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GSM-G-ATP.035

DOCUMENT TITLE
RADIO NAVIGATION

CHAPTER 7 – INSTRUMENT LANDING SYSTEM (ILS)

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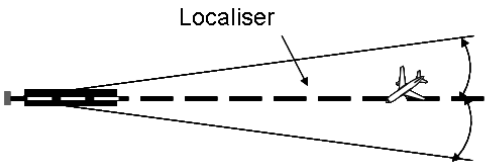
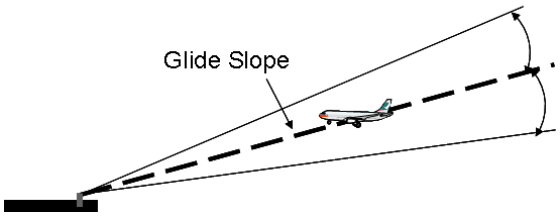
CHAPTER 7: INSTRUMENT LANDING SYSTEM

INSTRUMENT LANDING SYSTEM

Instrument Landing System is a runway approach aid providing lateral (localizer) and vertical (glideslope) guidance that allows aircraft to safely approach the runway from several miles out.





SYSTEM OVERVIEW - ILS GROUND TRANSMITTERS

The ILS consists of the following components:

The Localizer transmitter which provides lateral or azimuth guidance along a path which is normally aligned with the extended centre line.

The Glide Slope transmitter which provides approach guidance in the vertical plane.

The Marker beacons which provide range check points.

Equipment which may be used in conjunction with ILS includes the following:

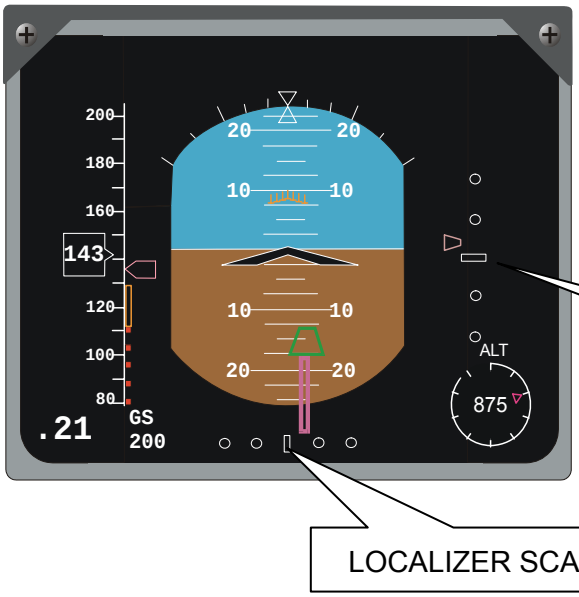
- Locators which are low power NDBs, usually at the Outer Marker
- Terminal VORs
- DME which can provide range to the ILS runway threshold.

SYSTEM OVERVIEW - ILS AIRBORNE EQUIPMENT

ILS equipment in the aircraft consists of a receiver with localizer, glideslope and marker beacon facilities, three aerials, a control unit, and an indicator displaying localizer and glideslope deviation and a set of marker beacon lights.

The control unit normally allows either ILS or VOR frequencies to be selected. Selection of the VHF localizer frequency automatically selects the paired UHF glideslope frequency.

ILS information can be displayed on several different types of indicator such as ILS/VOR deviation indicators, Flight Directors or EFIS (EADI or EHSI).



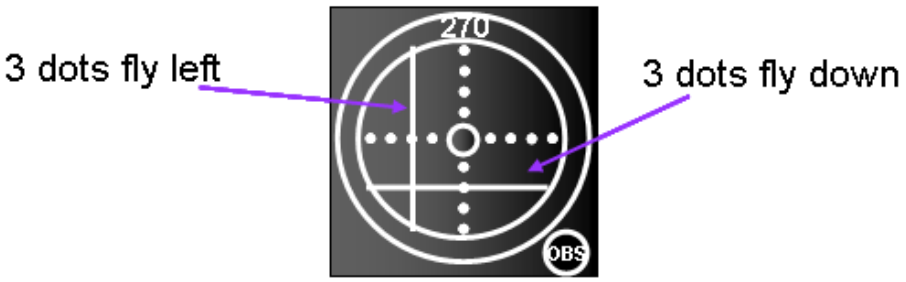
On this Electronic Attitude Director Indicator (EADI), the position of the aircraft in relation to the localizer can be seen from the pointer and scale at the bottom and in relation to the glideslope from the pointer and scale on the right.

