IMC GROUNDSCHOOL COURSE NOTES

The IMC ground examination consists of 25 questions (multi-choice) – 18 of which have to be answered correctly in order to pass.

The time allowed is 2 hours.

The subjects included in the examination are:-

AIR LAW

METEOROLOGY

FLIGHT PLANNING

FLIGHT INSTRUMENTS

INSTRUMENT APPROACHES

MORSE CODE

R.T.

NOTE

To gain an IMC the applicant must hold a Flight Radio-Telephony Operator's Licence. Therefore it is expected that the question of R.T. to be found within the written paper should present no real problems. However, CAP 413 should be read to refresh your memory.

A flight plan form will be required to be completed, and up to four questions based on that flight may be asked. Therefore, spend time on the flight plan, failure to complete this correctly may result in a fail.

The IMC paper contains one question on Morse, the de-code can be found on your chart.

PHYSIOLOGICAL FACTORS

Consideration must be given to the effects on the human body whilst in flight before undertaking flight training. Whilst enjoying our PPL privileges we can fly along quite happily maintaining visual contact with the ground and horizon ahead of us. Whilst flying in IMC conditions visual reference with the ground and horizon are lost – this then creates quite a different situation:-

SPATIAL DISORIENTATION

During instrument flight the sense of sight may sometimes disagree with the information being perceived by one or both of the supporting senses (motion and posture). When this happens a condition called **spatial disorientation** will occur, the severity of which depends upon the individual, his proficiency and the acuteness of the situation which caused the misleading information in the first place.

Whereas the sense of sight is not easily misled the senses of posture and motion are very easily confused in flight. The sense of motion originates with a balance mechanism located in the inner ear. During flight it becomes confused, as it is not able to distinguish between centrifugal force and gravity or detecting between constant airspeed and small changes in airspeed. The effects of gravity and centrifugal forces are experienced during many flight manoeuvres and can only be interpreted by sense of vision – looking outside the cockpit. During flight in cloud when outside vision is obscured the sense of motion will give false indications, which should be disregarded.

The sense of posture again is confused whilst in flight. It works by pressure on the muscles and tendons and is fine whilst in contact with the ground i.e. walking, sitting etc. In the air, it is a different matter. It becomes confused and gives false sensations. It is unable to tell you when the aircraft is entering a turn or climb etc.

To sum up, false sensations or illusions may occur at any time during flight and are far from uncommon. These illusions are most likely to occur when flying without adequate external references or when flying when sole reference to the instruments is required. Therefore, in order to operate an aircraft safely during instrument flight, a pilot must learn to ignore these false sensations and rely on his correct visual interpretations of the instruments.

AIR LAW

The IMC rating is only recognised in the UK. This in includes Channel Islands, Isle of Man etc. It is valid for 25 MONTHS from the DATE OF TEST.

An IMC rating does not allow the pilot to fly in AIRWAYS at any time. Neither does the rating allow the pilot to fly in IMC conditions inside CONTROLLED AIRSPACE (Notified Airspace).

AIRSPACE CLASSIFICATION

The ICAO re-classification procedure has brought about changes in classification of the airspace and it is now referred to by a letter A - G. It is also divided into uncontrolled and controlled (notified) airspace – the former being letters F and G and the latter being letters A – E. For your information Schedule 8 in the ANO is the section that should be referred to for all details on this new system. All reference to "Instrument Meteorological Conditions" has now been deleted and a new term "Specified Minimum Weather Conditions" (SMWC) is being used.

An IMC rated pilot has the following privileges:-

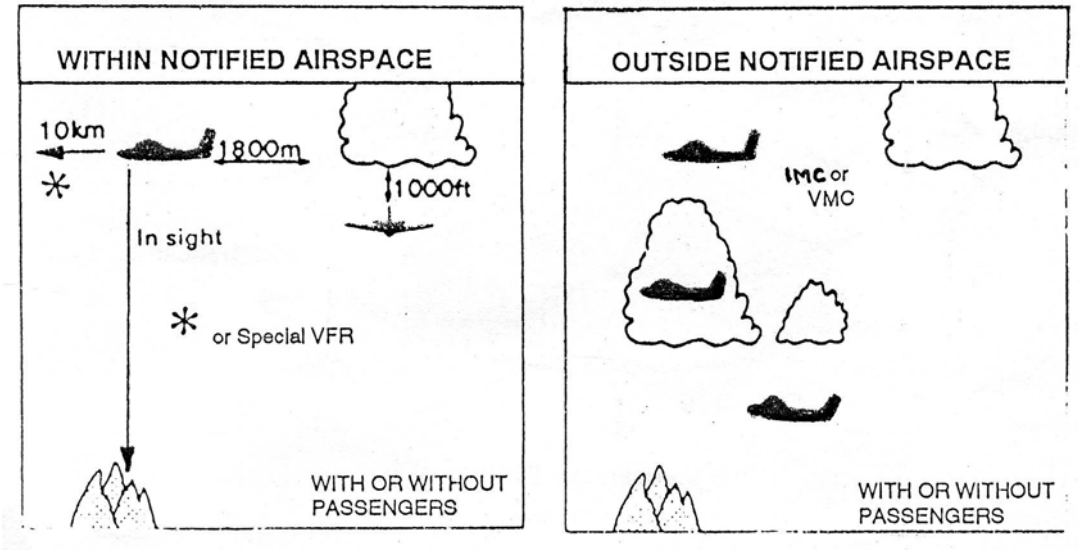
1) Take-off/landing visibility minima of 1800 metres

2) On a special VFR flight in a control zone a minimum flight visibility of 3 KM (but must remain in sight of the surface i.e. NO IMC CONDITIONS).

3) Flight in IMC conditions in uncontrolled airspace.

Outside Controlled Airspace although no minimum CLOUD CEILING for take-off and landing is imposed, pilots are required to operate in accordance with published AERODROME MINIMA (UK AIP).

The following diagrams indicate the visibility etc. for PPL with an IMC rating:



MINIMUM FLIGHT RULE

The FIR rule regarding terrain clearance is as follows:-

The flight must remain at least 1000 feet above the highest fixed object within 5 nm of track.

THE QUADRANTAL RULE

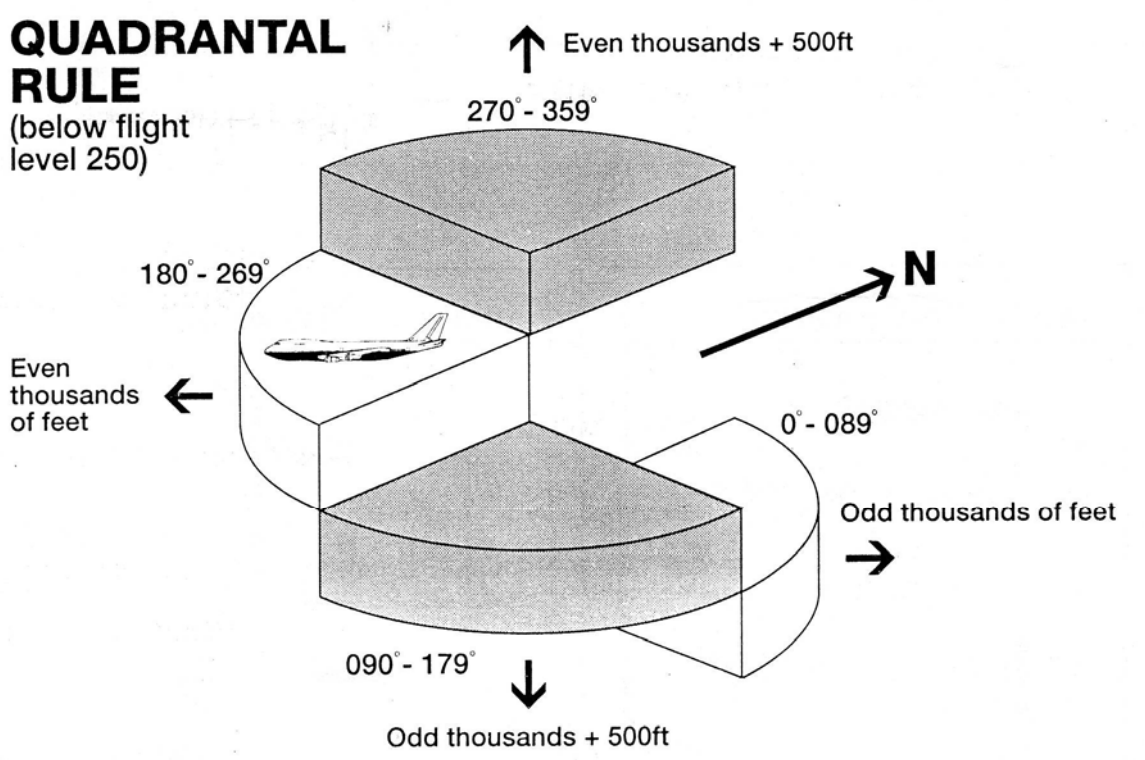
Pilots are responsible for the safe separation of their aircraft from others and whilst operating above the TRANSITIONAL ALTITUDE the altimeter subscale setting should be set to 1013.

Outside notified airspace the QUADRANTAL RULE should be used which is as follows:

MAGNETIC TRACK	**CRUISING LEVEL**
000 - 089 degrees incl.	Odd thousands of feet
090 - 179 degrees incl.	Odd thousands of feet plus 500
180 - 269 degrees incl.	Even thousands of feet
270 - 359 degrees incl.	Even thousands of feet plus 500

FLIGHT LEVEL 250 and above use the semi-circular rule but this is not a requirement in the IMC syllabus.

REMEMBER – the Quadrantal rule applies to the aircraft's magnetic track and not the HEADING!



WORKSHEET NO.1 – AIRLAW

1) You pass your IMC rating flight test on 28th December 1990 and the rating is subsequently issued to you on 12th January 1991. What is the last day on which you may exercise the privileges of the rating without a further flight test?

   a) 12th January 1993
   b) 27th January 1993
   c) 31st January 1993
   d) 11th February 1993

2) Which instrument flight rule applies to an IMC rated pilot who is flying in accordance with IFR rules **OUTSIDE** controlled airspace?

   a) Minimum height rule and flight plan/ATC clearance rule
   b) Minimum height rule and position reporting rule
   c) Minimum height rule and quadrantal rule
   d) Position reporting rule and quadrantal rule

3) What is the minimum flight visibility in which an IMC rated pilot may accept a Special VFR clearance?

   a) 3 km
   b) 3 nm
   c) 1500 mtrs
   d) 1800 mtrs

4) When is an IMC rated pilot allowed to fly IFR in an airway?

   a) When ATC give permission
   b) When the aircraft is fitted with 2 nav/comms and has a transponder
   c) Never
   d) At any time

5) Which destinations do not recognise the IMC rating?

   a) Isle of Man and Jersey
   b) Spain and Holland
   c) Shetland Isles and Orkneys
   d) Guernsey and Isle of Wight

6) An IMC rated pilot may only enter controlled airspace under what clearance when a VFR clearance is unable to be given?

   a) Special ATC clearance
   b) IMC clearance
   c) Special VFR clearance
   d) Special IFR clearance

WORKSHEET NO. 1 – AIRLAW (Continued)

7) Maintaining a magnetic track of 265 degrees, which of the following flight levels would have to be used?

a) FL 55
b) FL 65
c) FL 60
d) FL 50

8) Maintaining a magnetic heading of 080 degrees and flying magnetic track of 090 degrees, what would be the correct flight level to select?

a) FL 40
b) FL 45
c) FL 35
d) FL 30

9) Which of the following is a privilege afforded to an IMC rated pilot?

a) Take-off and landing flight visibility not less than 1 km
b) Flight in controlled airspace under IFR
c) No cloud base limits
d) Flight in IMC outside controlled airspace

10) In which of the following publications would you check the Aerodrome Operating Minima?

a) Aeronautical Information Circulars
b) The NOTAMS
c) The UK AIP
d) The Air Navigation Order

AIRLAW ANSWER SHEET

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METEOROLOGY

TAFS AND METARS

TAFS and **METARS** are available from meteorological observation stations. A **TAF** is issued for a 9 HOUR period updated every THREE hours. Up to four are available by telephone.

A **METAR** or **"ACTUAL"** is issued every half-hour and is valid for 2 hours. A **METAR** will include the temperature and dewpoint as well as the QNH. This information is NOT included in a TAF.

Both of the above are preceded by a time, i.e. A TAF will have four figures indicating the time it is valid for – 0716 indicates 07.00 hrs to 16.00 hrs. METAR will also have four figures – 0850 indicates it was issued at 08.50 hrs.

METAR EXAMPLE

EGBB SA 0750 08010 4500 58RA 8ST003 09/08 1006 NO SIG

BIRMINGHAM	TIME	0750
	WIND	080/10
	VIS	4500 Metres
	WEATHER	RAIN
	CLOUD	8 0KTAS STRATUS 300 ft.
	TEMP	+ 09C DEW POINT = + 08C
	QNH	1006 mbs NO SIG (No significant Change in next 2 hours)

Runway visual range (RVR) is included in a METAR when needed (if runway visibility falls below 1500 metres). Two extra figures are added to the group to define the runway to which the RVR applies.
e.g. R0800/26 decodes as RVR 800 metres on runway 26.

RVR is never included in a TAF as it cannot be forecast.

TREND

A trend is a short term landing forecast which is valid for up to 2 hours after the observation. A METAR could be supplemented with a trend.

TAF EXAMPLE

EGBB 0716 23010 4000 06HZ 3 CU040 TEMPO 1012 6ST022 3000

BIRMINGHAM	TIME	07.00 hrs – 16.00 hrs
	WIND	230/10
	VIS	4000 metres
	WEATHER	Haze
	CLOUD	3 oktas cumulus 4000 feet
	TEMPORARY CHANGE	between 10.00 hrs and 12.00 hrs
	CLOUD	6 oktas stratus 2200 feet
	VIS	reducing to 3000 metres

The following abbreviations may be used in a TAF or METAR:-

NO SIG	No significant change
GRADU	Gradual change
TEMPO	Temporary variations
INTER	Intermittent variations
RAPID	Rapid change (within next 30 mins
PROB 20	Probability of – in this example 20% (indicating that there is also an 80% chance that it might not happen)
CAVOK	Visibility in excess of 10 KM, no cloud below 5000 feet or below minimum sector altitude, whichever is the highest, no precipitation reaching the ground, no CB's, thunderstorms, shallow fog or low drifting snow.

