6 Instrument Landing System

6.1 Principle of Operation

The instrument landing system is the primary precision approach facility for civil aviation, a precision approach being one in which both glideslope and track guidance are provided. The ILS signals are transmitted continuously and provide pilot interpreted approach guidance. When flying the ILS approach, the pilot descends with approach guidance to the decision height (DH), at which point he makes the final decision to land or go around. Any installation must conform to the standards laid down in ICAO Annex 10 and an appropriate performance category will be allocated to it. Any exception to these standards will be published in NOTAMs. *Fig. RN 6.1* shows a typical ILS system.

The ILS consists of three main components: Localiser, glide path and marker beacons. *Fig. RN 6.2* shows a typical ILS installation.

The localiser transmitter supplies approach guidance in azimuth along the extended runway centre line. The glide path transmitter provides approach guidance in the vertical plane. Marker beacons provide accurate range fixes along the horizontal plane. Many ILS installations use an associated DME to provide a continuous

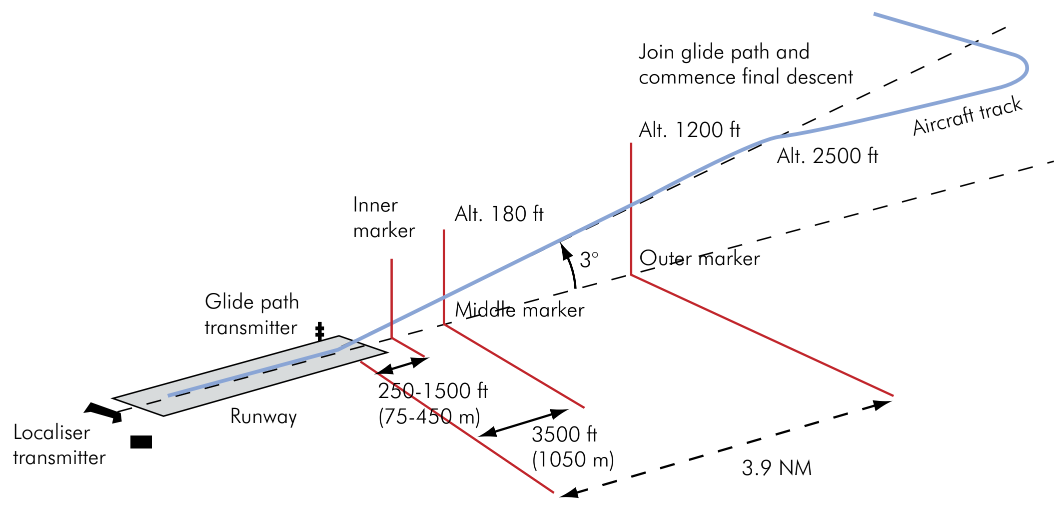

Fig. RN 6.1 ILS system

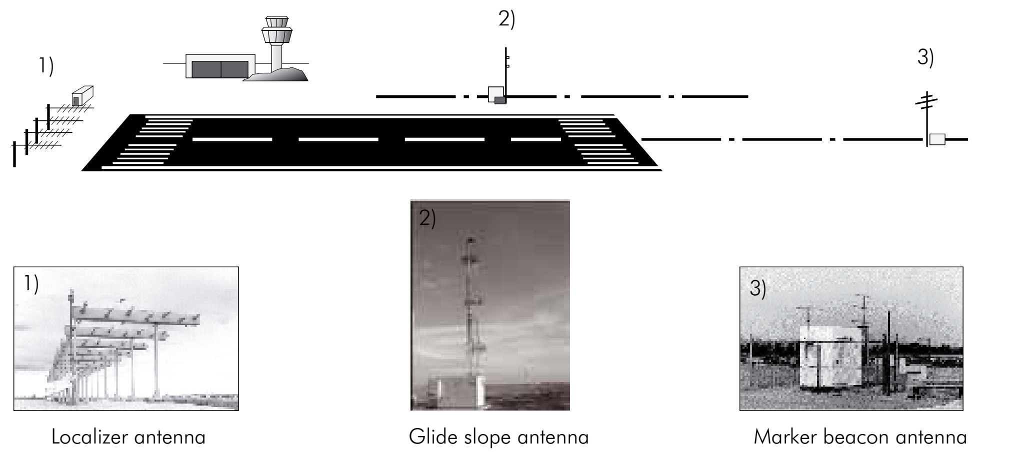

Fig. RN 6.2 A typical ILS installation

ranging facility than that provided by the markers. ILS installations may also be complemented with a low power NDB, known as a locator beacon. The function of the locator is to provide guidance, during intermediate approach, into the final approach path, which is marked by the ILS. The ideal flight path on an ILS approach is where the localiser and the glide slope planes intersect. To fly this flight path, the pilot follows the ILS cockpit indications.