GLIDESLOPE SCALE

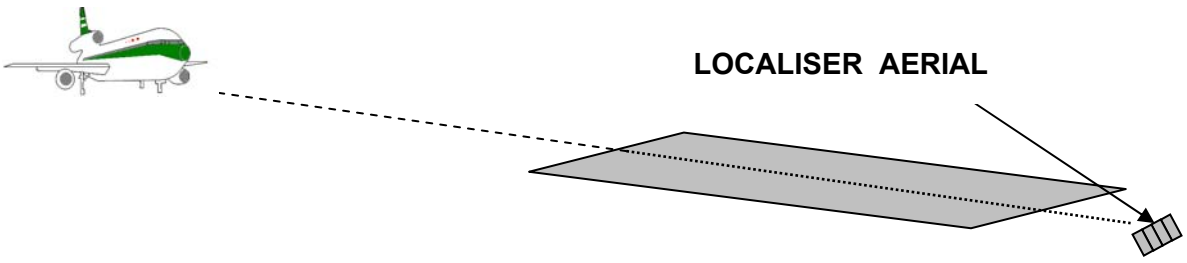
LOCALIZER SCALE

An old style deviation indicator (see below) shows lateral deviation (localizer) and vertical deviation (glideslope) in relation to the aircraft represented by the centre of the indicator. Warning flags are displayed when the airborne equipment has detected that the localizer or glideslope information has become unreliable.

An old style ILS indicator

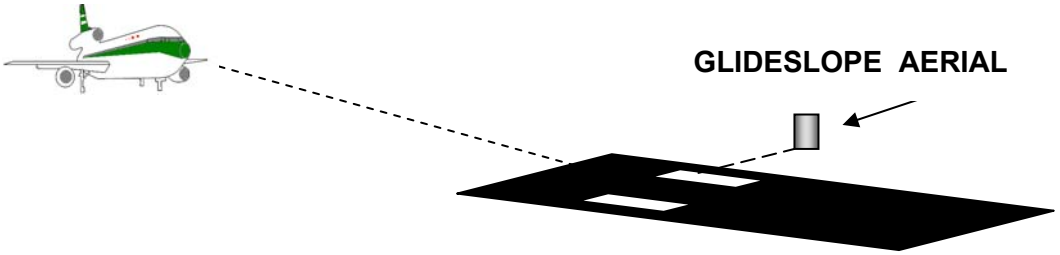


LOCATION OF THE TRANSMITTER (TX) AERIALS



The Localizer aerial is positioned approximately 300 m beyond the far end of the runway and ideally transmits in line with the extended centre line. At some airports this may not be possible due to topographical features and so an “offset localizer” may be required.

The Glide Slope aerial is located abeam the ILS touch down zone, typically 300 m upwind from the threshold and 100-200 m away from the centre line.



The Marker beacons are located as follows:

OUTER MARKER	3 to 6 nm from threshold
MIDDLE MARKER	1/2 to 1 nm from threshold
INNER MARKER	Close to threshold

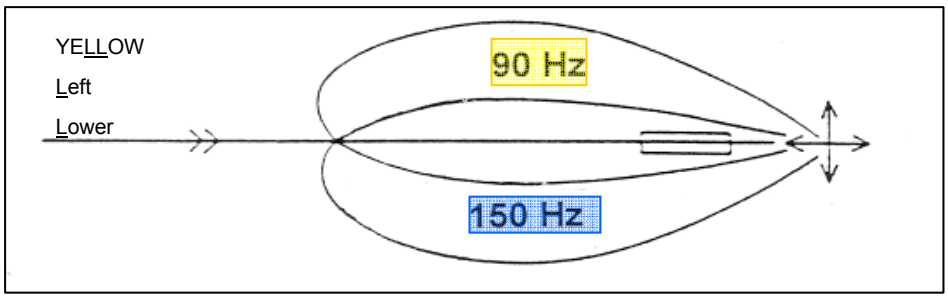
Markers may not be exactly on the extended centre line.