THE ABOVE DEFINITION IS OFTEN TESTED

AIRMET SERVICE

The AIRMET service consists of three routine forecasts issued four times daily. The areas cover the UK and near Continent, SCOTTISH REGION, NORTHERN REGION and SOUTHERN REGION. The vertical coverage is surface to 15,000 feet AMSL with winds and temperatures up to 18,000 feet. The AIRMET information can be received by dialling the appropriate telephone number for the area required and listening to the recorded message. (Telephone numbers can be found in UK AIP).

VOLMET

VOLMET is a recording of current weather reports from principal airports throughout the country. It is broadcast on VHF frequencies and can be picked up both in the air and on the ground when within range of the transmitter. **VOLMET** frequencies can be found in the UK AIP and there are four in all – **LONDON (Main), LONDON (South), LONDON (North)** and **SCOTTISH**. The broadcasts are available on a continuous 24 hour basis.

LONDON (MAIN) 133.375

Actual weather and forecast trend for:-
Amsterdam, Brussels, Dublin, Glasgow, London Gatwick, London Heathrow, London Stansted, Manchester, Paris Charles de Gaulle.

LONDON (SOUTH) 128.60

Actual weather and forecast trend for:-
Birmingham, Bournemouth, Bristol, Cardiff, Jersey, Luton, Norwich, Southampton, Southend.

LONDON (NORTH) 126.60

Actual weather and forecast trend for:-
Blackpool, East Midlands, Leeds/Bradford, Liverpool, London Gatwick, Manchester, Newcastle, I.O.M. Ronaldsway, Teeside.

SCOTTISH 125.725

Actual weather and forecast trend for:-
Aberdeen, Belfast/Aldergrove, Edinburgh, Glasgow, Inverness, London Heathrow, Prestwick, Stornoway, Sumburgh.

SIGMET

The above **VOLMET** reports are available over the radio on a continuous basis as already mentioned and these are known as ROUTINE REPORTS. However, there are weather reports that are given to en-route aircraft when special circumstances arise. One in particular which we are now referring to is **SIGMET.**

These reports are issued when one or more of the following conditions occur:

Active Thunderstorms	Tropical Revolving Storms
Severe Line Squall	Severe Turbulence
Heavy Hail	Marked Mountain Waves
Icing	Severe Airframe

WORKSHEET NO. 2 – METEOROLOGY

1) Decode in LONGHAND the following TAFS:

EGPD 0817 21020 3500 58RA 5 ST012 6 CU050 TEMPO 1012 1500 7 ST 008 80XXRA
EGLL 0716 15010/20 9999 3 CU010 NO SIG

2) Decode the following METARS in LONGHAND

EGWW 0920 29025/35 9999 5CU030 7AC070 10/04 1032 NO SIG
EGSS 1750 22005 0500 46FG 08/08 998 GRADU 3500 7ST005

3) What is the meaning of the abbreviation RAPID?

a) The clouds are moving rapidly
b) The significant change is expected to occur within 20 minutes of the observation
c) The significant change will occur rapidly
d) The significant change is expected to occur within 30 minutes of the observation

4) RVR is never included in a TAF – why?

a) Because a TAF does not include QHN and temperature/dewpoint
b) Because the MET Office don't think that it is necessary
c) Because it cannot be forecast
d) It is included in a TAF

5) What is a TREND?

a) A short term landing forecast valid for up to 1 hour
b) An abbreviated METER
c) A short term landing forecast
d) A short term landing forecast valid for up to 2 hours

6) The term CAVOK is correctly described as:

a) Vis in excess of 10 kl, No cloud below 5000 ft. No CBs, TSs, shallow fog, precipitation or low drifting snow
b) No cloud below 5000 ft. or the minimum sector safety altitude, whichever is the higher, no CB's, TSs, snow or shallow fog. Vis. In excess of 10 kl.
c) No cloud below 5000 ft. or the minimum safety sector altitude, whichever is the greater, no precipitation, shallow fog, low drifting snow, TSs, CBs, Vis in excess of 10 kl.
d) Vis in excess of 10 kl. No CBs at any level, TSs, low drifting snow, shallow fog, precipitation reaching the ground. No cloud below 5000 ft. or the minimum safety sector altitude, whichever is the greater.

METEOROLOGY ANSWER SHEET

No.	a	b	c	d
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RADIO

AIR TRAFFIC SERVICES IN THE FIR

Air Traffic Services in the Flight Information Region have been rationalised for pilots flying outside controlled and special rules airspace. There are FOUR types of services available:

a) **RADAR ADVISORY SERVICE (RAS)**

b) **RADAR INFORMATION SERVICE (RIS)**

c) FLIGHT INFORMATION SERVICE (FIS)

d) **PROCEDURAL SERVICE**

These services may be provided on request at the departure, en-route and arrival stages of your flight. FULL DETAILS AIC 66/1985 YELLOW 87.

RADAR ADVISORY SERVICE (RAS)

This radar service gives information and advisory avoiding action necessary to maintain separation from all other traffic. THIS IS THE ONE TO USE IN IMC CONDITIONS. Remember, if unqualified to fly in IMC conditions then only accept an instruction to maintain VMC. However, you must inform the controller, furthermore, under this service report any height or heading changes.

RADAR INFORMATION SERVICE (RIS)

RIS is a service where the controllers will warn the pilot of conflicting traffic, but NO avoiding action will be offered. Again, you must inform the controller of any height and heading changes.

FLIGHT INFORMATION SERVICE (FIS)

This is a non-radar service but controllers give position reports of other aircraft in the area. Furthermore, they can provide information on serviceability of Nav Aids, weather and conditions at the aerodrome.

PROCEDURAL SERVICE

This service is non-radar ATC which provides separation only between participating traffic. For example, it is used to separate IFR traffic using an approach control service and aircraft flying along advisory routes.

RADIO COMMUNICATIONS

POSITION REPORTS

Position reports are **MANDATORY** when crossing a UK FIR. They should also be given to controllers when using services such as LARS as this greatly assists the controller on the other end of the RT. They should include the following contents in this order.

Aircraft Identification/position/time/flight level or altitude/next position and time over it.

e.g. G-BOKK PA 28/overhead Daventry VOR/10.00/3000 feet/estimate Cranfield at 10.18.

All positions of importance to controllers are shown on aviation charts. Visual Reporting Points are indicated on VFR charts and **MANDATORY** (solid triangle) or **ADVISORY** (outline triangle) points are indicated on **AIRWAYS** charts.

RADIO FAILURE

In the event of a complete radio failure whilst in flight, there are certain procedures that should be followed. If your aircraft is fitted with a transponder – select **MODE ALPHA 7600.** This will then indicate to a radar controller that you are without radio communication.

If you are within **CONTROLLED** airspace and have been given a **CLEARANCE** then you should continue with the instructions of your clearance.

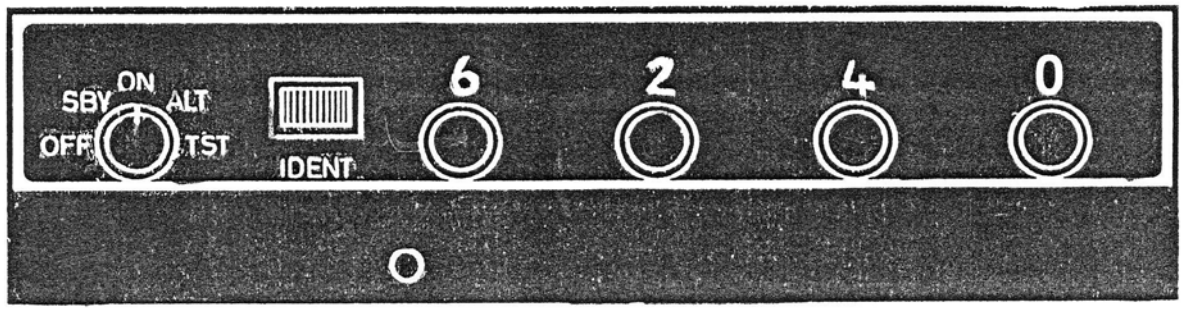
If you are within **UNCONTROLLED** airspace but are receiving some type of radar service then a left-hand sided triangle should be flown with two minute sides.

ATC

The maximum range that aircraft can expect to receive a Radar Advisory Service from ATC is 40 NM. A request to enter a Control Zone etc. should be made 15 nm or 10 minutes from the zone boundary, whichever is the greater.

THE TRANSPONDER

The transponder is a piece of equipment found in the aircraft cockpit and which is used in order for radar controllers to identify individual aircraft. A picture of the aircraft equipment is found below. You may or may not have used this equipment during your initial flight training. Some aircraft, however, are not fitted with a transponder.



TRANSPONDER

Whilst in flight the transponder switch should be turned to the ON position and the conspicuity code 7000 should be set. If a radar controller wants to identify an aircraft he would then give the pilot another four-digit code to display. The switch should then be turned to the STANDBY position whilst the pilot selects the code number that the controller has given him. The switch is then returned to the ON position. That four-digit number will then appear on the controller's radar screen identifying that particular aircraft. When the service of the controller has ended, the pilot will be instructed to return to the conspicuity code of 7000. The pilot may at some time be asked to IDENT – this simply means that he should push the IDENT button on the transponder which will enable the controller to see the aircraft more clearly on his screen as this button, when pressed, causes a ring to circle the four digit number on the radar screen.

The standby code to be used is obviously 7000. However, there are other codes which pilots should be familiar with. They are as follows:-

7700	**EMERGENCY**
7600	**RADIO FAILURE**
7500	**UNLAWFUL INTERFERENCE (HIJACK)**
2000	**WHEN INBOUND TO A UK FIR/UIR AND NO OTHER CODE HAS BEEN GIVEN**

You may have heard a **MODE ALPHA** and **MODE CHARLIE**. Mode ALPHA is used for identification but no height information is given. Mode CHARLIE when used (not all aircraft are fitted with mode C equipment) indicates height of the aircraft which is based on the pressure setting 1013.25.

Some airspace is subject to various degrees of restriction. These areas are:-

DANGER AREAS - Permanent and non-permanent – an RT frequency will be listed for the pilot to check activity.

PROHIBITED AREAS - These areas may be over land or sea over which aircraft MUST NOT fly.

RESTRICTED AREAS - These areas are published in order to restrict aircraft overflying them for non-security reasons e.g. Bird Sanctuaries etc.

IF THERE IS NO RESOPNSE FROM THE NOMINATED ATC CENTRE REGARDING THE DANGER AREA, IT MUST BE CONSIDERED ACTIVE.

VHF DIRECTION FINDING (VDF)

Ground direction finding is principally used by ATC units to determine the bearing of an aircraft from a station. Many radar control units use this facility automatically but these stations are not published as they do not directly offer a service to pilots. The stations that are listed in the UK AIP can be used by pilots but only in an emergency and not as a navigational facility.

Four different bearings can be obtained by the station and they are as follows:-

QDR the **MAGNETIC** bearing of the **AIRCRAFT** from the station

QTE the **TRUE** bearing of the **AIRCRAFT** from the station

QDM the **MAGNETIC** bearing of the **STATION** from the aircraft

QUJ the **TRUE** bearing of the **STATION** from the aircraft

The most frequently used information is the **QDM**

The ATC unit will give the pilot a bearing on request but the pilot must be aware of the accuracy of that bearing.

CLASS A	=	accurate to within + / - 2 degrees
CLASS B	=	accurate to within + / - 5 degrees
CLASS C	=	accurate to within + / - 10 degrees
CLASS D	=	accuracy **EXCEEDING** 10 degrees

LOWER AIRSPACE RADAR ADVISORY SERVICE (LARS)

Much of the UK is covered by a radar service provided by the Royal Air Force. It is available to pilots outside controlled airspace up to and including FLIGHT LEVEL 95. Pilots requiring this service must be within 30 NM of the radar head. The time of watch varies from station to station, some have a full 24 hour service, others have just a daytime service. The full details etc. can be found in the UK AIP.

SEARCH AND RESCUE

An important part of the aviation emergency service is the joint military/civil Search and Rescue Service (SAR). There are two main centres in this organisation covering the UK and surrounding waters and these are situated at Plymouth and Edinburgh. The UK also has arrangements enabling assistance from other nations should they be required.

A continual watch on the frequency 121.5 MHZ is maintained. This frequency, however, can be used to practise PAN calls but not MAYDAY calls. In other words, urgency or emergency calls may be simulated but not DISTRESS calls. You may have practised a PAN call on this frequency during your PPL training.

WORKSHEET NO. 3 – RADIO COMMUNICATIONS

1) A QDM is:

   a) A true heading to fly to the beacon assuming no wind
   b) A magnetic bearing of an aircraft from a beacon
   c) A heading to fly to the beacon
   d) The magnetic bearing of the beacon from the aircraft

2) The LARS service is available up to what range from the radar head?

   a) Up to 35 nm and flight level 95
   b) Up to 30 nm and flight level 90
   c) Up to 40 nm and flight level 95
   d) Up to 30 nm and flight level 95

3) A Class C bearing is:

   a) Accurate to + / - 2 degrees
   b) Accurate to + / - 4 degrees
   c) Accurate to + / - 10 degrees
   d) Accurate to + / - 7 degrees

4) Which of the following statements is true of a danger area?

   a) It must be avoided at all times
   b) It is noted in the NOTAMS when active
   c) There are only danger areas around military areas
   d) They may be permanent or non-permanent – an RT frequency is listed for the pilot to check activity

5) In the event of radio failure in controlled airspace after receiving a clearance, what is the appropriate action to be taken?

   a) Turn through 180 degrees and exit controlled airspace
   b) Continue with the clearance given
   c) Fly a right-hand sided triangle of 2 minute sides
   d) Orbit for ten minutes

6) In the event of a radio failure before entering controlled airspace but after receiving a clearance you should:

   a) Continue with the clearance
   b) Fly a right-hand sided triangle of 2 minute sides
   c) Remain clear of controlled airspace and land as soon as possible
   d) Orbit until receiving visual signs from the ground

WORKSHEET NO. 3 – RADIO COMMUNICATIONS (Continued)

7) An aircraft outside controlled airspace but receiving radar coverage experiences complete radio failure – what should it do?

   a) Carry on with the flight as normal
   b) Orbit until visual signs to land are received from the ground
   c) Select 7700 on its transponder
   d) Select 7600 on its transponder and fly a left-hand sided triangle of 2-minute sides to alert the ground station

8) What is the range from the radar head that you can expect to receive radar advisory service from ATC?

   a) 25 nm
   b) 35 nm
   c) 40 nm
   d) 50 nm

9) A position report is mandatory – when?

   a) When entering controlled airspace
   b) When crossing a UK FIR boundary
   c) On final approach
   d) Before reaching the overhead of an airfield

10) Which of the following is the correct order and contents of a position report?

   a) Aircraft Callsign/Type/Height or Altitude/Speed/Estimate
   b) Aircraft Callsign/Height or Altitude/Next position and time over it
   c) Aircraft identification/Position/Flight level or Altitude / Next position and estimate over it
   d) Aircraft identification/Position/Time/Flight level or Altitude / Next position and time over it.

