INSTRUMENT LANDING SYSTEM

ECE 514E – RADAR & SATELLITE ENGINEERING

Wednesday, 19 November 2025

HISTORICAL DEVELOPMENT OF ILS

- **1920s:** Early experiments with radio guidance systems
- **1938:** The first scheduled passenger airliner to land using ILS.
- **1940s:** Standardization by ICAO (International Civil Aviation Organization)
- **1960s:** Category II and III systems developed
- **Present:** ILS remains the most widely used precision approach system worldwide.

INSTRUMENT LANDING SYSTEM (ILS)

1. **Instrument Landing System (ILS)** facilitates a highly accurate and dependable means of navigating to the runaway in poor visibility conditions.
2. ILS provides lateral and vertical guidance necessary to fly a precision approach landing.
3. ILS consists of the following components:

   (a) **Localiser** provides the pilot with the airplane's position relative to the runaway centreline.

   (b) **Glideslope** provides information on the airplane's vertical position relative to the ideal approach, i.e the glide angle - usually 3 degrees. Glideslope is broadcast from the side of the runaway in the frequency range 329 – 335MHz.

   (c) Outer marker which gives the pilot a blinking indicator when the airplane is approaching the runaway from the correct direction and positioned at about 2Kms from the touch point.

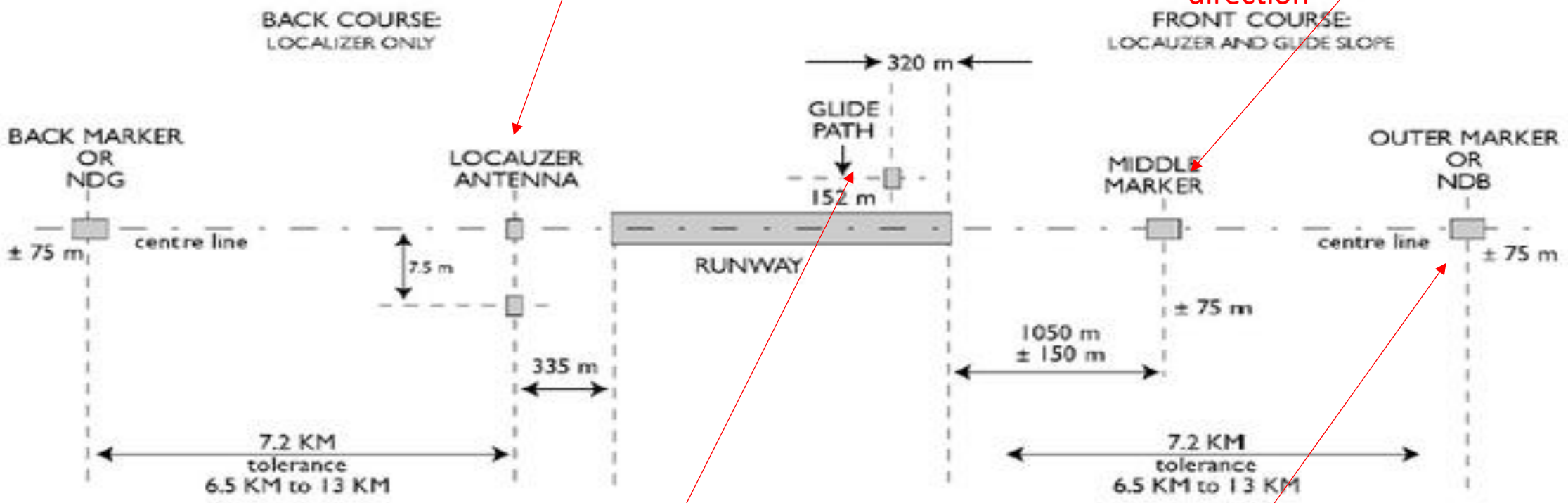
   (d) Middle Marker gives the pilot a blinking indicator when the airplane is approaching the runaway from the right direction at about 1Km from the touch point.

   (e) Approach light system are a medium/high intensity light systems to guide the pilot.

PHYSICAL LOCATION OF ILS SUB-UNITS

Localizer
Provides airplane's position relative to the runaway centreline.