6.2 Localiser

The localiser provides directional guidance along the extended centre line of the landing runway. It transmits on a frequency between 108.10 and 111.95 MHz, in the VHF band, thus sharing this band with terminal VORs. Localisers transmit on frequencies with ODD first decimals only. Therefore, 108.30 MHz would be a localiser frequency, whereas 108.40 MHz would not.

The localiser transmitter aerial is located in line with the runway centre line, at a distance of approximately 300 m from the "up-wind" end of the runway. *Fig. RN 6.3* shows a typical localiser aerial.

This aerial, which is of frangible construction, may be 20 m wide and 3 m high, and consists

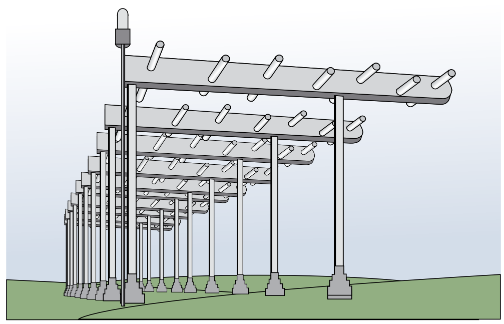

Fig. RN 6.3 Localiser aerial

of a number of dipole and reflector elements. The radio signal transmitted by the localiser aerial, *see fig. RN 6.4,* produces a composite field pattern consisting of two overlapping lobes. The two lobes are transmitted on a single ILS frequency and, in order to make the receiver distinguish between them, they are modulated differently. For an approaching aircraft the lobe on the left-hand side is modulated by a 90 Hz tone and the sector formed by it is called the YELLOW sector. The lobe on the right hand side as seen by the pilot making an approach is modulated by a 150 Hz tone and the sector it forms is called the BLUE sector.

A receiver located to the left of the centre line will detect more of the 90 Hz modulation tone and relatively less of the 150 Hz modulation. This difference is called DDM (Difference in Depth of Modulation) and it causes the vertical indicator needle to indicate that a correction to the right is necessary. Conversely, a receiver right of the centre line receives more 150 Hz than 90 Hz modulation and therefore, the needle will indicate that a correction to the left is necessary.

The line along which the DDM is zero, defines the localiser centre line. When flying along this line, there will be no deflection of the needle, indicating that the aircraft is on the centre line.

Range

On each side of this line the DDM increases in a linear fashion up to at least 3° on both sides of the runway. The localiser coverage should provide adequate signals to distances of 25 NM within 10° on either side of the centre line. Further coverage must be provided to distances of 17 NM between 10° and 35° on either side of the centre line.

Finally, coverage must be provided to distances of 10 NM at angles greater than 35° from the centre line, for those installations in which all round coverage is provided.