Inner Markers are seldom used but may be found at CAT 2 or CAT 3 facilities.

THE LOCALIZER TRANSMISSIONS

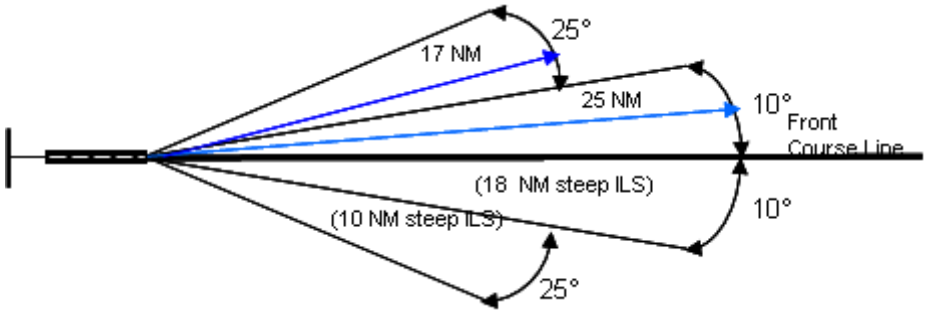
Localizers transmit in the VHF band on frequencies between 108 and 112 MHz. This range of frequencies is shared with VOR so only the odd tenths (plus 50 kHz) are available for ILS. Typical localizer frequencies are 108.10, 108.15, 108.30 etc.

The transmission pattern of the Localizer consists of two overlapping lobes transmitted on a single VHF frequency but carrying different amplitude modulation. For an approaching aircraft the left lobe is modulated at 90Hz and the right at 150Hz.



The depth of modulation is made to vary so that it is greatest at the centre and least at the sides of the lobes. The Difference in Depth of Modulation (DDM) determines the position of the localizer needle; when the lobes are received with equal depth the needle will be centralized.

The localizer may be identified by a Morse audio signal consisting of 3 letters beginning with I. In addition ATIS may be received through voice modulation. The service area of the localizer is shown below. This is also known as localiser coverage or validity area.



SERVICE AREA OF THE LOCALIZER

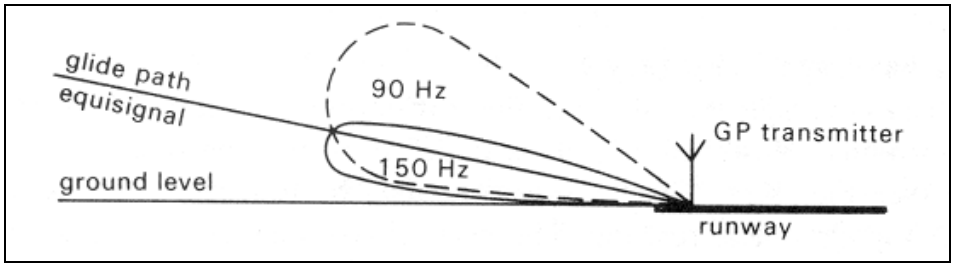
Pilots are warned that use of the localizer outside the service area may lead to both false course and reverse sensor indications being received.

Some ILS localizers transmit significant back course lobes but pilots are advised that no provision is made in some countries, such as the UK, for such back beams to be used and any indication from them must be ignored. In any case, an approach to an ILS equipped runway in the reverse direction by means of a back beam would have the following problems:

- No glide slope indications.
- Less accurate than front beam.
- No markers.
- Needle sense reversed.