Middle Marker
Shows the airplane is approaching the runaway from the right direction

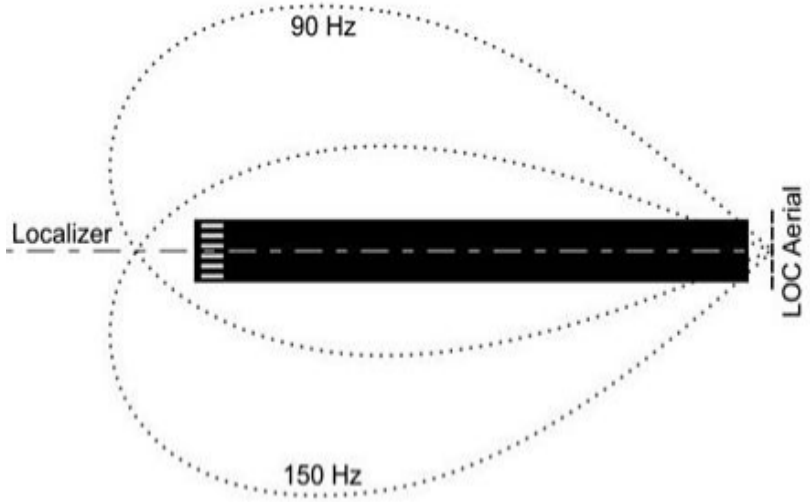


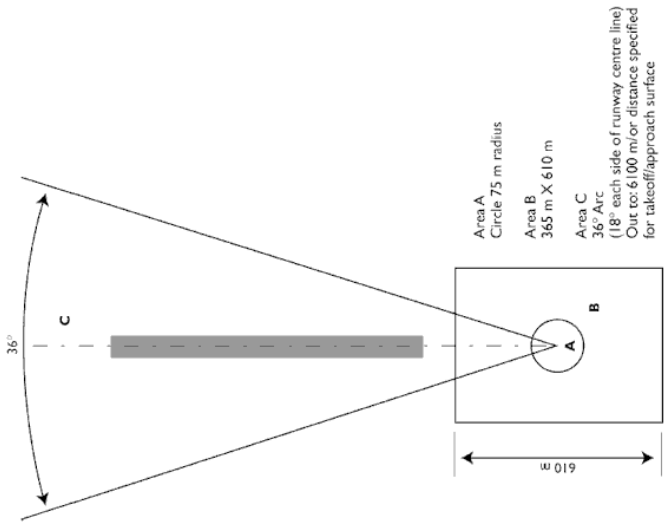
Glideslope
Provides information on the airplane's vertical position relative to the ideal approach

Outer marker
Indicates the airplane is approaching the runaway from the correct direction

LOCALIZER (1)

1. The localizer provides lateral guidance to the pilot, i.e the position of the aircraft with respect to the centreline of the runaway.
2. A localizer is an antenna array normally located beyond the departure end of the runway and generally consists of several pairs of directional antennas.
3. Two signals at 90Hz and 150Hz are transmitted on one of 40 ILS channels from co-located antennas ooerating in the frequency band 109-112 MHz.
4. Each antenna transmits a narrow beam, one slightly to the left of the runway centerline, the other slightly to the right.
5. A localizer receiver on the aircraft measures the difference in the depth of modulation (DDM) of the 90 Hz and 150 Hz signals.
6. The difference between the two signals varies depending on the deviation of the approaching aircraft from the centreline of the runway.