11) The four different services available to pilots from ATC units are:

   a) Radar Information Service, Radar Advisory Service, Flight Information Service, Traffic Information Service
   b) Traffic Information Service, Radar Information Service, Procedural Service, Radar Advisory Service
   c) Radar Advisory Service, Radar Information Service, Flight Information Service, Traffic Advisory Service
   d) Radar Advisory Service, Radar Information Service, Flight Information Service, Procedural Service

WORKSHEET NO. 3 – RADIO COMMUNICATIONS (Continued)

12) Which is correct regarding a Radar Information Service?

a) Information regarding other traffic in the area is given and avoiding action is instructed by ATC
b) No information regarding other traffic is given
c) Information and position of other traffic is given but no instructions regarding avoiding action is offered
d) All traffic positions and avoiding action is relayed to the aircraft in the area

13) Whilst flying in IMC conditions, what service should be requested by the pilot?

a) Radar Advisory Service
b) Flight Information Service
c) Radar Information Service
d) Procedural Service

14) In connection with the above question, why would you use the above service?

a) It offers all information

b) You are on radar coverage, other traffic information is given to you, and avoiding action is given by means of headings/heights to fly

c) ATC advise you to use it as they are responsible for your aircraft

d) It doesn't make any difference which service you use in IMC conditions.

RADIO COMMUNICATIONS ANSWER SHEET

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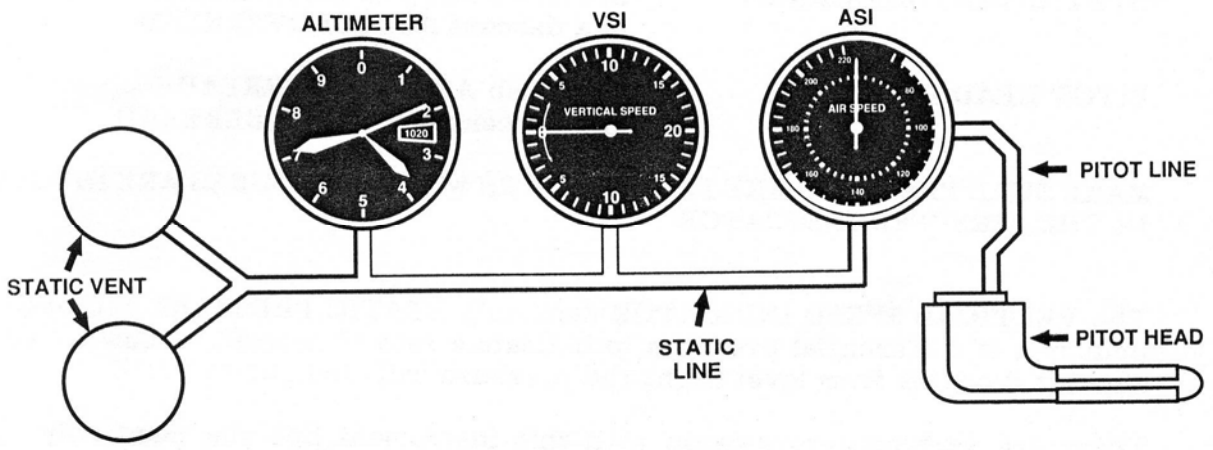
FLIGHT INSTRUMENTS

You need to be familiar with the subject of flight instruments in order to be able to answer the questions in the written paper. A study of the errors of the pressure instruments is of great importance. These consist of the **AIRSPEED INDICATOR, VERTICAL SPEED INDICATOR** and the **ALTIMETER**.

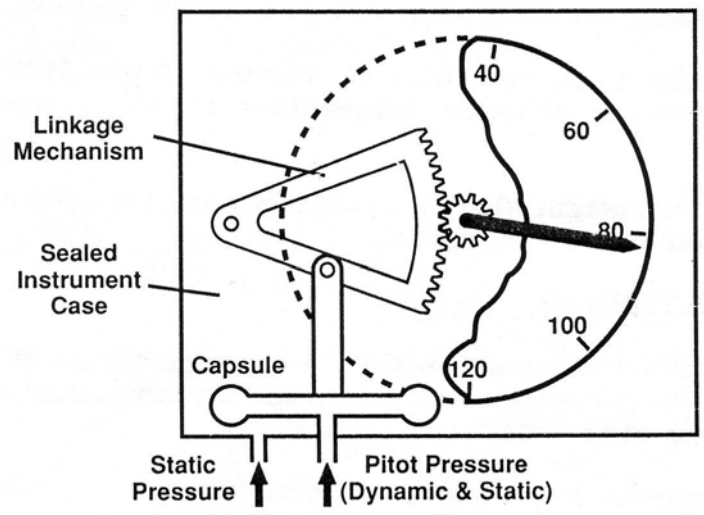


The Airspeed Indicator measures **TWO** pressures, **STATIC PRESSURE** and **PITOT PRESSURE**. If the aircraft is stationary on the ground it is subject only to **STATIC** pressure, but when it is moving **PITOT** pressure is also included.

PITOT = **DYNAMIC + STATIC** pressure.

If one or the other becomes blocked as you would expect, this then has an effect on the indicated reading of the airspeed.

Below is a simplified diagram of the workings of the ASI.



AIRSPEED INDICATOR

BLOCKAGES in ASI

After looking at the diagram indicating the working of an ASI you can see that static pressure is fed into the sealed instrument case and pitot pressure is fed directly into the capsule inside the instrument. You do not need to worry about how the instrument actually converts these pressures to an airspeed indication but you need to know what happens to the indication should a blockage occur.

STATIC VENT BLOCKAGE In a climb ASI will **UNDERREAD**
In a descent ASI will **OVERREAD**

PITOT HEAD BLOCKAGE In a climb ASI will **OVERREAD**
In a descent ASI will **UNDERREAD**

MAKE SURE THAT YOU ARE FAMILIAR WITH WHAT PRESSURES ARE INVOLVED IN THE AIRSPEED INDICATOR.

The **VERTICAL SPEED INDICATOR** uses only **STATIC PRESSURE** and uses the principle of differential pressure to indicate a rate of descent or climb. As the aircraft deviates from level flight the pressure will change.

There are various errors again with this instrument but you need only again worry about blockages. If there is a blockage, the indicator needle will return to ZERO.

The **ALTIMETER** is an aneroid barometer adapted for use in aviation. In theory, an aneroid barometer is used to measure the atmosphere pressure of a column of air over a given point. As we know from our PPL studies atmospheric pressure decreases with an increase in height.

The altimeter is calibrated to the constants used in the ISA:-

Pressure at mean sea level	=	1013.25 mb
Temperature at mean sea level	=	+15 degrees C
Density at mean sea level	=	1225 gm/cubic metre

A temperature lapse rate of 1.98 degrees C per 1000 feet up to the tropopause and a constant temperature of –56 degrees C above the tropopause.

TROPOPAUSE = Given height where temperature ceases to lapse at 1.98 degrees C and remains constant at –56 degrees C.

BLOCKAGES in ALTIMETER

Again, the altimeter's indications suffer if a blockage occurs in the static intake or system itself. The system becomes sealed and the instrument continues to read the height indicator at that time. A potentially dangerous situation when descending!

THE ATTITUDE INDICATOR

This is commonly referred to as 'the Master Instrument' simply because of its presentation of the aircraft attitude (pitch and bank). These indications relate only to the aircraft attitude and not to the aircraft performance i.e. constant height, climbing and descending. This instrument is gyro operated as opposed to the previously mentioned 'pressure instruments'.

THE TURN INDICATOR AND TURN CO-ORDINATOR

Several types of instrument presentation are currently in use but all incorporate a balance indicator (usually a ball indication). Again the instrument is gyro operated which is usually electrically driven. The turn indicator has a needle presentation to indicate the rate of turn whilst the turn co-ordinator has a little model aeroplane display to show the rate of turn. The instruments may be calibrated to show a two minute turn through 360 degrees, although a pilot should check the aircraft's correct indication of a rate one turn. This can be worked out as follows:

Take 10% of the aircraft TAS and add 7 degrees

i.e. an aircraft TAS of 100 kts – the rate one angle of bank would be 17 degrees.

THE DIRECTIONAL INDICATOR

Again this instrument is gyro operated. It provides the pilot with a steady heading indication, although it does suffer from 'gyro topple' and should be regularly checked and re-set against the magnetic compass. During the IMC flight training a simulated vacuum pump failure is carried out and one of the instruments lost will be the DI.

THE MAGNETIC COMPASS

The magnetic compass suffers from errors of which the pilot must be aware. The compass is only any good for indicating headings when the aircraft is in straight and level flight. It will be inaccurate whilst descending, climbing and turning.

Whilst turning in the Northern Hemisphere and using the compass – remember the following neumonic NUSO – North under South over.

Turning on to a northerly heading undershoot the heading by approximately 30 degrees.

Turning on to a southerly heading overshoot the heading by approximately 30 degrees.

THE OPPOSITE APPLIES IN THE SOUTHERN HEMISPHERE.

INSTRUMENT CHECKS WHILST TAXIING

Whilst taxiing, it is important to check certain flight instruments, namely the **ATTITUDE INDICATOR, DIRECTION INDICATOR, MAGNETIC COMPASS and TURN AND BALANCE INDICATOR (**or **TURN CO-ORDINATOR**).

These checks, however, should be carried out away from the parking area and consist of turning the aircraft to the LEFT and checking that the turn indicator shows a turn to the LEFT with the balance ball moving to the RIGHT. The direction indicator and magnetic compass should be checked that they show a DECREASE in heading. A turn to the RIGHT should then be made to check that a turn indicator shows a turn to the RIGHT with the balance ball moving out to the LEFT. The direction indicator and magnetic compass should correctly be indicating an INCREASE in the heading.

The attitude indicator should remain relatively steady during both of these turns. If, whilst checking these instruments, any of them fail to indicate correctly then the flight should be cancelled.

WORKSHEET NO.4 – FLIGHT INSTRUMENTS

1) Which of the following are pressure-driven instruments?

a) VSI, ASI, Turn Co-ordinator
b) Altimeter, VSI, Artificial Horizon
c) DI, Artificial Horizon, ASI
d) VSI, ASI, Altimeter

2) Which instrument needs both pitot and static pressure?

a) VSI
b) DI and ASI
c) ASI
d) Turn Co-ordinator

3) If the static vent becomes blocked in-flight, what will happen to the VSI needled indicator?

a) It will return to zero
b) It will stick at whatever the reading was when it became blocked
c) It will over-read
d) Nothing

4) If the pitot tube becomes blocked in-flight by ice, what will happen to the altimeter reading?

a) It will over-read
b) It will under-read
c) Nothing
d) It will stick

5) What will happen to the ASI if the static vent becomes blocked whilst in a descent?

a) It will over-read
b) It will under-read
c) Nothing – it will indicate correctly
d) The needle will give inaccurate indications =/- 300 feet

6) What will happen to the ASI if the pitot tube becomes blocked whilst in a climb?
a) It will indicate correctly
b) It will over-read
c) It will under-read
d) It will return to zero

FLIGHT INSTRUMENTS ANSWER SHEET

No.	a	b	c	d
1				
2				
3				
4				
5				
6				

VHF OMNIDIRECTIONAL RADIO RANGE – VOR

The VOR system supplies accurate bearing information over ranges up to 200 NM. The VOR ground transmitter radiates a number of lines out from the station called RADIALS. To try to picture this think of a bicycle wheel lying on the ground. The spokes of the wheel resemble the direction of the radials although there are 360 radials in a VOR.

A pilot is able to tune into a chosen radial and track along it using it as a navigational aid and also as a position fix. In order to use the VOR it must first be identified by the pilot and this is done by listening to the Morse Code ident which is transmitted from the VOR usually six times per minute. The Morse Code consists of three letters which will be found on your chart or in the UK AIP. This is checked in the pre-flight planning stage.

Another point to remember about the VOR is that the equipment operates in the VHF band and so it is limited to line of sight operation. The higher the aircraft the better the signal is received.

The UK AIP specifies a Designated Operational Coverage (DOC) for each VOR.

i.e. Detling VOR has a DOC of 60 NM/50,000 feet (UK AIP 2-1-15).

The DOC is published so that pilots know the limits that the VOR can be used within. Outside these limits the equipment is subject to interference from other stations etc.

VHF line of sight calculations can be worked out as follows:-

The range = square root of height of aircraft plus square root of elevation of transmitter x 1.25.

If an aircraft is at 2000 feet and the transmitter has an elevation of 250 feet, what is the line of sight range?

ANSWER = 76 NM

There is, however, a rule of thumb calculation that you can use to calculate VHF line of sight and it is as follows:-

1500 feet	-	range approx 50 NM
2500 feet	-	range approx 60 NM
3500 feet	-	range approx 70 NM
4500 feet	-	range approx 80 NM

DISTANCE MEASURING EQUIPMENT (DME)

Although DME may be used on its own, it is primarily used in conjunction with a VOR. It then forms a combined navigational system known as VOR/DME and gives bearing and distance information to the pilot.

In order to obtain distance information, the DME frequency has to be selected (if this is a combined system the frequency will normally be the same as the VOR). The cockpit indication will give the distance from/to a transmitter and also some equipment will measure groundspeed and estimate a time in minutes to the station.

IT MUST BE APPRECIATED THAT A DME MEASURES SLANT RANGE AND SO THE HEIGHT OF THE AIRCRAFT MUST BE TAKEN INTO CONSIDERATION.

THE VOR COCKPIT INSTRUMENT

The VOR cockpit display is often referred to as the Omni Bearing Indicator or OBI. The OBI displays the radial selected by the pilot using the Omni Bearing Selector of OBS.