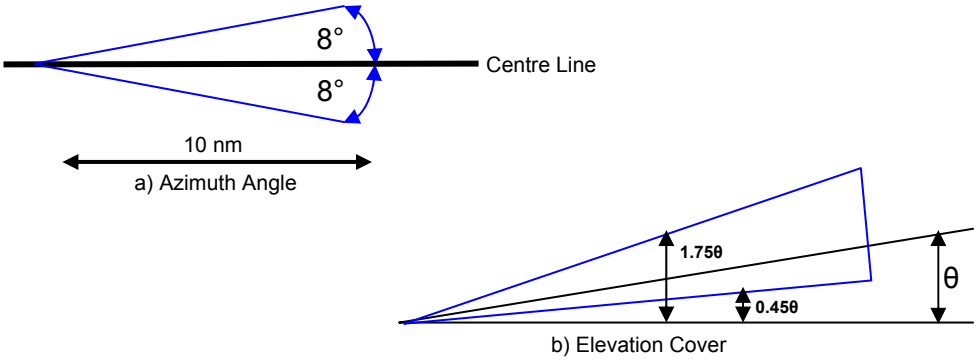
THE GLIDE SLOPE TRANSMISSIONS

Glide Slope transmissions are in the UHF band on frequencies between 329 and 335 MHz. Like the localizer, the Glide Slope transmission pattern consists of two overlapping lobes on the same radio frequency but at different rates of amplitude modulation. The lobe above the glide slope is modulated at 90Hz and the lobe below is modulated at 150Hz.



The Glide Slope carries no identification as verification of the correct localizer frequency through its call-sign is sufficient. The correct glide slope frequency is automatically set when the correct localizer frequency is selected and verified.

The service area of the Glide Slope in azimuth and elevation is shown below. This is also known as glide slope coverage or validity area.

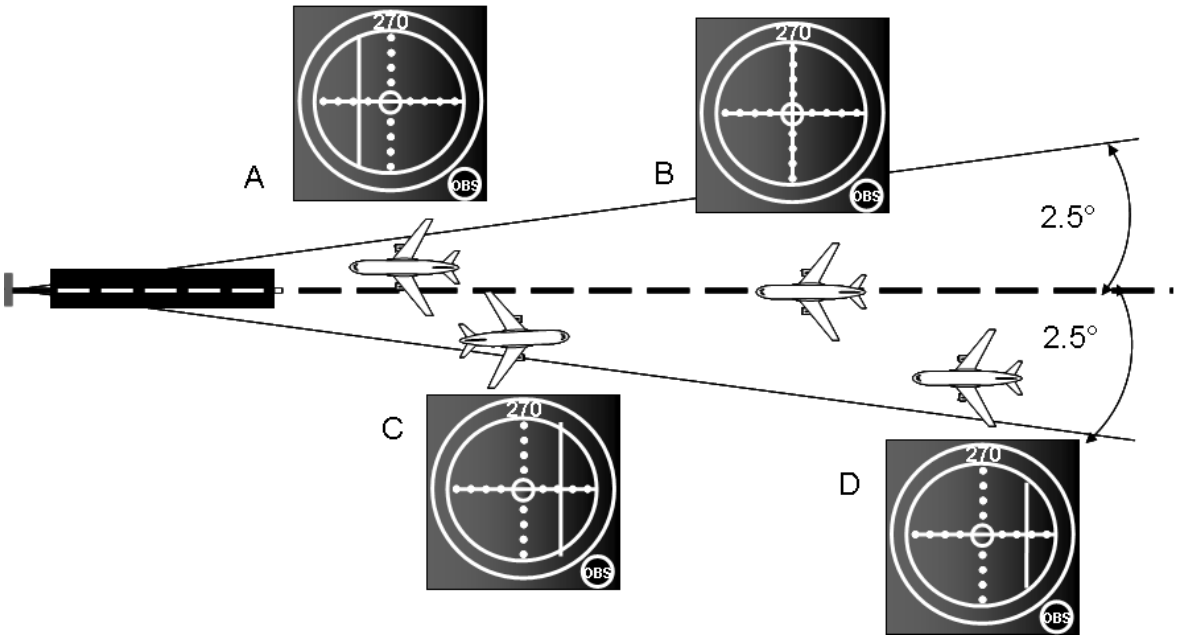


SERVICE AREA OF THE GLIDE SLOPE

LOCALIZER INDICATIONS

The localizer needle moves left or right according to which modulated signal is more strongly received. For example, an aircraft approaching the runway but right of the extended centre line would result in needle deflection to the left. If the aircraft is on the localizer, the 90Hz and 150Hz signals will be received with equal strength and the needle will be centred.