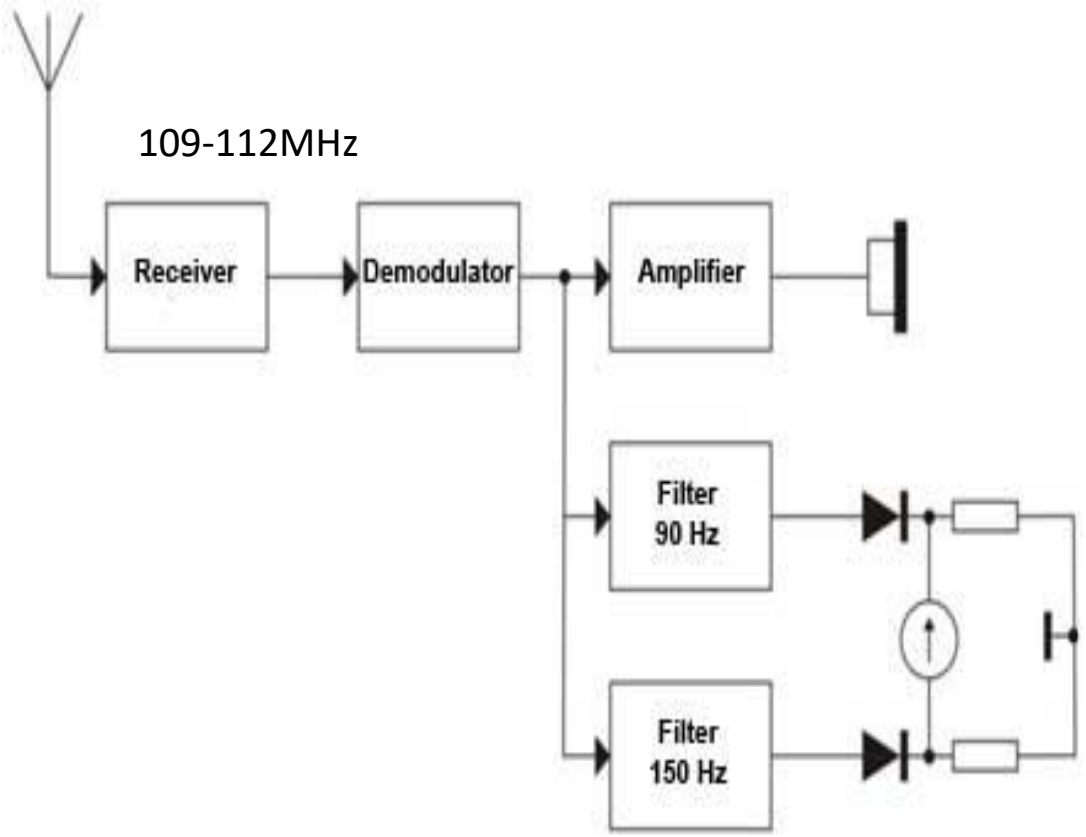




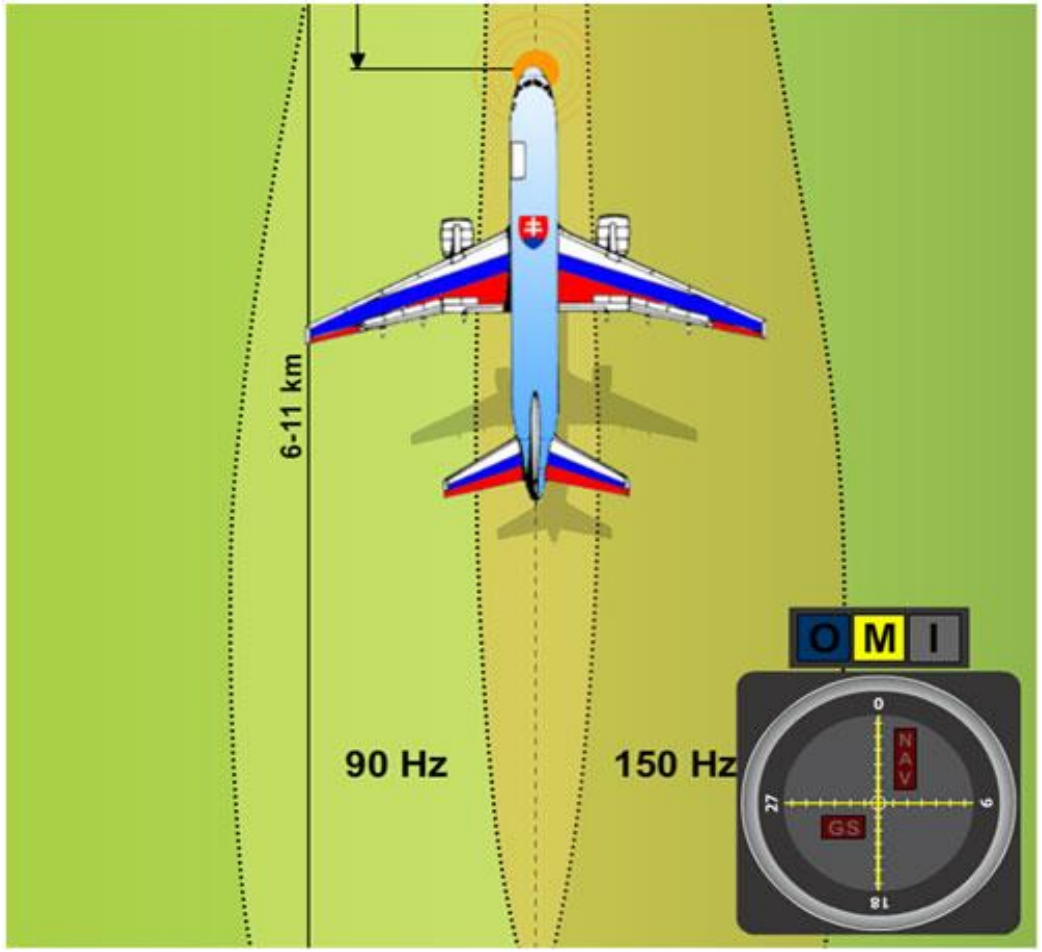
LOCALIZER RECEIVER

- The signal is received on board of an aircraft by an on-board localizer receiver.