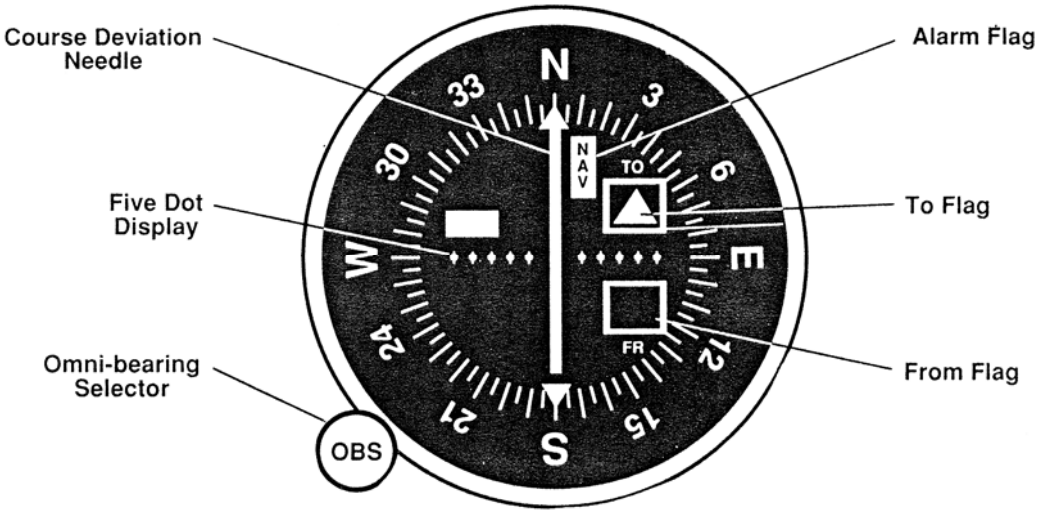
If the aircraft is on the radial selected by the pilot then the VOR needle known as the Course Deviation Indicator (CDI) will be centred. Whether the selected track would take the aircraft to or from the VOR ground station is indicated by the TO or FROM flags.

When a VOR is operating normally the radials are transmitted to an accuracy of +/- 1 degree.

The amount of angular deviation from the selected track is indicated by the five dot display on the cockpit instrument. The inner dot is represented by the centre circle. Each dot represents 2 degrees and so a full scale deflection is 10 degrees or more.

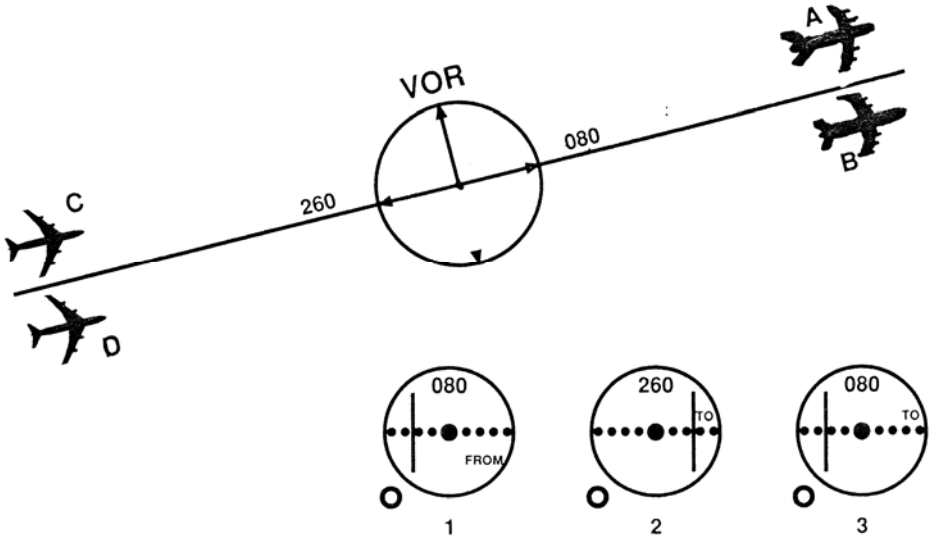
If the red flag is showing then that indicates that the instrument should not be used.

Below is a diagram of a cockpit instrument:



A typical question on the examination paper is as follows:-

Specify which of the aircraft below could have the indications shown:-



You will find the answers at the back of the folder in the answer section.

Remember if flying **TO** a VOR you should have the **TO** flag showing and if flying **FROM** a VOR you should have the **FROM** flag showing. If you have the wrong flag indicating then the needle will act in the OPPOSITE sense.

i.e. If you are tracking to a VOR but have a FROM flag showing and the needle is out to the right – it really means fly LEFT!

AUTOMATIC DIRECTION FINDING

The ADF is an essential part of the radio navigation equipment found in modern aircraft. It is used to measure the bearing of an NDB from the aircraft.

NON DIRECTIONAL BEACONS

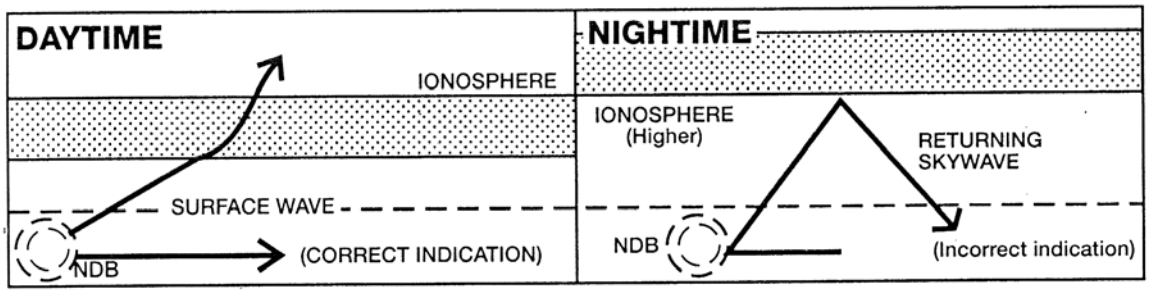
NDBs transmit vertically polarised signals in all directions. The power of the transmitter on the ground determines what range the surface waves can achieve. NDBs situated in AIRWAYS i.e. Lichfield, are very high powered and are used as en-route navigational purposes for aircraft flying in the airways. However, some NDBs are low powered and are referred to as LOCATORS i.e. Shobdon. Low powered NDBs are sometimes co-located with Outer Markers and are used to assist the pilot on instrument approaches.

ERRORS

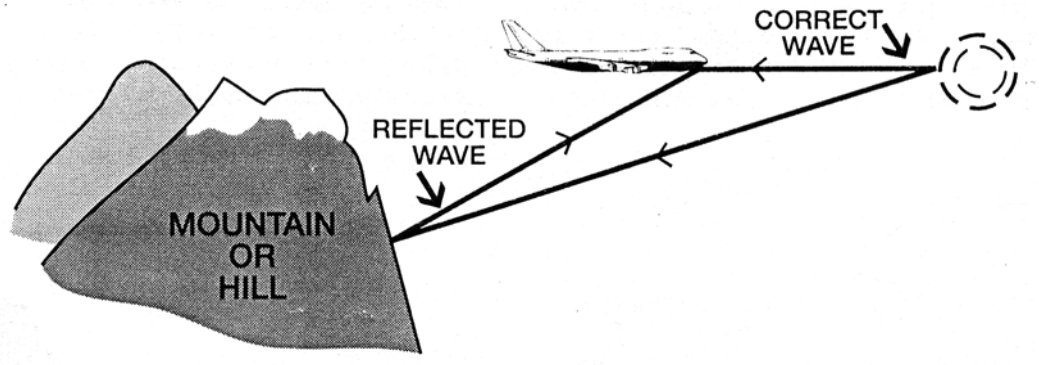
Although the NDB/ADFs are very useful for navigational purposes they do suffer from various errors concerning the accuracy of the bearing information. NDBs have a promulgated range which is printed in the COM section of the UK AIP which limits the bearing errors to +/- 5 degrees, but this is only guaranteed for use during daylight hours due to 'the night effect'.

THUNDERSTORM EFFECT – Cumulonimbus cloud formation produce an amount of electromagnetic noise which affects some NDB frequencies. The needle in the ADF in this case would much rather point towards the nearest thunderstorm than the NDB to which it is tuned.

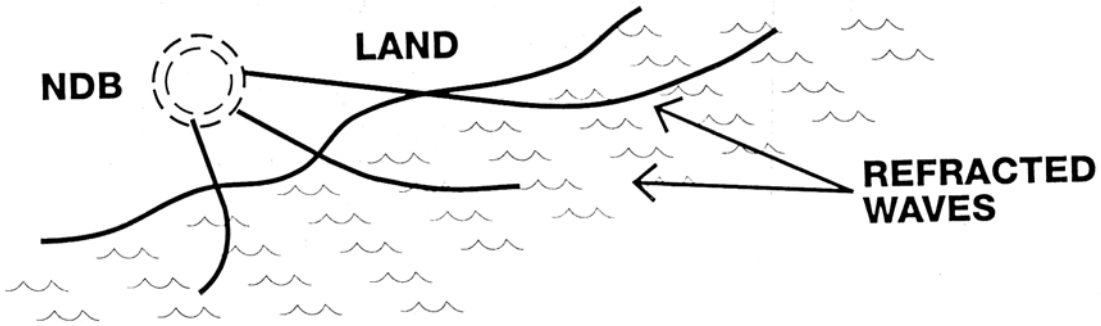
NIGHT EFFECT – As already mentioned NDBs should only be used during daylight hours. As night falls the IONOSPHERE becomes partly de-ionised and this then affects the signals from the NDB as they arrive a the ADF transmitter as SKY WAVES rather than SURFACE WAVES. ADF equipment is not able to convert sky waves into bearings and so all indications would be suspect.



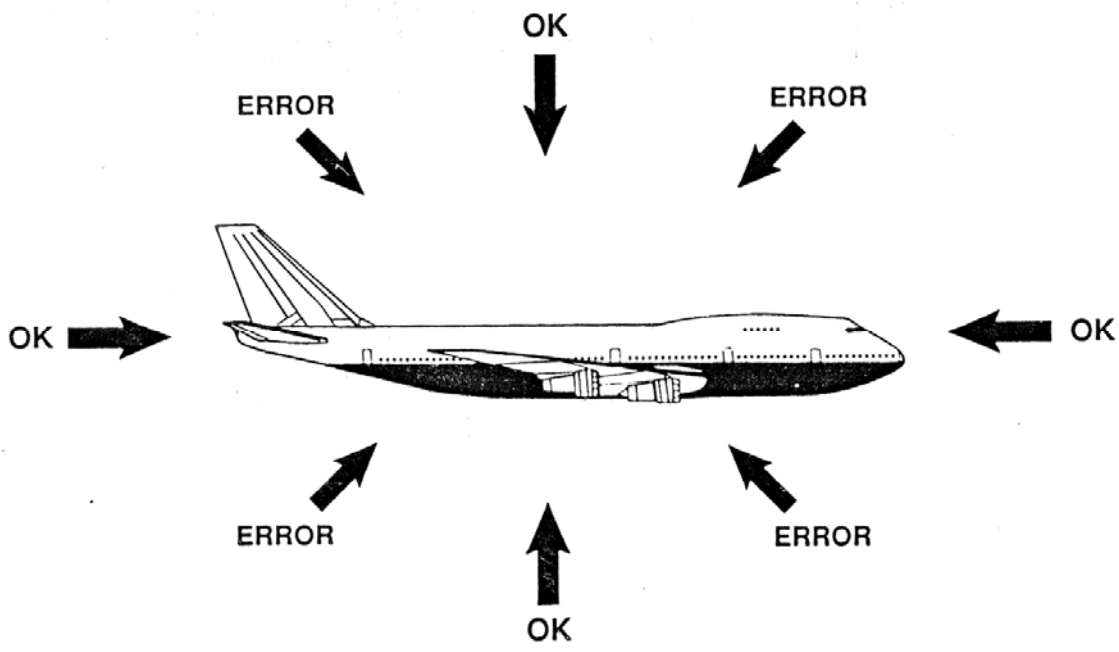
MOUNTAIN EFFECT – If a range of hills or mountains lie close to the path of the surface wave from an NDB, the mountain/hill will reflect this signal and the ADF bearing indicator will point somewhere between the two signals it has received.



COASTAL REFRACTION - This is due to radio waves travelling faster over water than over land. To minimise this effect, the pilot should select NDBs that are close to the coast. The diagram below should hopefully explain this effect.



QUADRANTAL ERROR – This is caused by the effect of the airframe on the ADF aerial. Signals arriving directly fore, aft or abeam the aircraft are not affected by this error although a correction device is fitted in the receiver to minimise this effect. You may also hear this referred to as Installation Error.



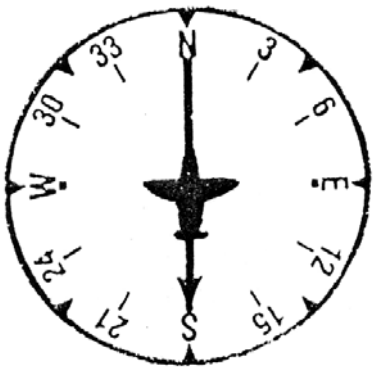
STATION INTERFERENCE – This effect should be minimal if the equipment is used within its range and limitations (ranges can be found in UK AIP). The frequencies used by NDB's are carefully selected and distances between transmitters with the same frequency are considered to ensure that surface waves do not overlap from beacons with the same frequency and cause interference.

THE ADF COCKPIT INSTRUMENT

The ADF cockpit instrument is used to assist the pilot in "pointing" the way to an NDB. Roughly speaking, when correctly tuned into an NDB station by dialling in the correct frequency (normally three numbers) the needle on the instrument should point at the NDB in relation to the aircraft giving a RELATIVE BEARING.

A RELATIVE BEARING is a bearing from the aircraft using the aircraft's nose as North (360d), the tail as South (180d), the starboard wing as 090d and the port wing as 270d.

The diagram below is indicating a relative bearing of 180d.



QDM

Should the pilot wish to fly to the NDB then he will need to work out a QDM which is a MAGNETIC heading to fly assuming still wind conditions. There are two ways to calculate a QDM and you may be asked questions on these in the examination. They are as follows:-

1) a) Take your heading i.e. 260 d

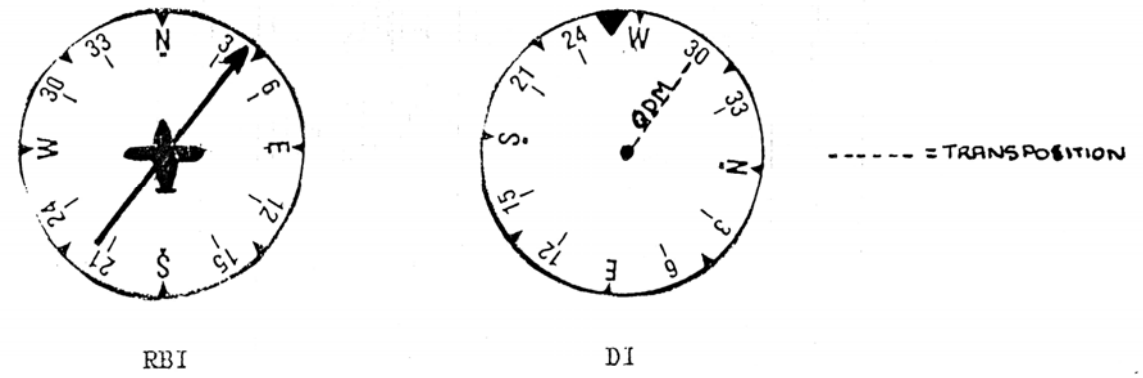
b) Take your relative bearing i.e. 040 d.

c) Add them together 300 d.