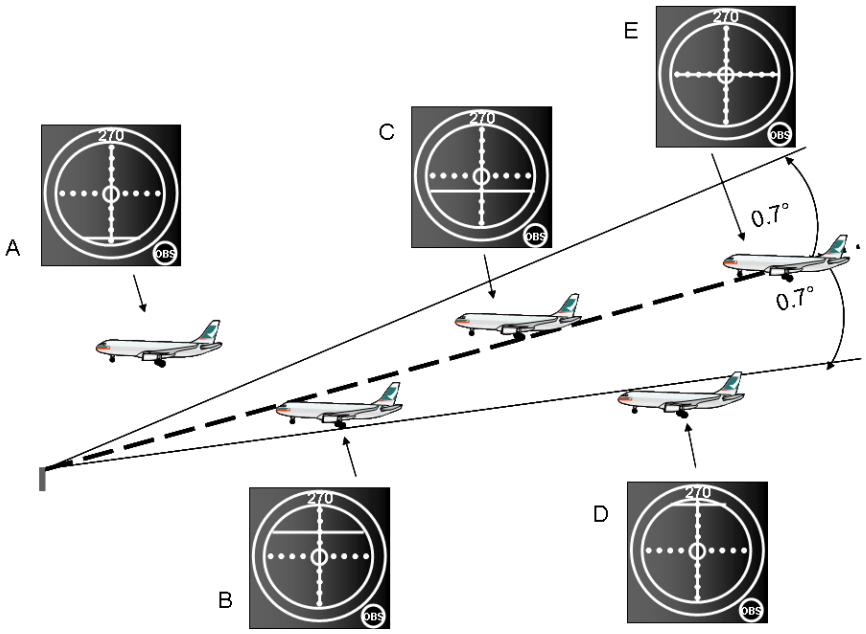
Full scale deflection of the localizer needle occurs when the aircraft is 2½° left or right of the centre line. On a 5 dot display, each dot is worth ½°.



It should be noted that the indications depend on which modulated signal is more strongly received (DDM) and not on the heading of the aircraft. An aircraft outbound from the airport on the approach side of the ILS would obtain 'non-command' indications, that is the aircraft would need to fly away from the needle to regain the centre line.

GLIDE SLOPE INDICATIONS

The glide slope needle responds in a similar way to deviation from the desired flight path. If the aircraft is below the glide slope, the needle will be above the centre. Full scale deflection corresponds to .7° but is should be noted that the UK AIP advises than ½ full scale fly up is the maximum safe deviation below the centre line of the glide slope.



An aircraft outbound from an airport on the approach side of the ILS and above the glide path would obtain a 'fly-down' indication. There are no glide slope transmissions associated with any localizer back beam.

MARKER BEACONS

All marker beacons transmit on a radio frequency of 75MHz. The energy pattern is fan shaped and mainly vertical with the result that there is very little chance of interference. By comparing the pressure or radio altimeter readings with the published height of the glide slope at the markers, it is possible to check the proper functioning of the ILS. Passage over the markers also allows range from touch-down to be checked. Outer, middle and inner markers transmit on the same radio frequency but with different rates of amplitude modulation. The modulated signal contains Morse-type dots and dashes and activates the blue, amber or white lights which flash in synchronism with the dots and dashes.