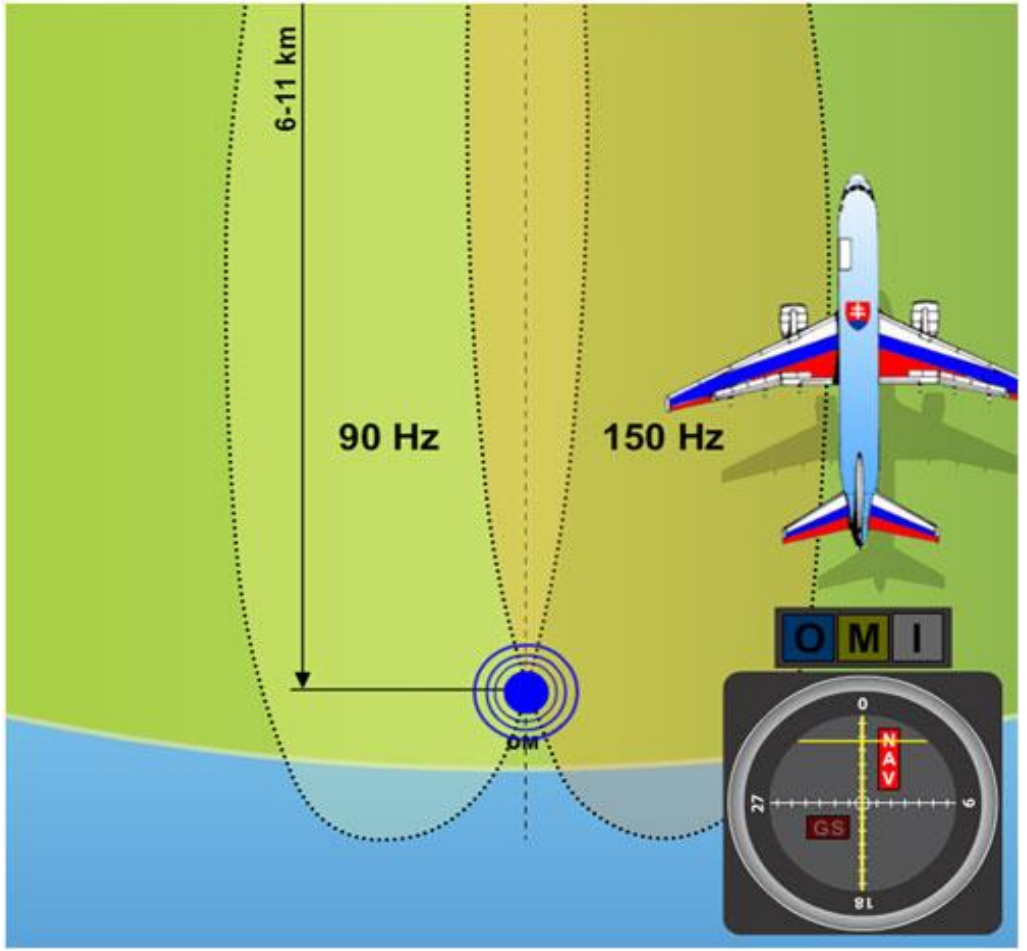
- A simplified block scheme of the on-board receiver of the localizer's signals is as shown.



LOCALIZER DISPLAY



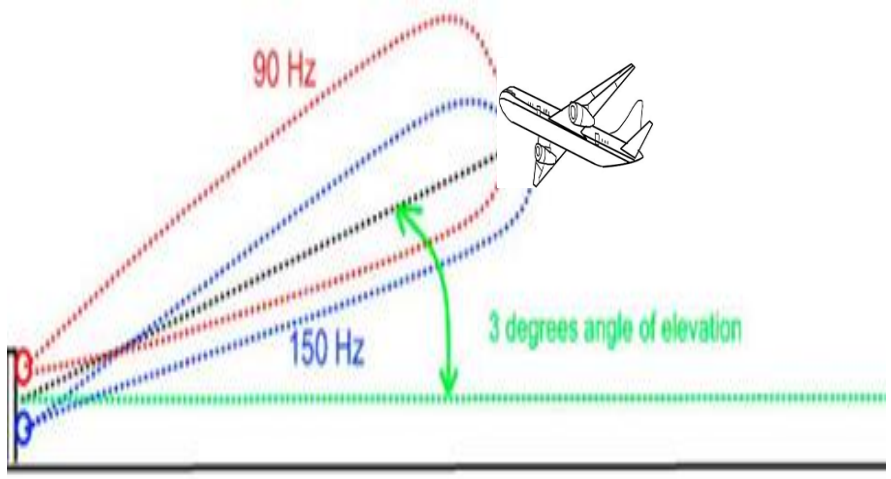
Plane flying towards the runaway centre-line