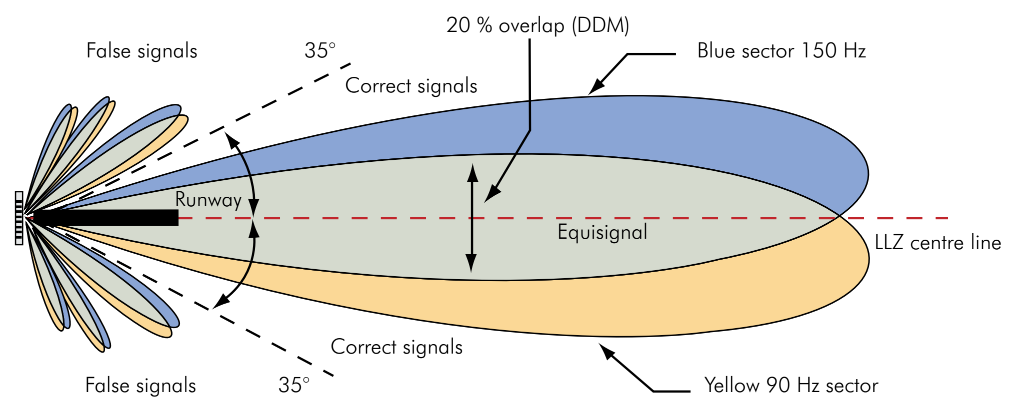

Fig. RN 6.4 Modulation pattern - localiser

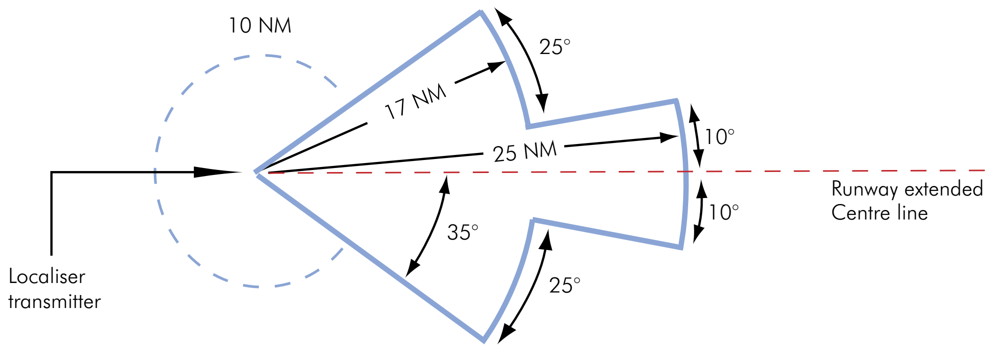

Fig. RN 6.5 Required localiser horizontal coverage

Where topographical features dictate or operational requirements permit, the limit may be reduced to 18 NM within the ±10° sector, and to 10 NM within the remaining coverage. *Fig. RN 6.5* shows the required localiser horizontal coverage.

6.3 Glide Path

The glide path transmitting aerial is usually placed about 300 m upwind from the threshold and 120 m (400 - 600 ft) from the centre line. The transmitter aerial is placed 300 m upwind from threshold because this is the optimum touch down point at which the extension of the glide path intersects the runway. This ensures adequate wheel clearance over the threshold and over any other object or terrain during landing approach.

Glide path transmission takes place in the UHF band on 40 spot frequencies from 329.15 to 335 MHz. UHF is used to produce more accurate and narrow beams. The transmission is beamed in the vertical plane in two lobes similar to the localiser transmission. The upper lobe has a 90 Hz modulation, while the lower lobe has a 150 Hz modulation.

The DDM (Difference in Depth of Modulation) will energise the horizontal needle of the instrument, so as to indicate whether the aircraft is in the 90 Hz lobe or in the 150 Hz lobe. In this way, it gives the position of the centre line of the glide path. The line, along which the two modulations are equal in depth, defines the centre line of the glide path. It is generally 3° from the horizontal, but it could be adjusted to between 2° and 4° to suit the particular local conditions. In special circumstances the glide slope angle is more than 4° (e.g. London City = 5.5°). A glide slope much in excess of 3° requires a higher rate of descent for the normal turbo jet aeroplane.

It should be noted that, in the vicinity of the landing threshold, the glide path becomes curved and gradually flattens. This is only of consequence if fully automatic landing operations are considered. It is one of the reasons why a CATIII landing requires the use of a radio altimeter. The siting of the glide path aerial and the choice of the glide path angle are dependent upon many interrelated factors:

- Acceptable rates of descent and approach speeds for aircraft using the airfield
- Position of obstacles and obstacle clearance limits resulting therefrom
- Horizontal coverage
- Technical siting problems
- The desirability of attaining the ILS reference datum 50 ft above the threshold on the centre line
- Runway length.

6.3.1 Glide Path Coverage

The coverage in azimuth extends 8° on either side of the localiser centre line, to a distance of 10 NM. The coverage in the vertical plane extends from 0.45 times the nominal glide path angle (θ) to 1.75 times the nominal glide path angle above the surface. Remember that correct signals are guaranteed only within the approved coverage zones and you can never trust signals received outside these zones, *see fig. RN 6.6.*

6.3.2 Critical and Sensitive Areas

The ILS critical area is an area of defined dimensions about the localiser and glide path antennae, where vehicles, including aircraft, are excluded during all ILS operations, *see fig. RN 6.7.* The area is protected to prevent aircraft or vehicles causing unacceptable disturbances to the signal-in-space.