MARKER	CHARACTER	RATE	PITCH	LIGHT
OUTER	dashes	2 per sec	400 Hz	Blue
MIDDLE	alt. dots/dashes	3 per sec	1300 Hz	Amber
INNER	dots	6 per sec	3000 Hz	White

MARKER LIGHTS

FLAG ALARMS

Flag alarms may appear and the needles may centralize when:-

- the aircraft is outside of the ILS service areas
- there is a significant fault in the transmission, e.g. modulation not detected.

- the ground or airborne equipment is switched off.

  Note: Extreme caution should be applied if the ground monitors (see 7.11) are unserviceable. It is possible that a faulty transmission may be undetected by the aircraft ILS receiver giving rise to dangerously incorrect ILS readings.

FALSE GLIDE SLOPE

It is difficult to transmit the 150 Hz lobe below the 3° (typical) glideslope without causing reflections of the transmission from the ground. The unwanted ground reflections can cause false glide slopes to appear, that is the glide slope needle may centralize when the aircraft is well above the true glide slope. In practice, false glide slopes are not dangerous as they are above the true glide slope and noticeably steep (not less than 2 x normal glide slope angle).

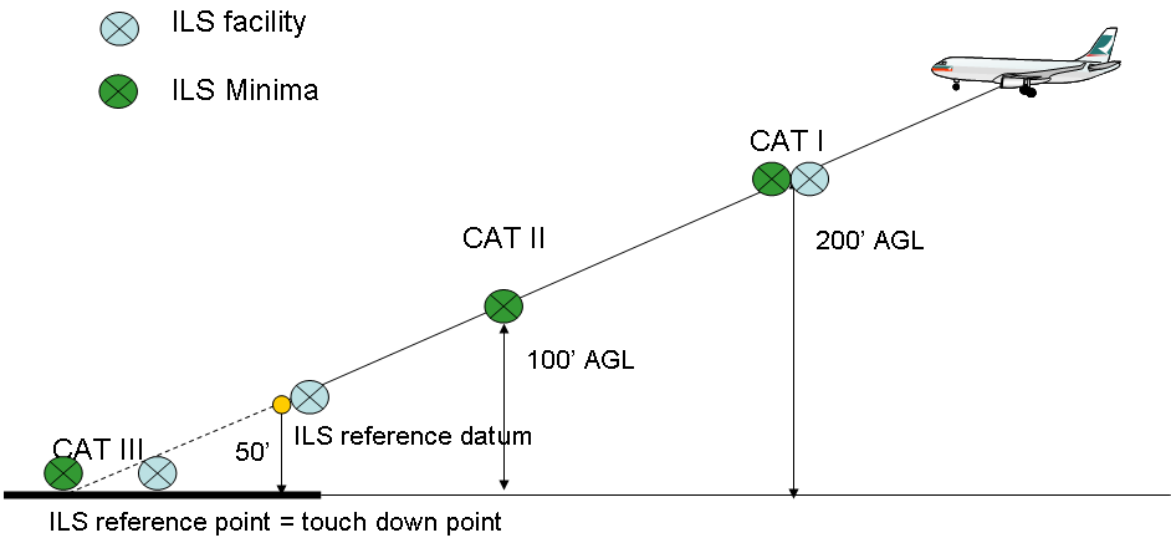
ILS MONITORS

Both Localizer and Glide Slope transmitters are automatically monitored to detect changes in the transmissions that could lead to dangerous errors. These changes might be detected as a shift in the localizer centre line or glide slope angle, or as a reduction in power output. The monitor may as a result bring on line a second transmitter but until this is achieved, the ident signal will be removed.