Plane flying to the right of the centreline

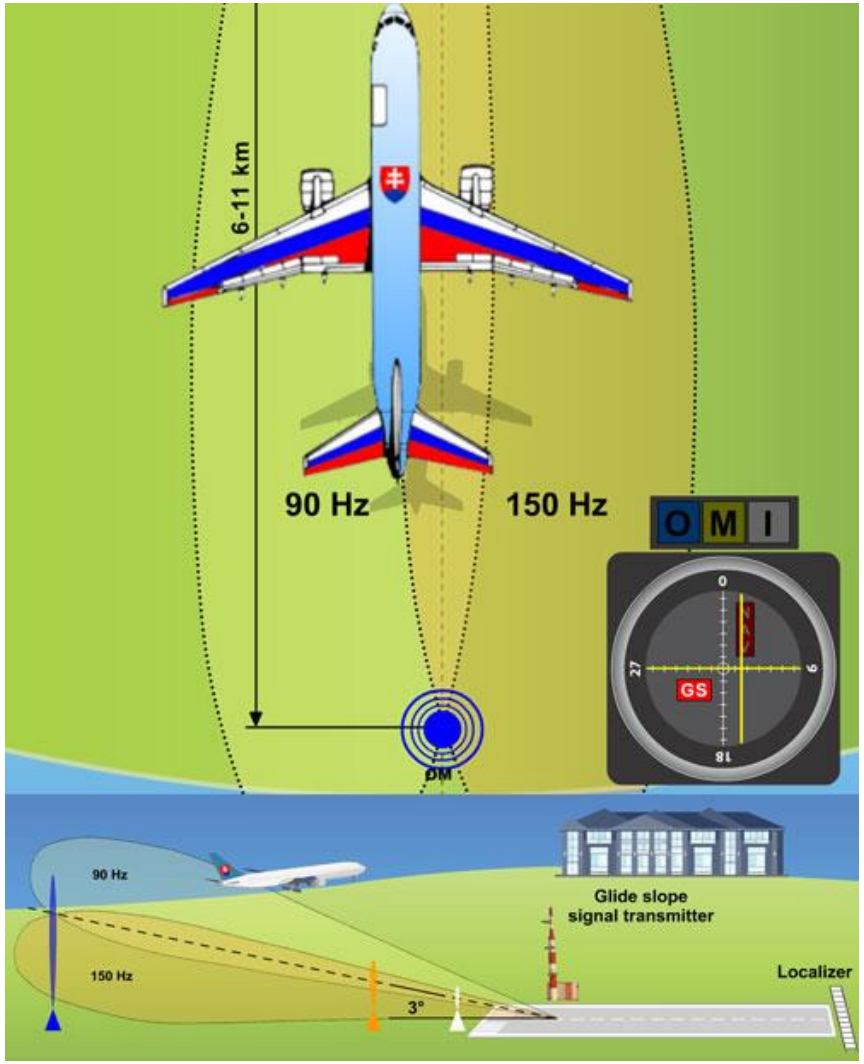
GLIDE SLOPE EQUIPMENT

1. A glide slope station is an antenna array sited to one side of the runway touchdown zone.
2. The GS signal is transmitted on a carrier frequency using a technique similar to that for the localizer.
3. The center of the glide slope signal is arranged to define a glide path of approximately 3° above horizontal (ground level).
4. The beam is 1.4° deep (0.7° below the glide-path center and 0.7° above).