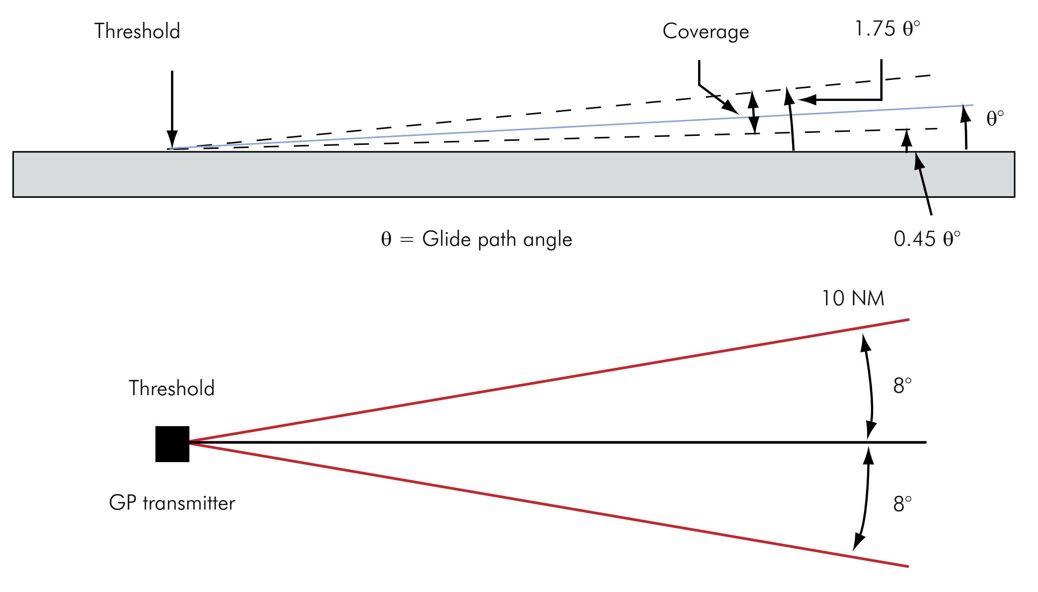

Fig. RN 6.6 GP coverage

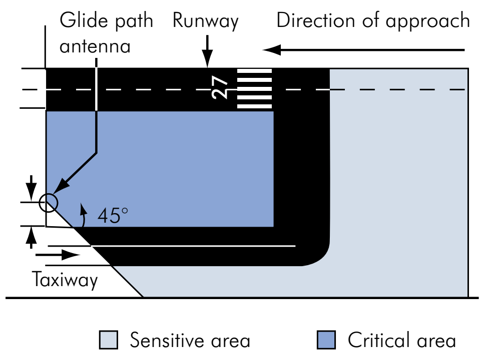

Fig. RN 6.7 ILS critical/sensitive areas

The ILS sensitive area extends beyond the critical area, where the parking and or movement of vehicles including aircraft is controlled to prevent the possibility of unacceptable interference to the ILS signal during ILS operations. The dimensions of the sensitive area depend of the intruding aircraft on the ground. For a B747 the sensitive area is bigger than for a B737.

6.3.3 Marker Beacons

Marker beacons, *see fig. RN 6.8*, operating on 75 MHz VHF (emission code N0NA2A) give the pilot an indication of range from the threshold.

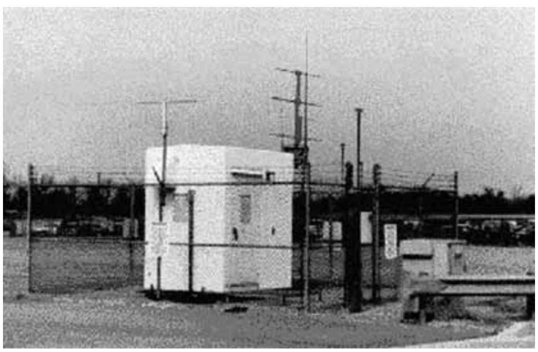

Fig. RN 6.8 Marker beacon transmitter

Where airways fan markers are provided (not in UK), the ident frequency and light colour is as per the inner marker.

The purpose of the markers is to provide range information while on the approach. They transmit an almost vertical beam. Almost all installations are equipped with an outer marker and a middle marker.

Category 2 or 3 ILS may be equipped with an inner marker as well. Audio- and visual signals in the cockpit will indicate when the aircraft is passing overhead. All marker beacons transmit on the same frequency 75 MHz and thus no frequency selections are necessary for the pilot. In many installations, marker beacons are being replaced or supplemented by the use of a DME associated with the ILS.

Z-markers and Fan Markers

The standard beacon is the fan-shaped beam, which is rectangular in shape and radiating vertically, so that signals will only be received during the short period of time that the aircraft is passing through the beam. Z-markers are dumbbell or bone-shaped, signals being received from the narrow portion of the pattern. The latter type of marker is generally used where "timed" approaches are in operation.

The Polar diagram of the transmitted signal is a vertical fan or funnel-shaped lobe. Quite opposite to the NDB, the marker beacon can only be received when directly overhead.