ILS FACILITY AND OPERATIONAL PERFORMANCE CATEGORIES

ILS can be used as a blind landing aid but only if the ground facility, the aircraft and the operating crew are appropriately certified. ILS facilities are categorised as follows:

CATEGORY	Providing accurate guidance from the limit of cover down to .....
1	200 feet above the horizontal plane containing the runway threshold.
2	50 feet above the horizontal plane containing the runway threshold.
3	the surface of the runway



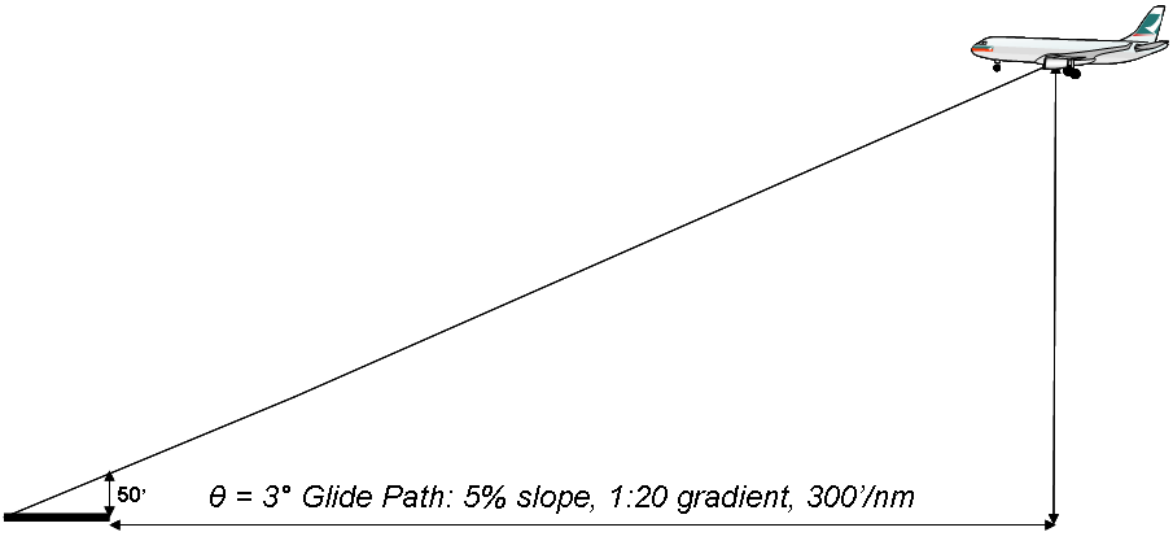
REQUIRED ROD

An approximate rate-of-descent (feet/min) to maintain the glide slope can be found using the formula:

$$\text{ROD (feet/min)} = \text{GS angle x } \frac{\text{Groundspeed (knots)}}{60} \text{ x } 100$$

For a 3° glideslope, this can be further simplified to:-

ROD (feet/min) = 5 X GROUNDSPEED (knots)



ILS SENSITIVE AND CRITICAL AREAS

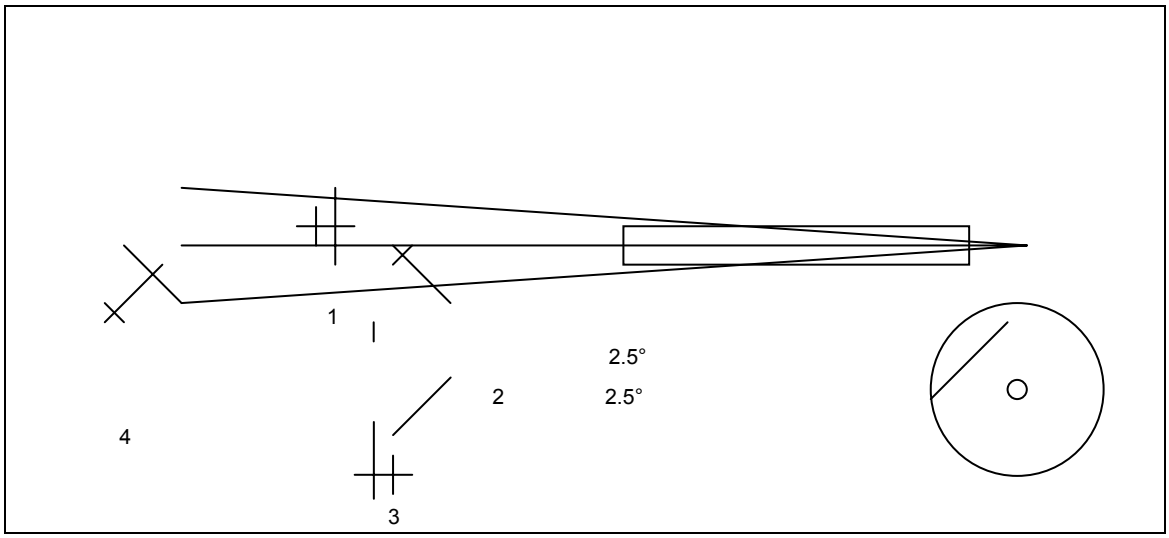
ILS is prone to problems created by the reflections of signals from terrain, buildings, taxiing aircraft and even vehicles moving close to the transmitters. Areas near the localizer and glideslope antennas are defined as protected zones to prevent interference that would affect ILS operations. The ILS critical area is an area of defined dimensions (according to ILS category) from which vehicles and aircraft are excluded during all ILS operations. The ILS sensitive area extends beyond the critical area and is an area in which the parking or movement of vehicles and aircraft is controlled. Note that the areas are larger for Cat. 2 and 3 operations than for Cat.1.