QDM to the beacon is **300 degrees**

NOTE: If when you add the two figures together they are greater than 360d then subtract 360d for your answer.

2) Look at your RBI and mentally transpose the needle onto your DI at that time.
(The diagrams below indicate both the DI and RBI in the above situation.)



Obviously in real conditions then corrections have to be made for the wind but this will be covered in your flight training.

SUPPLEMENTARY NDB/ADF

AND VOR QUESTIONS

ANSWERS IN BACK OF FOLDER

1) A particular NDB may be identified by:

   a) Music
   b) Morse Code
   c) ATC
   d) 5 letter Morse Code

2) An NDB positioned so that it provides a fix for an aircraft during an instrument approach, and co-located with an outer marker, is a:-

   a) Locator
   b) ADF
   c) Fan marker
   d) Outer marker

3) Mountains may reflect the NDB's signal making ADF indications:-

   a) More reliable
   b) Less reliable
   c) Reliable during daylight hours only
   d) No effect

4) An aircraft is heading towards Luton on a magnetic track of 175d. The Henton NDB is situated according to the radio compass on a relative bearing of 220d, what is the QDM to Henton?

   a) 395 d
   b) 220 d
   c) 035 d
   d) 350 d

5) The range promulgated in the UK AIP for NDBs is based on a daytime protection ratio between wanted and unwanted signals that limits bearing errors to +/- ? or less:-

   a) 10 d
   b) 15 d
   c) 5 d
   d) 20 d

SUPPLEMENTARY NDB/ADF

AND VOR QUESTIONS

Continued

6) The range of an NDB can be found in:-

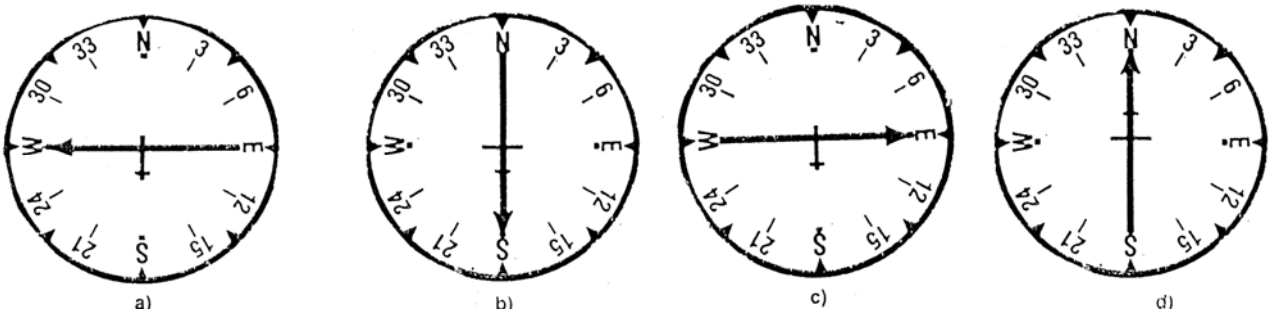
a) ANO
b) AIP
c) NOTAMS
d) NOTAMS CLASS A

7) The DI indicates a heading of 060d, the ADF indicates a relative bearing to the "GM" LOC at Birmingham of 060d, what is the QDM to the "GM"?

a) 060 d
b) 120 d
c) 160 d
d) 130 d

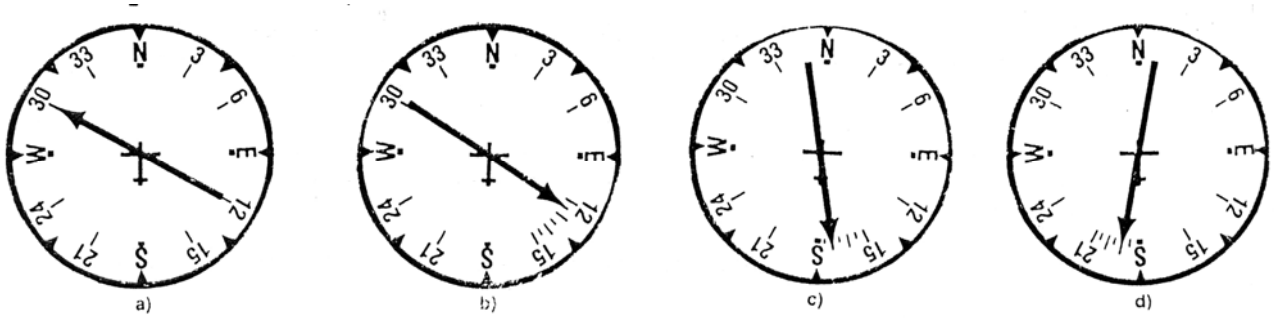
FOR THE FOLLOWING QUESTIONS ASSUME STILL WIND CONDITIONS

8a) Which of the following ADF relative bearing indicator displays shows that an aircraft is maintaining the centreline of an airway, magnetic track 270d by tracking away from an NDB?

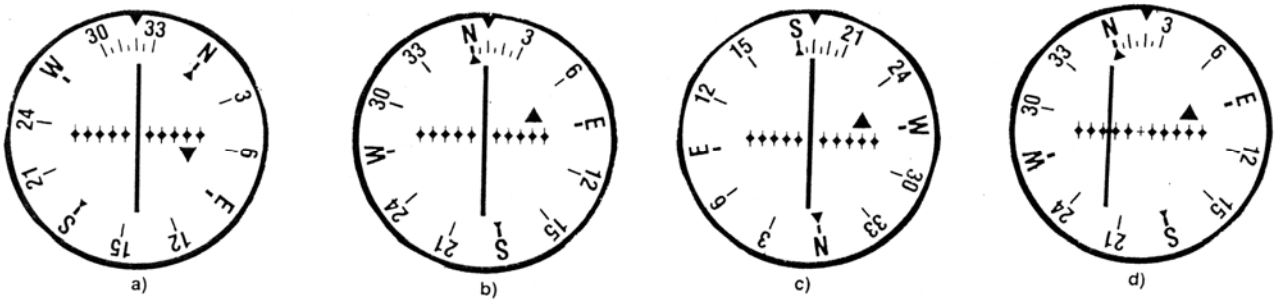


SUPPLEMENTARY NDB/ADF AND VOR QUESTIONS
Continued

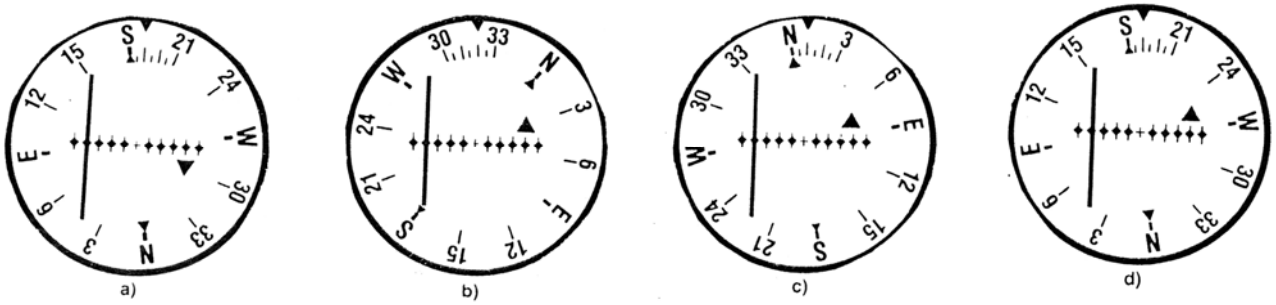
b) An aircraft is tracking away from an NDB on an airway with a designated magnetic track of 315d. The aircraft is maintaining a magnetic heading of 315d but is 10d off the airway centreline to starboard. Which of the following ADF RBIs correctly represents the situation?



c) Air aircraft is maintaining a magnetic track of 320d by dead reckoning. A VOR 30nm to the right of track is tuned and identified. The CDI is set so that a position fix can be obtained on crossing the VOR 190d radial. Which of the following OBI correctly displays the fix position?



d) The aircraft in the above question reaches the fix position and commences a right turn to track inbound on the 190d radial. After 3 minutes the aircraft has drifted 8d to starboard of the required track. Which OBI display is correct for this situation?



SUPPLEMENTARY NDB/ADF

AND VOR ANSWER SHEET

No.	a	b	c	d
1				
2				
3				
4				
5				
6				
7				
8a				
8b				
8c				
8d				

THE INSTRUMENT LANDING SYSTEM

The Instrument Landing System is the most widely used runway approach aid. It gives the pilot continuous glideslope and heading information by means of continuous ground transmissions. The pilot is able to descend to a given height (decision height) and upon reaching that height is then able to decide whether to land if he has visual reference to the runway or to commence a missed approach.

The runway has to be suitably equipped for ILS approaches as well as the individual aircraft. There are differing categories depending on the equipment available and they are as follows:-

ILS CATEGORY 1 - accurate guidance down to 200 ft. above reference point

ILS CATEGORY 2 - accurate guidance down to 50 ft above reference point

ILS CATEGORY 3 - accurate guidance down to and along the runway

ILS GROUND EQUIPMENT

The ground equipment consists of three components and these three components make up a **PRECISION APPROACH**. An ILS approach with one or more of these components missing is a **NON PRECISION APPROACH**.

The components are:-

LOCALISER provides pilot with information relating to 'extended runway centreline'

GLIDESLOPE defines a given descent slope and provides pilot with information relating to that slope

MARKERS arranged at intervals along the approach giving the pilot information regarding distance from touchdown.

The markers are:-

OUTER Marker normally located 3-6 NM from threshold and sometimes co-located with low powered NDBs i.e. 'GM' and 'GX' at Birmingham International.

MIDDLE Marker normally located ½ - 1½ NM from threshold.

INNER Marker if used will be located very close to threshold. Not many inner markers are used in UK as they may be closer to the threshold than DECISION HEIGHT and so are of little use.

ILS COVERAGE

The components of the ILS have differing coverages and these need to be studied in detail as they are a regular examination topic.

LOCALISER

The localiser, as we have already discovered, is an imaginary extended centreline of the runway. It extends out to 25 NM from the localiser transmitter. It gives coverage up to 35 degrees either side of the centreline out to 17NM and coverage of 10 degrees either side of the centreline out to 25 NM.

Localiser signals are checked out to 10 NM from the transmitter. They are protected from interference out to 25 NM and up to 6250 feet in altitude. This enables localiser signals to be used for navigational purposes as long as they are used WITHIN these limits.

GLIDESLOPE

The azimuth coverage extends out to 8 degrees either side of the centreline and out to a distance of 10 NM. However, the vertical limits range from 0.45 x the glidepath angle to 1.75 x the glidepath angle. In the case of a typical 3 degrees glidepath this would equate to 1.35 degrees to 5.25 degrees. YOU PROBABLY NEED TO READ THAT AGAIN to understand it fully.

MARKERS

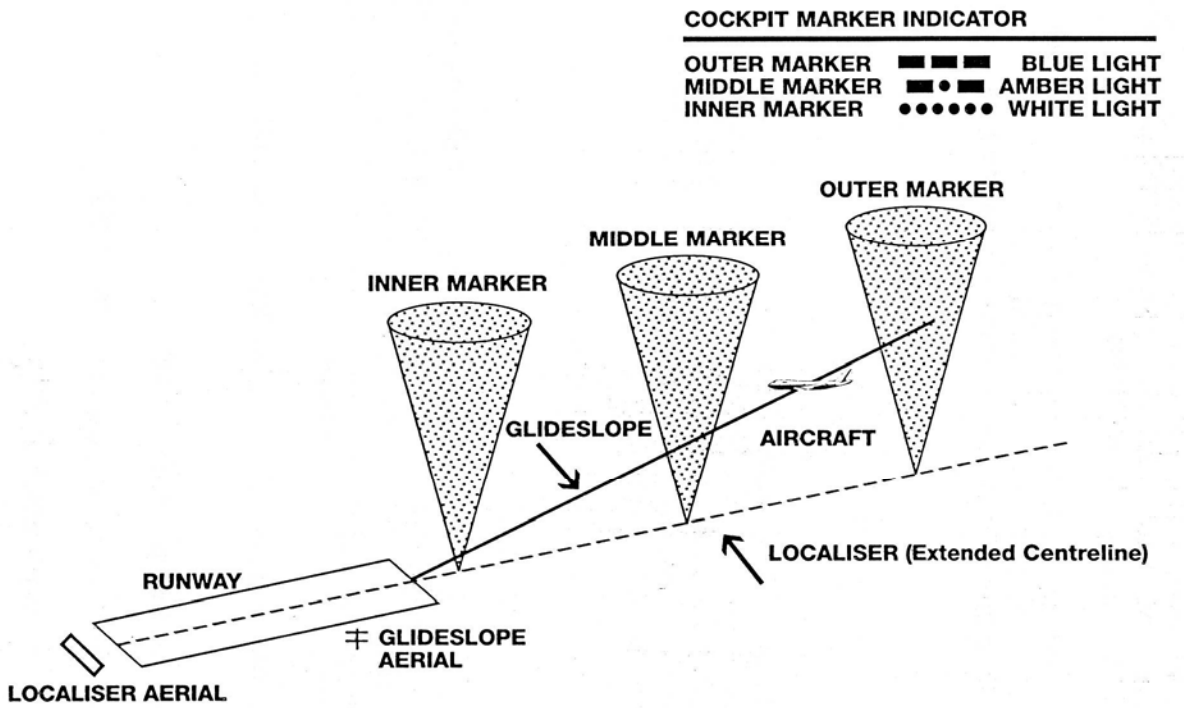
Marker beacons transmit out in the shape of a cone and they can only be picked up from an aircraft flying within the cone. Coverage extends up to approximately 5000 feet as they are fairly low powered, but do not get them mixed up with airways markers as these are much higher in power and can be used up to 50,000 feet so as to enable en-route aircraft navigational assistance.