GLIDE SLOPE EQUIPMENT

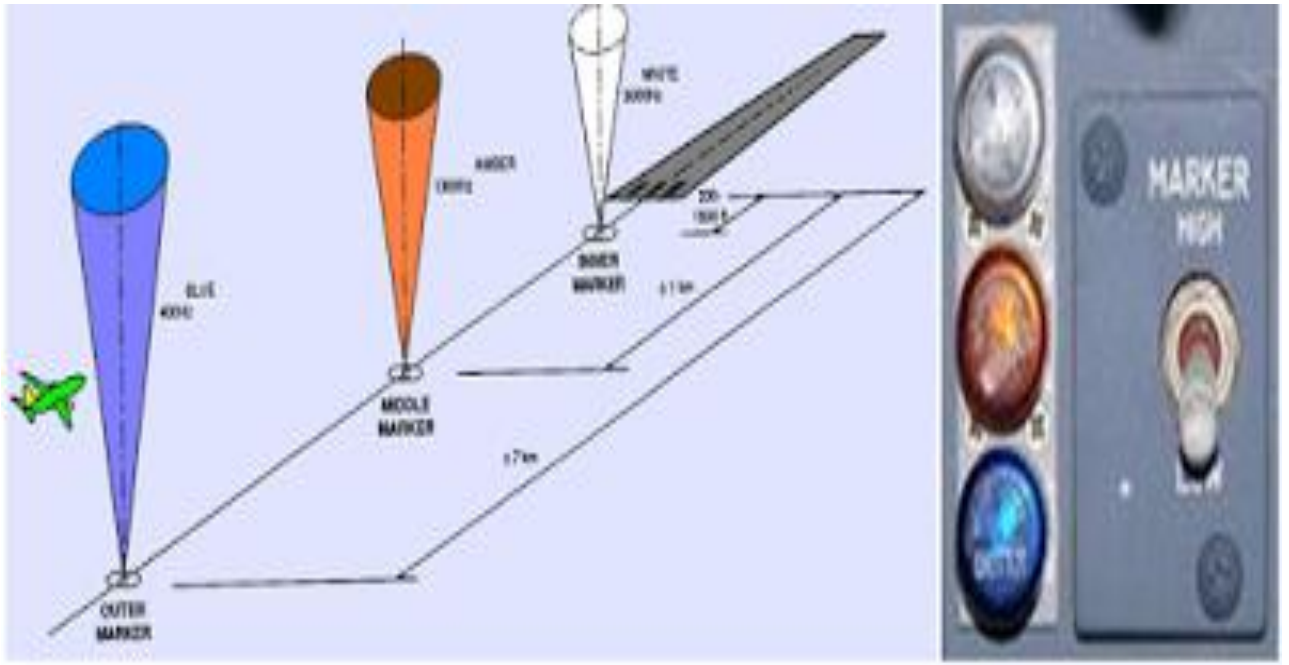
The pilot controls the aircraft so that the glide slope indicator remains centered on the display to ensure the aircraft is following the glide path to remain above obstructions and reach the runway at the proper touchdown point.



Diversion from the glide slope, a too weak received signal, or an obstacle on the way.

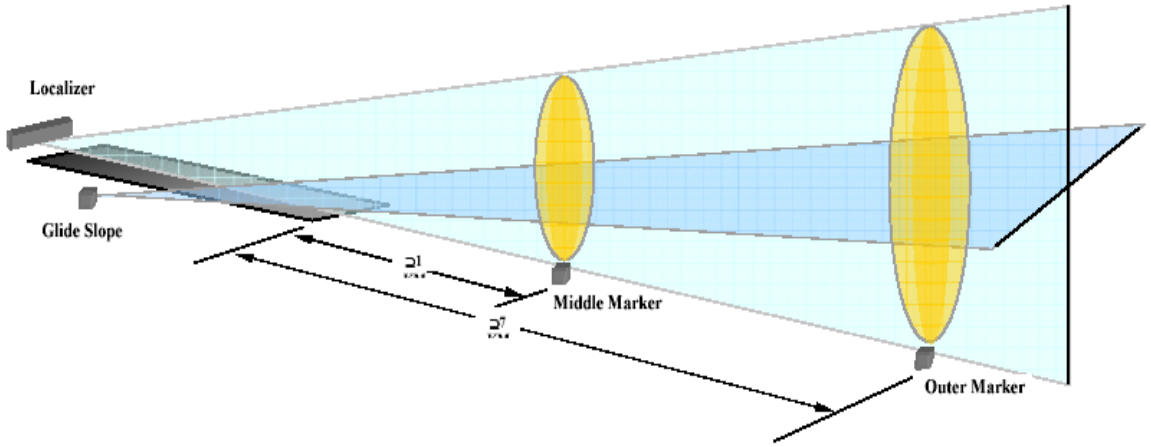
ILS MARKER BEACONS

1. ILS beacons provide information on the distance from the runaway at predetermined points along the airport approach path.
2. The Beacons are low power transmitters operating at 75MHz with 3W rated power output.
3. They emit elliptical beam upwards from the ground.