WORKSHEET – ILS

1. The ICAO emission designator for ILS is _____ and a typical localiser frequency is_____.

   (a) A2A 112.3 MHz
   (b) A2A 110.5 MHz
   (c) A8W 109.7 MHz
   (d) A9W 108.1 MHz

2. The diagram below shows four aircraft in relation to the localiser beam of an ILS.



Which aircraft would obtain the ILS indication shown?

   (a) 1
   (b) 2
   (c) 3
   (d) 4

3. The ILS glideslope transmission pattern consists of two overlapping lobes:

   (a) on the same VHF frequency but with different modulations.
   (b) on the same UHF frequency but with different modulations.
   (c) on different VHF frequencies but with the same modulation.
   (d) on different UHF frequencies but with the same modulation.

4. The coverage of an ILS category 1 localiser extends _____ either side of the centre line from the transmitter to a distance of _____.

(a) 35^0 / 17 nm
(b) 10^0 / 35 nm
(c) 25^0 / 17 nm
(d) 17^0 / 25 nm

5. The modulation rate of the outer marker is _____ and this will activate the _____ light.

(a)	75 kHz	Amber
(b)	75 Mhz	Blue
(c)	400 Hz	Blue
(d)	1300Hz	Amber

6. An aircraft is descending on a 2.7^0 glideslope with IAS 117 kt, TAS 130 kt and GS 120 kt. What rate of descent (feet per minute) is required?

(a) 350
(b) 450
(c) 550
(d) 650

7. Which of the following statements are true with reference to ILS glideslope transmissions?

(i) The IDENT is the same as that of the localiser.
(ii) The frequency band used is VHF
(iii) The azimuth coverage limit is 8^0 from the centreline to a range of 10 nm

(a) All are true
(b) (i) and (ii) are true
(c) (ii) and (iii) are true
(d) (iii) only is true.

8. An ILS which is facility performance Category 1 provides accurate guidance down:

(a) to and along the surface of the runway.
(b) to 200 feet above the ILS reference point.
(c) to 400 feet above the aerodrome elevation.
(d) to 400 feet above the ILS reference point.

9. Approximately how far is the middle marker from the threshold of the ILS runway?

(a) $^1/_2$ -1 nm
(b) 1-2 nm
(c) 2-4 nm
(d) 4-6 nm

10. Which of the following statements is true with reference to the ILS transmitters?

(a) All must be located on the extended centreline of the runway
(b) The glideslope transmitter is always on the centreline
(c) The glideslope and markers must always be on the centreline.
(d) None of the transmitters are necessarily on the centreline.

11. Which of the following statements is true with reference to the ILS back beam:

(a) The 90 Hz modulation is on the opposite side of the runway compared with the front beam.
(b) It is calibrated to the same level of accuracy as the front beam
(c) The glideslope transmitted with the back beam is not checked for accuracy.
(d) It cannot be used by aircraft that are over-shooting.