litres/Gallons for taxi and power checks etc) to give a Captains estimate of the fuel remaining.

For each leg, the time is measured and the Leg-Fuel-Burnt calculated, and this is deducted from a running total.

Multiply your "**REM**aining" fuel by Fuel Burn rate and at any given time you know your endurance.

Handy !

### Descent Planning

The included table on the PLOG gives the Pilot the opportunity to plan their descent based on:

- Time-per Altitude to lose, or
- Distance per Altitude to lose

This is one of those rare techniques where you can choose which one works the best for you. Just so long as it works.

Planning for Holds has been covered elsewhere, but again plan in plenty of time.

# Final Words

By the time you have got this far, you will have been reading for over 3 hours and there is a lot to take in.

If you have only stumbled across these series of Student Notes the night before your IR-exam then you have my sympathies and best wishes!

If however you are just about to embark on your Instrument Rating journey, then you will now have a very good idea of what to expect and what is expected of you. The first time you read this series of documents, many ideas and techniques will not necessarily make sense as you read through Chapter 1, Ch 2., CH3 etc. as you will not yet have come across all of the concepts in their correct place.

It is not until the end that the big-picture emerges and the logic makes sense.

For this reason, I would strongly urge you to go back to the beginning and re-read this series from the start. You will now naturally pick-up on concepts that you might otherwise have skimmed-over earlier as you didn't understand them at the time. .

I hope that this series has/will help you on the immensely satisfying journey that is the achievement of an Instrument Rating and in joining the Brotherhood ("*person-hood*"?) of Instrument Pilots.

As for me, if you have bought my book, then thank you.

If however you have downloaded the documents from my Web Site, then you are genuinely very welcome.

All I ask in return is that you make a contribution towards the "Steve Evans Beer Benevolent" fund to ease the finances of this impoverished Flying Instructor and cover the costs of my Web Site.

Think of it like this, have my notes saved you more than 6 minutes of SIM/MEP training ?

This is the equivalent of 1/10th the cost of a Sim Session (~€17) or 1/10 of an hour in a MEP (~€50).

If so, then there you go, my notes have got to be worth a small crate of beer (~€15), its easy,
payment to PayPal please at: stephen.e@event.co.uk

If not, then please, a contribution to Parkinsons Research (UK) (https://www.parkinsons.org.uk/donate ) in memory of my dear Dad.

So with that, time to sign-off and wish you all Safe Skies !

Stephen R.S. Evans
May 2024