OUTER MARKER

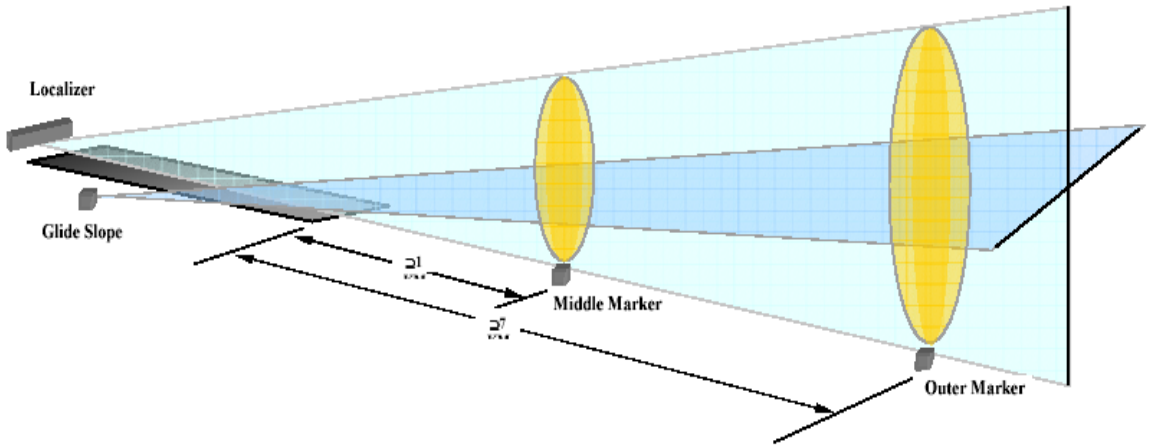
1. **The Outer Marker** designates the point at which the aircraft intercepts the glide slope.
2. It is the point where aircrafts commence the final approach segment.
3. The OM transmits at a carrier of 75MHz modulated by an interrupted 400Hz signal which is audible to the pilot.
4. The pilot hears the tone over the speaker and also sees a blue light blink on the dashboard in synchronization with the audible tone.