The cockpit display indicating identification of the markers is as follows:-

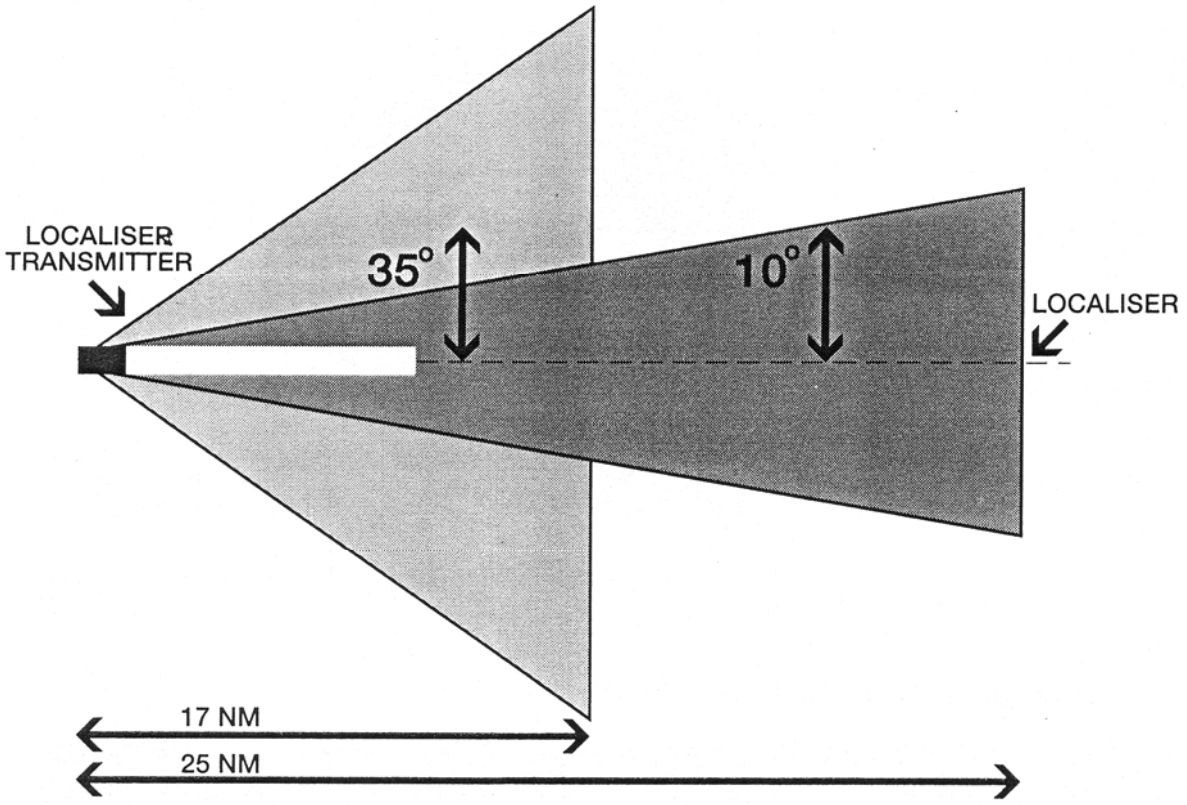
OUTER MARKER – BLUE light and low pitch DASHES

MIDDLE MARKER – AMBER light and medium pitch DASH – DOT – DASH

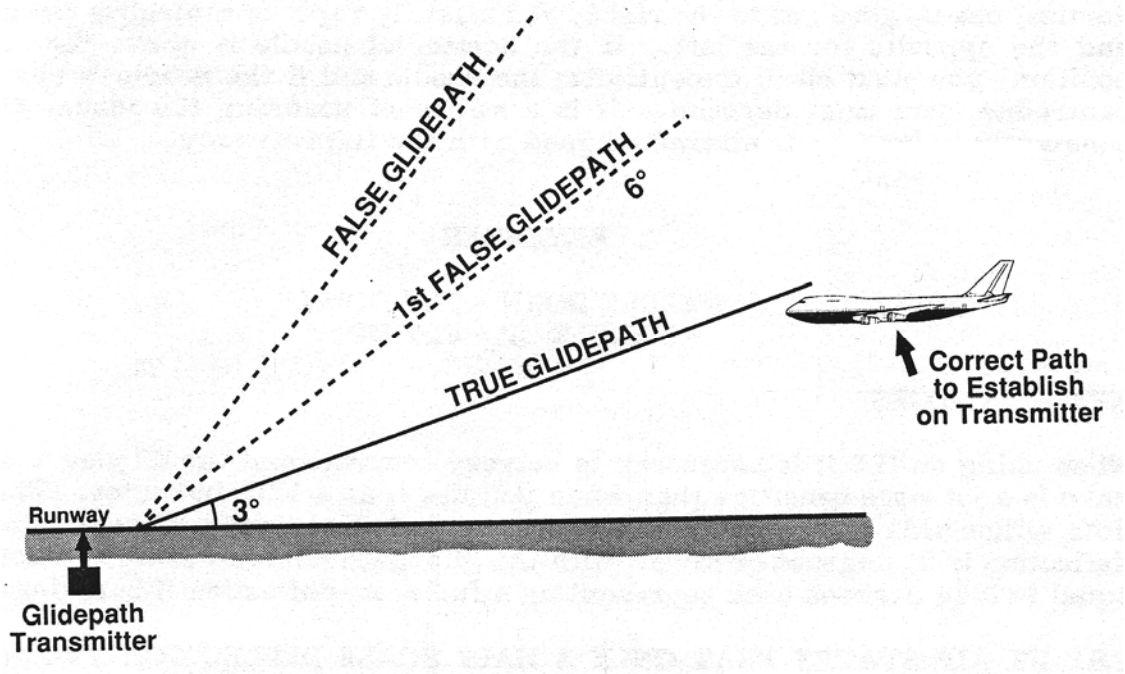
INNER MARKER – WHITE light and high pitch DOTS



LOCALISER COVERAGE

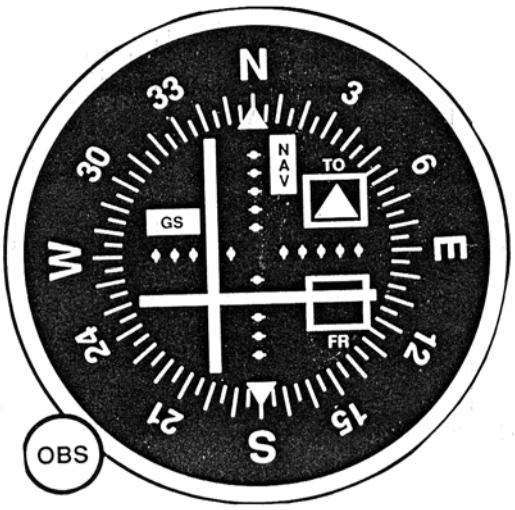


FALSE GLIDEPATHS



STANDARD GLIDEPATH = 3°

1st FALSE GLIDEPATH IS DOUBLE TRUE GLIDEPATH ANGLE = 6°



THE OMNIBEARING INDICATOR

The **OMNIBEARING INDICATOR** shown above is referred to as a five dot display. As you can see, the first dot is incorporated into the ring in the centre of the display. The two needles that you can see give localiser and glidepath information to the pilot. The vertical needle supplies localiser information and the horizontal needle supplies glidepath information. If the needles are not centrally situated it is indicating that the pilot is not correctly aligned with the ILS. If the vertical needle goes out to the right, you must fly right to centralise the needle and the opposite for the left. If the horizontal needle is above the central position, you must climb to centralise the needle, and if the needle is below the centreline you must descend. It is a matter of scanning the visual display constantly to keep your aircraft aligned with the ILS correctly.

REMEMBER

- NEEDLE DOWN – FLY DOWN
- NEEDLE UP – FLY UP

NEEDLE VALUES

When using an ILS it is necessary to be very accurate and the display that you have is a lot more sensitive than when you use it as a VOR indicator. The five dots either side of the centreline represent ½ degree each and so a full scale deflection is 2½ degrees or more. With the glidepath dots, however, the dots are equal to 0.14 degrees each, representing a full scale deflection of 0.70 degrees.

THE UK AIP STATES THAT ONLY A HALF SCALE DEFLECTION BELOW THE GLIDEPATH IS PERMITTED IN ORDER TO REMAIN 'SAFE'.
As you can remember from previous studies, when using the display to track to/from a VOR each dot represents 2 degrees - QUITE A DIFFERENCE!.

INSTRUMENT MINIMA

To be able to work out a minima for a particular approach, we have to decide whether it is a non precision approach or a precision approach.

The non precision approach is one in which tracking guidance only is given, without accurate slope guidance. The NDB and VOR let downs are NON PRECISION APPROACHES as an ILS approach WITHOUT a glideslope.

The minimum height calculated from a precision approach is known as a DECISION HEIGHT DH (based on QFE and height above the runway) or DECISION ALTITUDE DA (based on QNH and height AMSL).

The minimum height calculated for a NON PRECISION APPROACH is known as a MINIMUM DESCENT HEIGHT MDH based on QFE or MINIMUM DESCENT ALTITUDE MDA based on QNH. It should be understood that when making an approach with the aid of a NON PRECISION procedure then the aircraft can be flown usually for a known period of time at the MDH or MDA before a missed approach is commenced. However, on a PRECISION APPROACH when the DH or DA is reached, the missed approach procedure is commenced straightaway.

APPROACH SYSTEM MINIMA (The following figures are for information only and are taken from the UK AIP)

ILS	200 ft..
ILS (no Glide)	250 ft.
SRA (terminating at ½ nm)	250 ft.
VOR NDB VDF	300 ft.
SRA (terminating at 2 nm)	350 ft.

CALCULATION OF DH FOR A PRECISION APPROACH OR MDH FOR A NON PRECISION APP

1) Take the higher value of OCH or system minimum. (Obstacle Clearance Height)

2) An IMC rated pilot must add a further 200 ft. and take the greater of this figure. The absolute minima of 500 ft. for a PRECISION APPROACH and 600 ft. for a NON PRECISION APPROACH.

EXAMPLE: Birmingham RWY 33 ILS OCH CATEGORY A aircraft is 173. What is the DH for an IMC rated pilot?

ANSWER: Take the higher of the OCH 173 and ILS system minima 200 ft. For ILS add altimeter PEC 50 ft. = 250 ft. = IR rated pilot. For IMC rated pilot add 200 ft. = 450 ft. but absolute minima for precision approach is 500 ft.

Answer: 500 ft.

PUBLISHED APPROACH PROCEDURES

Published approach procedures can be found for individual aerodromes in the RAC section of the UK AIP. A detailed description of the procedure is written in this section for the pilot's use. However, diagrammatic approach descriptions are also available and there are two companies who have publications illustrating these. They are AERAD and JEPPERSON

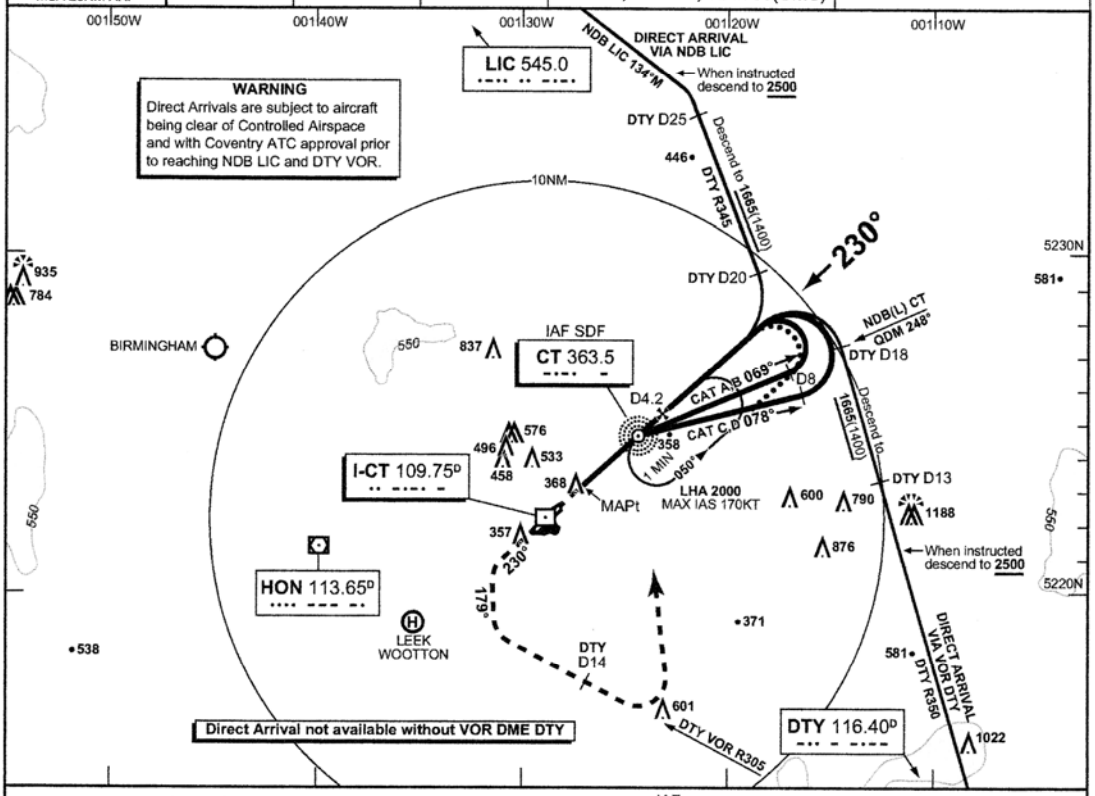
EGBE
CAT A,B,C,D

COVENTRY
NDB(L)/DME RWY 23
CT 363.5/I-CT 109.75

AD ELEV	THR ELEV	TRANSITION ALT	VAR
267FT	265FT	4000	3°W

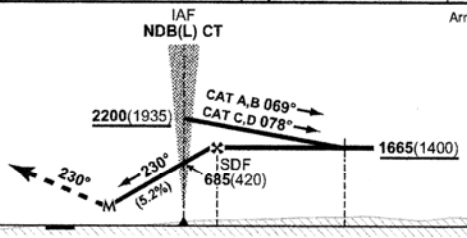
ATIS	APPROACH	RADAR	TOWER
126.050	119.250	122.000	119.250, 124.800, 121.700(GMC)

MSA 25NM ARP



MAPt (M) I-CT DME 1
(2.2NM after NDB(L) CT)

Climb to **1500**. Straight ahead to **765**(500) or I-CT DME 1 outbound whichever is later, NO DME; straight ahead to **1265**(1000), then turn left to track 179° to intercept VOR DTY R305 towards DTY VOR. When within DTY DME 14 (HON DME 9 or more) turn left to NDB(L) CT and continue climb to **2000** or as directed.