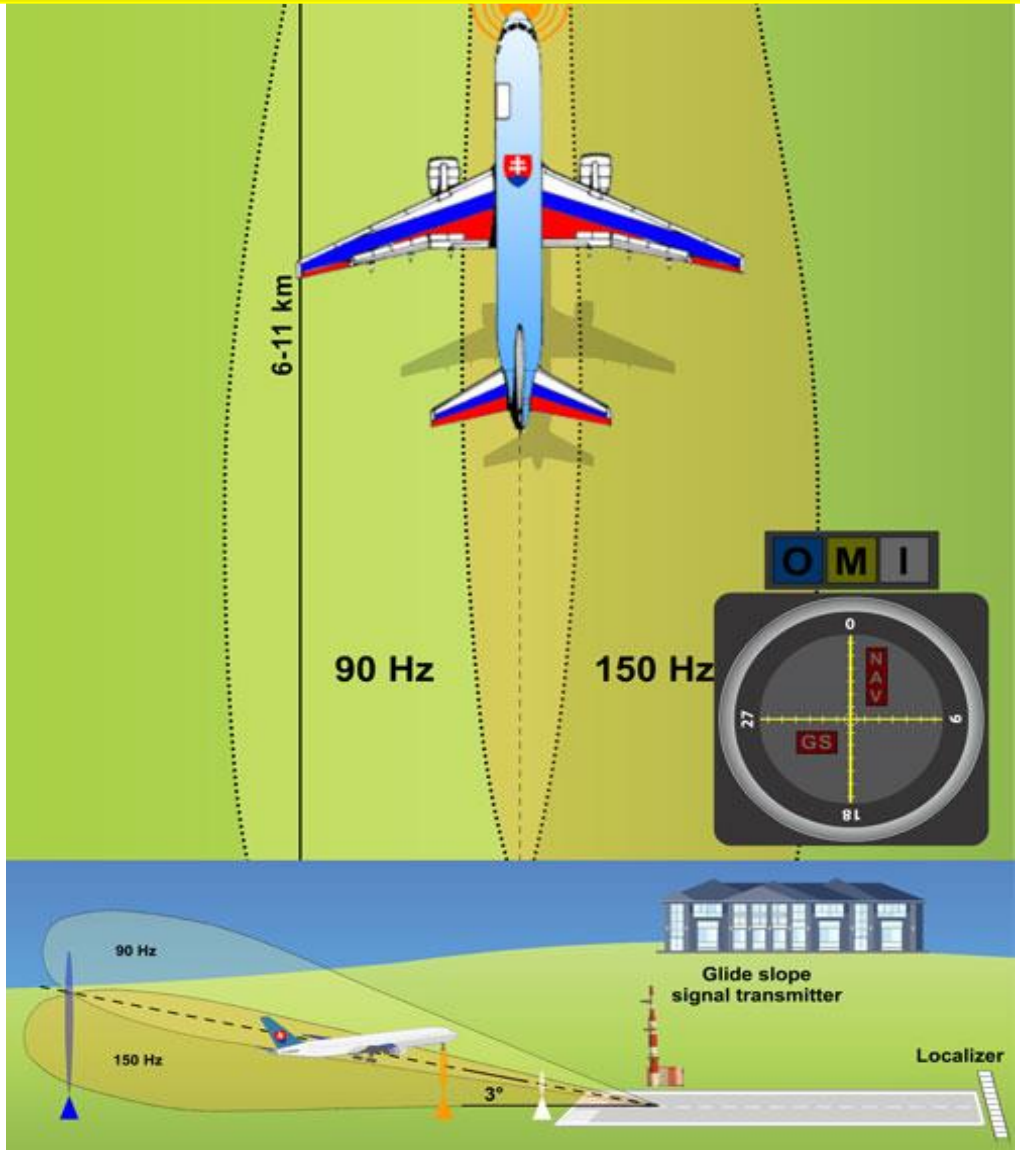
MIDDLE MARKER

1. The Middle Marker is located at 0.6 NM from the threshold on the runaway centre line.

2. The beam from the middle marker crosses the glide slope at approximately 200 ft above the runaway elevation.



LOCALIZER & GLIDE SLOPE SHOWING CORRECT APPROACH



Correct Approach-The aircraft is located in the point of intersection of the course and descent plane.

APPROACH LIGHT SYSTEM

- Approach Lighting System is a medium/high intensity light system to guide the pilot when landing under poor visibility.

ILS LIMITATIONS

System Limitations

- Sensitive to terrain and obstacles
- Critical and sensitive areas
- Susceptible to multipath interference
- Limited to straight-in approaches
- Frequency congestion in some regions

Sources of Interference

- Multipath reflections
- Other transmitters on same frequency
- Harmonics from other systems
- Site-specific errors
- Atmospheric conditions

ALTERNATIVE LANDING SYSTEMS

SYSTEM	FREQUENCY	ADVANTAGES	DISADVANTAGES
Instrument Landing System (ILS)	VHF/UHF	Proven, precise, widely deployed	Site sensitive, limited approaches
Microwave Landing System (MLS)	5 GHz	Curved approaches, less site sensitive	Limited deployment, higher cost
Ground-Based Augmentation System (GBAS)	VHF	Multiple approaches, flexible paths	Dependent on GPS, implementation cost

GBAS (Ground-Based Augmentation System) is gradually replacing ILS at major airports due to its flexibility and ability to support multiple approach paths.

FUTURE DEVELOPMENTS

1. GBAS (Ground-Based Augmentation System)

- Satellite-based precision approach
- Multiple approach paths from single installation
- Less sensitive to site conditions
- Currently being deployed at major airports

2. SBAS (Satellite-Based Augmentation System)

- WAAS (US), EGNOS (Europe), MSAS (Japan)
- Provides approach guidance without ground equipment

3. Advanced ILS

- Digital ILS (D-ILS) concepts
- Improved multipath mitigation
- Enhanced monitoring systems
- Integration with other navigation systems

ILS will likely remain in service for decades due to its reliability and the massive installed base of ILS-equipped aircraft.

WHAT IS IN IT FOR ELECTRICAL ENGINEERS?

Key EE Concepts in ILS

- **Antenna Theory:** Radiation patterns, beam forming
- **RF Engineering:** VHF/UHF propagation, filtering
- **Signal Processing:** Modulation, demodulation, filtering
- **Control Systems:** Feedback, autopilot coupling
- **Electromagnetic Compatibility:** Interference mitigation

Career Opportunities

- Avionics Systems Engineering
- Navigation Systems Design
- RF Engineering
- Air Traffic Systems
- Regulatory Compliance

CONCLUSION

Key Takeaways

- ILS is a critical safety system for aviation
- Uses precise radio signals for lateral and vertical guidance
- Based on comparison of 90 Hz and 150 Hz modulation depths
- Multiple categories support different weather conditions
- Integration of multiple EE disciplines

Future Outlook

- ILS will coexist with satellite-based systems
- Continued evolution of precision approach systems
- Opportunities for innovation in aviation electronics

HOME ASSIGNMENT

Visit the website:

http://instrument.landingsystem.com/ils-tutorial-animation/

Carry out the simulation ILS landing clicking on the play button.

Answer the following questions:

1. What is the purpose of the localizer in an airport
2. What is the function of a glide slope indicator on the aircraft
3. Why was it necessary to combine the localizer and the glide slope displays?
4. What are the frequencies of the two tones heard , which instrument produces them and what is their purpose?
5. Which human factors can make a pilot not land the plane successfully during poor visibility?