DME I-CT zero ranged to THR RWY 23. 0 D4.2 D8

RECOMMENDED PROFILE			RATE OF DESCENT	NDB(L) CT to MAPt		OCA (OCH)		VM(C) OCA (OCH AAL)	
Gradient 5.2%, 320FT/NM						PROCEDURE		TOTAL AREA	
DME I-CT	ALT/HGT	G/S KT	FT/MIN	MIN:SEC					
4	**1595**(1330)	160	800	0:50	A	**645**(380)		**817**(550)	
3	**1275**(1010)	140	700	0:56	B	**645**(380)		**867**(600)	
2	**955** (690)	120	600	1:06	C	**645**(380)		**957**(690)	
		100	500	1:19	D	**645**(380)		**1017**(750)	
		80	400	1:39					

ALTERNATIVE PROCEDURE EXTENDED HOLDING PATTERN
Extend the outbound leg of NDB(L) CT holding pattern to I-CT DME 8, descending to **1665**(1400). At I-CT DME 8, turn left to establish on the extended FAT. Once established continue as for Main Procedure.

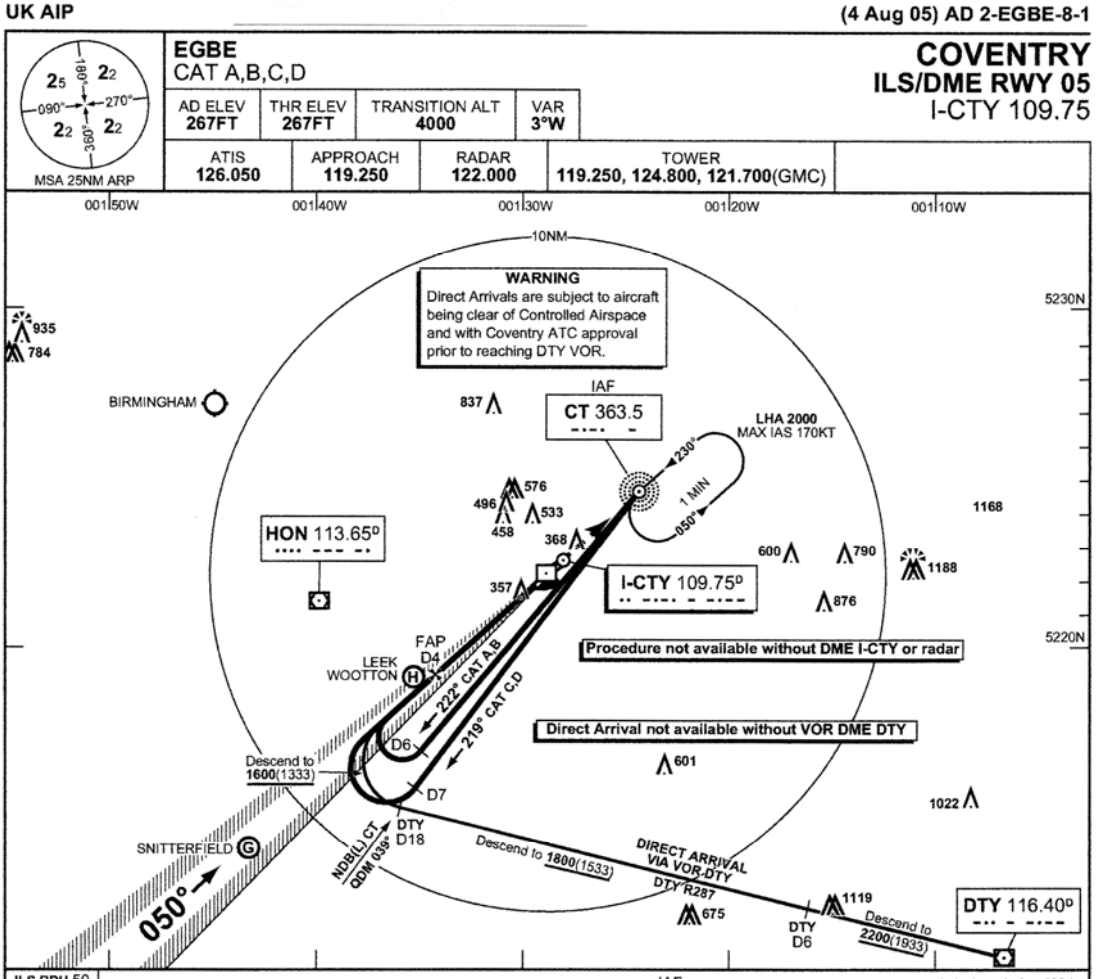
AIRCRAFT UNABLE TO RECEIVE DME I-CT
Fly outbound for 2.5 MIN (CAT A,B); 1.5 MIN (CAT C,D) descending to not below **1665**(1400), then turn left to establish on the extended FAT. When established continue as for Main Procedure.

NOTE Lowest altitude to commence procedure from hold is **2000**.

CHANGE FINAL APPROACH TRACK/HEADINGS UPDATED. OBSTACLES. BEARINGS ARE MAGNETIC

AERO INFO DATE 25 MAY 05 INSTRUMENT APPROACH CHART - ICAO

AMDT 8/05 Civil Aviation Authority



RECOMMENDED PROFILE			RATE OF DESCENT		OCA (OCH)		VM(C) OCA (OCH AAL)	
GLIDE PATH 3°, 320FT/NM					CAT I		TOTAL AREA	
DME I-CTY	ALT/HGT	G/S KT	FT/MIN					
4	**1597** (1330)	160	860	A	**487** (220)		**817** (550)	
3	**1277** (1010)	140	750	B	**497** (230)		**867** (600)	
2	**957** (690)	120	640	C	**507** (240)		**957** (690)	
1	**637** (370)	100	540	D	**517** (250)		**1017** (750)	
		80	430					

AIRCRAFT UNABLE TO RECEIVE DME I-CTY
Advise ATC . Radar ranges will be provided at 6NM (CAT A,B) or 7NM (CAT C,D), outbound and at 4NM inbound.

NOTE Lowest altitude to commence procedure from hold is **2000**.

CHANGE FINAL APPROACH TRACK/HEADINGS UPDATED. OBSTACLES. BEARINGS ARE MAGNETIC

AERO INFO DATE 25 MAY 05 INSTRUMENT APPROACH CHART - ICAO

Civil Aviation Authority AMDT 8/05

WORKSHEET NO. 5 – RADIO AIDS

1) Which of the following are errors affecting NDBs?

   a) Night effect, thunderstorm effect, mountain effect, radiation effect
   b) Night effect, mountain effect, coastal effect, distance effect
   c) Thunderstorm effect, mountain effect, night effect, coastal refraction, quadrantal error, station interference.
   d) Station interference, mountain effect, thunderstorm effect, slant range.

2) An NDB has a promulgated range which is printed in the UK AIP. It is guaranteed to what range?

   a) +/- 10 degrees during daylight hours only
   b) +/- 5 degrees
   c) +/- 5 degrees during daytime hours
   d) +/- 5 degrees 24 hours of the day

3) Which statement is correct concerning NDBs?

   a) They are all high powered beacons used for navigational purposes
   b) Some NDBs are higher powered than others but all are used for en-route navigational purposes
   c) Some lower powered beacons are co-located with outer markers and are used for approach procedures
   d) NDBs transmit polarised signals horizontally.

4) How is a VOR correctly identified by the pilot?

   a) By identifying the beacon on the chart and tuning into the correct frequency
   b) By turning into the correct frequency and identifying it by de-coding the 2 letter morse code ident
   c) By selecting the correct frequency and de-coding the three letter morse code ident
   d) By selecting the required radial and centralising the indicator needle

5) What is the line of sight limitation of a VOR transmitter at a height of 900 feet above sea level and an aircraft flying towards it at 4500 feet?

   a) 220 nm
   b) 155 nm
   c) 450 nm
   d) 121 nm

WORKSHEET NO. 5 – RADIO AIDS (Continued)

6) If you are tracking TO a VOR and you have a FROM flag indicating on your OBS display what will happen to the needle indications?

a) They will indicate incorrectly
b) They will indicate in the opposite sense
c) They will not indicate at all
d) The NAV flat will appear to warn the pilot that the wrong flag has been selected

7) The horizontal dots on the OBS indictor are equal to how many degrees?

a) 5 degrees
b) 1.5 degrees
c) 2 degrees
d) 3 degrees

8) Which of the following statements is correct concerning a DME?

a) It measures slant range and so will never read zero if flying over it
b) It measures distance slant range from the station to the aircraft and gives this distance in km
c) It is always coupled with a VOR and uses the same frequency
d) It is identified by listening to the music through the headset

9) A category 3ILS is:

a) Accurate guidance down to 200 feet
b) Accurate guidance down to 50 feet
c) Accurate guidance down to 100 feet
d) Accurate guidance down to and along the runway

10) What are the colours of the marker lights in the cockpit in order outer, middle and inner?

a) Amber, blue and green
b) Blue, white and green
c) Blue, amber and white
d) White, amber and blue

11) The middle marker is normally located --------- nm and has an ---------- indication

a) 2 and - - - .
b) 1-1½ and . . . . .
c) 1 and - - - .
d) ½-1½ - . –

WORKSHEET NO. 5 – RADIO AIDS (Continued)

12) Given a 2.5 degree glideslope, the first false glideslope is found above this angle. What would it be?

a) 6 degrees
b) 7.5 degrees
c) 5 degrees
d) 3 degrees

13) The localiser gives coverage out to --- nm from the transmitter and is checked out to --- from the transmitter

a) 12 nm and 10 nm
b) 25 nm and 10 nm
c) 15 nm and 12 nm
d) 10 nm and 25 nm

14) The needle values when using the onmibearing indicator on an ILS approach are --- glideslope and --- localiser

a) 0.14 and 2 degrees
b) 1.4 and 2 degrees
c) 0.14 and 0.5 degrees
d) 2 and 0.14 degrees

15) Decision height is related to what approach?

a) Non precision approach
b) Precision approach
c) ILS approach
d) Both and b

16) If after calculating your minima for an ILS approach and it is 420 feet, what is your absolute minima you can descend to?

a) 420 feet
b) 620 feet
c) 500 feet
d) 600 feet

17) For an IMC rated pilot carrying out a VOR/DME let down into an airfield with an OCH of 550 feet, what is the absolute minima he can descend to?

a) 600 feet
b) 500 feet
c) 750 feet
d) 1000 feet

18) Which of the following is a precision approach?

a) ILS with markers and localiser information
b) NDB let down
c) VOR/DME let down
d) ILS approach with glideslope, markers and localiser

RADIO AIDS ANSWER SHEET

	a	b	c	d
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				

No.	a	b	c	d
16				
17				
18				

FLIGHT PLANNING

The flight planning section in the IMC written paper mainly involves completing a flight plan similar to the one on the next page. You will be expected to complete the form using your 'whizzy wheel' computer No pre-programmable computers are allowed! Up to six questions could possibly be asked regarding the information you have worked out on the flight plan.

It should really only mean perhaps a little revision on how to compute drift magnetic headings, groundspeeds and fuel calculations etc. Time should be taken on this section as accuracy is needed. Worksheet six should give you a little practice.

In the flight planning stage all the following points must be considered:-

1) It is a requirement that the pilot in command of an aircraft complies with Article 31 of the ANO – Airfield Operating Minima.

   The weather en-route and at the destination alternate and a forecast at the departure airfield must be checked for landing minima (icing levels).

2) Aircraft and its equipment must be pre-flighted (PITOT HEAT, ALTINATOR RADIOS)

3) NOTAMS (Is the let down procedure available – en-route NAV AIDS working?)

4) Preparation of charts – Are they current?

5) Is a flight plan required?

The **QUADRANTAL RULE** should be considered as well as the IFR regulation of 1000 ft. above the highest fixed object within 5 nm of track. This later point must be used in the examination flight plan when working out the minimum safety sector altitude.

APPROACH INFORMATION

Minimum Safety Altitude, Obstacle Clearance Height and a description of an instrument approach reference to the UK AIP RAC 4-1-1 lists all procedures for published instrument approaches, together with missed approach procedures. This of course is where AERAD and JEPPERSON glean the details for their familiar plates.

FLIGHT PLAN FORM CA48

Although the flight plan form CA48 is not a requirement in the IMC ground syllabus, it may be useful to you to study the enclosed example of a flight plan for a journey Birmingham International to Le Touquet – France. For those of you who have not filed a flight plan, the form is not as daunting as it looks!

A full explanation of how to complete the form is available in CAP 511 available from CAA printing and publishing department, Cheltenham - but, in brief, follow through this example.

Item 7: Aircraft Identification

8 **Flight Rules** V = VFR, I = IFR, Others refer CAP 511. Type of flight G = General Aviation, S = Scheduled air service – others see CAP 511.

9 **Number of aircraft** – only fill this in if more than one aircraft. Type of aircraft e.g. PA 28. Wake turbulence category L = Light up to 7000 kgs, M = Medium over 7000 kgs and up to 136000 kgs, and H = Heavy over 136000 kgs.

10 **Equipment**. For full decodes refer CAP 511 but S = standard equipment (VOR, ADF, VHF, RTF and ILS). Transponders – 4 = mode ALPHA 4096 codes and C = mode ALPHA and CHARLIE 4096 codes.

13 **Departure Aerodrome** – use ICAO four-letter code. Time = departure time GMT.

15 **Cruising speed** – use N for knots, K for km per hour and M for mach number, e.g. N0105 = TAS is 105 knots. Use the TAS of the aircraft. Level is flight level required on first sector i.e. FL010 = Flight level 10. If either the cruising airspeed or level is planned to change en route then this must be indicated on the flight plan in the route section. Refer CAP 511. The route section should include all beacons and reporting points en route as in our example Daventry, Bovingdon, Lambourne, Detling, Lydd, Le Touquet.

16 **Destination Aerodrome** – use ICAO four-letter code. Total EET = total estimated elapsed time from departure until overhead destination. Alternate and 2nd alternate aerodrome use ICAO four-letter code.

18 **Other Information** should include EETs for crossing mandatory reporting points and boundaries i.e. EET/EFFF 0110 decodes estimate for crossing London FIR is 1 hr 10 mins from departure time.

19 **Endurance** is aircraft fuel endurance in hours and minutes. Persons on board 004 = 4 POB 4-- = 400 POB.

FLIGHT PLAN

PRIORITY: FF

ADDRESSEE(S):

FILING TIME:

ORIGINATOR:

SPECIFIC IDENTIFICATION OF ADDRESSEE(S) AND/OR ORIGINATOR:

3 MESSAGE TYPE: (FPL

7 AIRCRAFT IDENTIFICATION: GBOKK

8 FLIGHT RULES: V

TYPE OF FLIGHT: G

9 NUMBER:

TYPE OF AIRCRAFT: P.A.2.8

WAKE TURBULENCE CAT.: L

10 EQUIPMENT: S/C

13 DEPARTURE AERODROME: EGBB

TIME: 0900

15 CRUISING SPEED: N0105

LEVEL: V.F.R.

ROUTE: DTY BNN LAM DET LYD LT

16 DESTINATION AERODROME: LFAT

TOTAL EET HR.MIN: 0150

ALTN AERODROME: EGMD

2ND. ALTN AERODROME:

18 OTHER INFORMATION: EET/EFFF 0110

SUPPLEMENTARY INFORMATION (NOT TO BE TRANSMITTED IN FPL MESSAGES)

19 ENDURANCE HR.MIN: E/ 0430

PERSONS ON BOARD: P/ 004

EMERGENCY RADIO: R/ U V E

SURVIVAL EQUIPMENT: S / P D M J / L F U V

DINGHIES: NUMBER D / 01 CAPACITY 004 COVER C COLOUR YELLOW

AIRCRAFT COLOUR AND MARKINGS: A/ WHITE BLUE STRIPE

REMARKS: N /

PILOT-IN-COMMAND: C/ YOUNG

FILED BY

SPACE RESERVED FOR ADDITIONAL REQUIREMENTS

SURVIVAL EQUIPMENT

Cross through any survival equipment NOT carried on board. If dinghies are carried the number, capacity, cover and colour should be indicated. If they are not carried cross through D for dinghy.

The aircraft's colour and markings should be included and any remarks, if necessary, entered in the remarks section.

The pilot in command should enter his name in the last section and whoever is filing the flight plan should sign the bottom of the form.

Hopefully this explanation has helped you to understand this form a little better, but obviously the more flight plan forms you complete the quicker they become to fill out.

It is mandatory to file a flight plan with ATC if you plan to cross a UK FIR boundary and if you plan to fly IFR in controlled airspace but, as you know from the airlaw section, you must have an INSTRUMENT RATING to fly IFR in controlled airspace. However, a flight plan can be filed with ATC for any flight whatsoever!

WORKSHEET NO. 6 – FLIGHT PLANNING

1) Convert 27.4 statute miles to nautical miles and kilometres

   a) 23.4 nautical miles and 43.3 kilometres
   b) 23.2 nautical miles and 43.5 kilometres
   c) 24.5 nautical miles and 45.9 kilometres
   d) 23.8 nautical miles and 44.1 kilometres

2) Convert 46 nautical miles to metres

   a) 78,200 metres
   b) 74,000 metres
   c) 85,000 metres
   d) 82,500 metres

3) Convert 3,300 metres to feet

   a) 10,400 feet
   b) 11,200 feet
   c) 10,800 feet
   d) 10,100 feet

4) Convert 116 imperial gallons to US gallons and litres

   a) 139 US galls and 526 litres
   b) 127 US galls and 482 litres
   c) 151 US galls and 572 litres
   d) 132 US galls and 500 litres

5) Convert 404 litres to US gallons and imperial gallons

   a) 116 US and 97 imperial
   b) 107 US and 89 imperial
   c) 112 US and 93 imperial
   d) 103 US and 86 imperial

6) The forecast wind velocity is 270/35 kt. The TAS is 132 kts and the true track required is 026 degrees. The mean variation for the flight is 5 degrees W. The magnetic heading and ground speed will be:

   a) 025 and 143 kits
   b) 045 and 147 kits
   c) 017 and 112 kts
   d) 014 and 146 kits

7) The TAS calculated for the flight is 124 kits and the track required is 302 degrees True. The forecast wind velocity is 140/20 kts. What will be the true heading and groundspeed:-

a) 306 and 142 kts
b) 299 and 144 kts
c) 325 and 149 kts
d) 286 and 135 kts

8) How long will it take to fly 246 nautical miles at 147 miles per hour:

a) 107 minutes
b) 100 minutes
c) 115 minutes
d) 123 minutes

FLIGHT PLANNING ANSWER SHEET

No.	a	b	c	d
1				
2				
3				
4				
5				
6				
7				
8				

Morse code

A .−	N −.
B −...	O −−−
C −.−.	P .−−.
D −..	Q −−.−
E .	R .−.
F ..−.	S ...
G −−.	T −
H	U ..−
I ..	V ...−
J .−−−	W .−−
K −.−	X −..−
L .−..	Y −.−−
M −−	Z −−..

Private Pilot's Licence IMC Rating

MOCK PAPER

EXAMINATION ANSWER SHEET

Name	
Signature	Date

No.	a	b	c	d
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				

No.	a	b	c	d
16				
17				
18				
19				
20				
21				

IMC MOCK PAPER

1) When is the holder of an IMC rating allowed to fly under IFR in controlled airspace?

   a) When visual contact with the ground can be maintained.

   b) When in a noted entry or exit lane for a specific aerodrome.

   c) When flying at an altitude not exceeding 3000 feet.

   d) Never.

2) You pass the IMC rating flight test on 24th January 1990 and the rating is subsequently issued to you on 5th February 1990. What is the last day on which you may exercise the privileges of the rating without further successful flight test?

   a) 28 February 1991

   b) 5 February 1992

   c) 23 February 1992

   d) 4 March 1992

3) In planning a cross-country flight to be flown outside controlled airspace under IFR you find that the highest obstacle within 5nm of the track between B and C is 2015 amsl. If the magnetic track is 055 deg. What is the lowest quadrantal level for the leg?

   a) 3000 feet

   b) 3500 feet

   c) FL 40

   d) FL 50

COMPLETE THE ATTACHED FLIGHT PLAN USING THE ICAO 1:500 000 CHART FOR SOUTHERN ENGLAND AND THEN ANSWER QUESTIONS 6 TO 10. Safety heights should be the minimum heights to fly calculated in accordance with the instrument Flight Rules and rounded up in hundreds of feet.

From	To	FL.Alt	Safety Alt ft amsl	TAS kt	W/V	Trk T	Drift	Hdg T	Varn	Hdg M	GS kt	Dist nm	Time min
Cambridge Airport	Daventry VOR	Climb		120	260/25								
Daventry VOR	Brecon VOR	40		120	280/20								
Brecon VOR	Cardiff NDB	Desc		120	300/20								
	ALTERNATE												
Cardiff NDB	Swansea NDB	45		120	300/20								

4) The total distance for this route from Cambridge to Cardiff is:

a) 76 nm.

b) 126 nm.

c) 151 nm.

d) 247 nm.

5) What is the flight plan groundspeed between Daventry and Brecon?

a) 96 kt.

b) 99 kt.

c) 102 kt.

d) 105 kt.

6) What is the flight plan safety altitude between Daventry and Brecon?

a) 2900 ft

b) 3000 ft

c) 3600 ft

d) 4000 ft.

7) What is the flight plan magnetic heading between Cardiff and Swansea?

a) 287 deg.

b) 290 deg.

c) 299 deg.

d) 302 deg.

8) Assuming an ET of 1030 UTC from Cambridge, the flight plan ETA at Cardiff will be:

a) 1150

b) 1159

c) 1209

d) 1218

9) What is signified when an NDB is described as a locator?

a) It is a relatively low power and supplementary to a stronger NDB at the aerodrome

b) It is an aid for use as part of a published instrument approach procedure

c) It is intended for use as an en-route navigation aid only

d) It has a cone-shaped radiating pattern which concentrates power close to the beacon to minimise interference with other navaids.

10) What will happen to the altimeter if the pitot pressure source becomes blocked in flight?

a) It will under-read at all levels

b) It will over-read at all levels

c) It will be unaffected

d) It will give the same reading as when it became blocked.

11) If the recommended Minimum Descent Height (MDH) for a given procedure is 330 feet, what MDH should be applied by an IMC rating holder when using such a procedure?

a) 730 feet

b) 530 feet

c) 500 feet

d) 600 feet

12) What range would be indicated from a frequency paired DME/ILS facility when at the threshold of the runway with which it is associated?

a) Zero

b) Slant range from the DME facility

c) Range from the DME facility to the point on the ground directly beneath the aircraft

d) Slant range from the localiser transmitter

13) Which is the Morse Code identification for the letters S A M?

a) ...-.--

b) .-.-.--

c) ...-.--

d) ..-.-....

14) Flying a magnetic track of 135 degrees with 11 degrees of port drift you wish to revise ETA by checking the time which an NDB to left of track is on a bearing exactly at right angles to track. If the aircraft is fitted with an ADF relative bearing indicator, what will it read at this time?

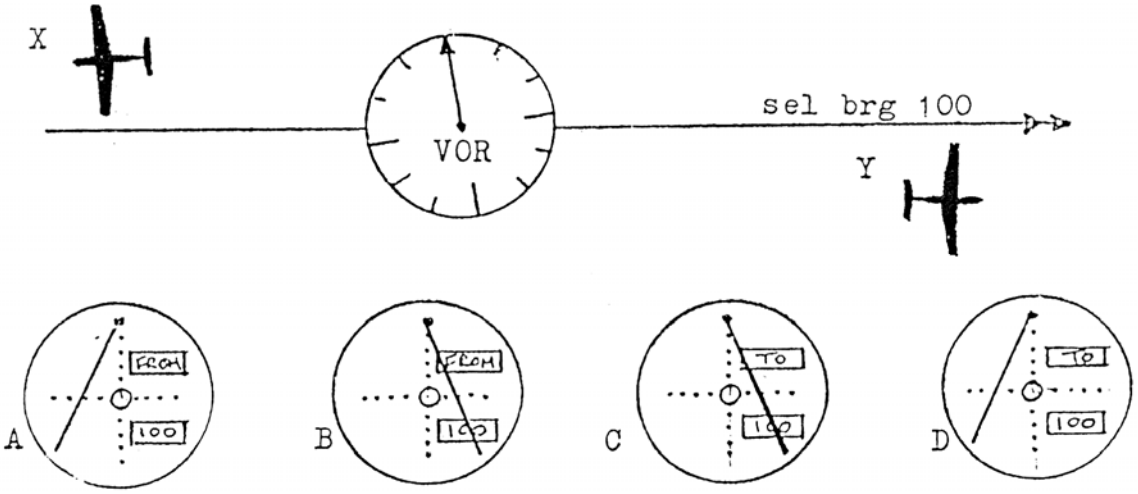
a) 270 degrees

b) 259 degrees

c) 248 degrees

d) 281 degrees

EXAMINE THE SITUATION SHOWN BELOW WHRE AIRCRAFT X AND Y BOTH HAVE A VOR BEARING OF 100 SELECTED ON THEIR DEVIATION INDICTORS AND THEN ANSWER QUESTIONS 15 AND 16.



15) Which of the four indications shown above is being obtained by X?

a) A

b) B

c) C

d) D

16) Which of the four indications shown above is being obtained by Y?

a) A

b) B

c) C

d) D

17) What is the theoretical maximum range at which an aircraft at an altitude of 3000 feet can expect to receive VHF signals from a station at sea level?

a) 65 nm.

b) 109 nm.

c) 85 nm.

d) 79 nm.

18) What is the azimuth coverage of the glide path either side of the ILS localiser centreline, 10 nm from the threshold?

a) 25 deg.

b) 10 deg.

c) 8 deg.

d) 5.25 deg.

19) An NDB has a promulgated range during the daytime from which pilots can expect to obtain bearing information to an accuracy of:-

a) +/- 2 deg.

b) +/- 10 deg.

c) +/- 7 deg.

d) +/- 5 deg.

20) A bearing with a +/- 10 degrees is known as what flass?

a) A

b) B

c) C

d) D

21) When should QFE be set if performing a published let down procedure at an airfield?

a) In the hold

b) With the FREDA checks on approaching the airfield

c) Beacon inbound

d) On final approach

WORK SHEET ANSWERS

Worksheet 1 – Aviation Law

1. b

2. c

3. a

4. c

5. b

6. c

7. c

8. c

9. d

10. c

Worksheet 2 - Meteorology

1) TAF 0800 hrs - 170 hrs 210 degrees 20 knots visibility 3500 metres in rain 5 oktas stratus 1200 feet 6 oktas cumulus at 5000 feet temporary variations between 10.00 hrs and 12.00 hrs visibility reducing to 1500 metres 7 oktas stratus at 800 feet and heavy rain.

TAF 07.00 hrs – 16.00 hrs 150 degrees 10 gusting 20 knots in excess of 10 km visibility 3 oktas of cumulus at 1000 feet and No significant change expected.

2) METAR issued at 09.20 hrs 290 degrees 25 gusting 35 knots visibility in excess of 10 km 5 oktas of cumulus 3000 feet 7 oktas altocumulus at 7000 feet temperature is 10 degrees and dew point is 4 degrees QNH is 1032 No significant change expected.

METAR issued at 17.50 hrs 220 degrees 5 knots visibility is 500 metres in FOG temperature is 8 degrees and dew point is 8 degrees. QNH 12 998 Gradual change with visibility improving to 3500 metres and 7 oktas of stratus at 500 feet.

3. d

4. d

5. d

6. c

7. c

8. c

9. c

10. d

11. d

12. d

Worksheet 3 – Radio

1. **d**
2. **d**
3. **c**
4. **d**
5. **b**
6. **c**
7. **d**
8. **c**
9. **b**
10. **d**
11. **d**
12. **c**
13. **a**
14. **b**
15. **b**

Worksheet 4 – Flight Instruments

1. **d**
2. **c**
3. **a**
4. **c**
5. **a**
6. **b**
7. **b**
8. **c**
9. **d**
10. **b**

Worksheet 5 – Radio Aids

1.c

2.c

3.c

4.c

5.d

6.b

7.c

8.a

9.d

10.c

11.d

12.c

13.b

14.c

15.b

16.c

17.c

18.d

Worksheet 6 – Flight Planning

1.d

2.c

3.c

4.a

5.b

6.d

7.b

8.c

ADF/NDB Answers

1.b

2.a

3.b

4.c

5.c

6.b

7.b

8a.b

8b.d

8c.b

8d.c

VOR Cockpit Display Answers

1. **B**
2. **B**
3. **D**

Private Pilot's Licence IMC Rating

MOCK EXAMINATION ANSWER SHEET

No.	a	b	c	d
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				

No.	a	b	c	d
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