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Review Article

Operational usage and importance of instrument landing system (ILS)

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ABSTRACT

Aviation technologies are developing day by day and air transport is becoming the rapidly rising star of the transportation industry. Navigation and approach systems play a significant role in the safe flight and landing of the aircraft. Instrument landing system (ILS), in the appropriate direction of the aircraft and the glide angle, horizontal and vertical guiding the aircraft, for automatically approach and landing runway is the most widely used in precision approach navigation system types. In this study, the parts, operational categories, working principle and importance of the ILS are mentioned.

Keywords: Instrument Landing System; Operation Categories; Precision Approach

1. Introduction

Instrument landing system is a precision approach system that aids the landing of aircraft by means of transmitters placed at the runway. ILS is a navigation assistance system that allows the aircraft to approach the runway with precision. In weather conditions where the cloud ceiling is low and the visibility factors are bad, it enables the aircraft to approach the runway low and land safely with electronic devices. The system gives direction and glide line information to pilot [1]. In this system, the pilot does not deactivate, only keeps the data under constant control. It is the system that greatly facilitates the landing of pilots when visibility is very low, especially in foggy and snowy weather. This system is not required for airports established in flat and fog-free areas.

The first ILS system tests began in the U.S.A. in 1929 and was first tested in the U.S.A. in 1939. In addition, it was recommended for the first time by ICAO in 1949 [2]. The broadcast performance of the ILS system should be checked at regular and continuous intervals to ICAO standards. Thus, it passes in front of the negativity that may arise improving safety can be ensured.

The disadvantage of ILS is that it can not be installed in every airport. The airport where the ILS system will be located should have a geographical location that does not affect the broadcast performance of the system. Signal generation area needs corrected terrain. The environmental terrain conditions of the location of the airport must be suitable. The roughness criteria; slope should be less than 2% at take-off and 2.5% at landing. The necessity of the device is determined by the physical conditions of the airport. It provides safe landing in foggy weather with a visibility range of 800-1200 m. The visibility provided by the ILS also varies depending on the runway lighting.

ILS; It consists of the Localizer, Glide Path and Marker series (Figure 1).

2. Parts of ILS

The three main ground facilities and duties of ILS are as follows:

a. Localizer that creates a horizon plane to show the electronic centre runway line.
b. Glide path, which creates a vertical plane to approach the landing point at a right angle (3°).

c. Markers that line up along the approach line and broadcasting vertically.

Firstly, the aircraft that enters the ILS sector starts to create its route by establishing a connection with the localizer. Then, it establishes on glide path and creates its route in vertical direction. After all, the aircraft comes to the stage of putting a wheel on the runway by taking distance information along the approach line with the help of markers.

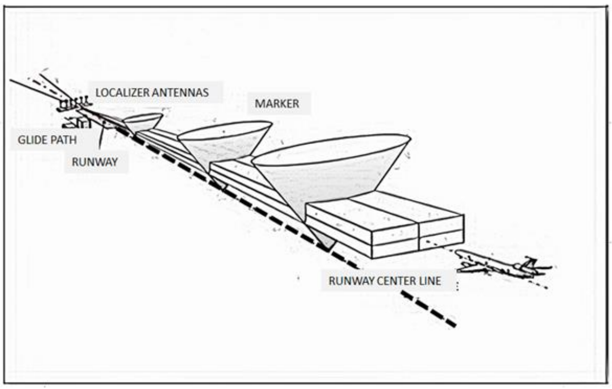

Fig. 1. Image of ILS [3]

2.1. Localizer

The Localizer system, which is a path-determining part of the ILS, operates in the very high frequency (VHF) band with a frequency range of 108-112 Mhz. It consists of two patterns, 90 Hz and 150 Hz (Figure 2) [4]. These patterns consist of modulated frequencies and have the same amplitude. A route occurs where these two patterns cross each other. This is called the center line or the localizer route. The aircraft flying within this route moves in the direction of the runway.

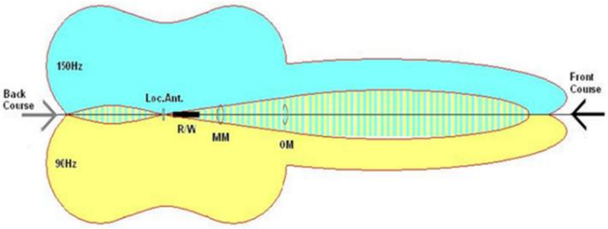

Fig. 2. Localizer release pattern [2]

In Figure 2, the localizer system meets the incoming aircraft on the front course. There are also systems that meet the incoming aircraft on the back course in Europe [2].

It is the equipment that broadcasts in the horizontal direction on the runway surface and in the opposite direction of the landing direction. The system directs the aircraft in the direction of the runway axis. It is 1000 feet (300 meters) far from the runway end. Localizer transmitters emit signals up to 25 NM. That is, the aircraft starts to receive the signal from 25 NM from the runway extension.

The localizer is a device placed at the end of the runway (Figure 3), it provides direction information to the aircraft along the approach line and allows the aircraft to approach along a fixed line by preventing lateral slippage during approach.

Fig. 3. ILS Localizer antenna array [5]

2.2. Glide slope

Glide Slope system, which is another path determinant part of ILS, works in the ultra high frequency (UHF) band between 329 Mhz-335 Mhz. It consists of two top and bottom patterns, 90 Hz and 150 Hz [4]. These patterns consist of modulated frequencies and have the same amplitude. In the area where these two patterns intersect, an artificial route occurs. It matches the frequency with which it works with localizer. When connected to localizer, glide path (Figure 4) is automatically connected.

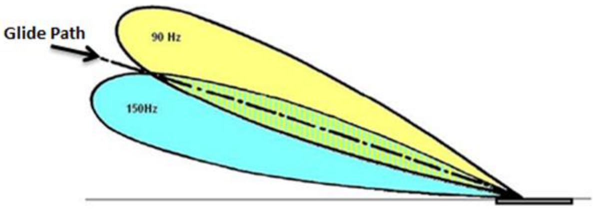

Fig. 4. Glide path release pattern [2]

Glide slope works in the direction of localizer front course. Glide path is the part of the glide slope signal that is received with the localizer front course. While glide slope means the slope of the route, glide path states the descent path. Glide path is matched with the ILS localizer frequency, and there is no need to connect a frequency [2].

Glide slope (Figure 5), thanks to the signals it sends, enables the aircraft to glide towards the runway at an angle of approximately 3.0 degrees, thereby creating vertical approach stability.

Fig. 5. Glide slope antenna [6]

2.3. Marker beacons

Markers (Figure 6) are the component that determines the distance used in ILS system. In order to introduce themselves, they broadcast by cutting the signals of localizer and glide-slope / path equipments vertically at certain distances. They give information to the descending aircraft about their distance to the runway's beginning. Approach lights are used as a part of the ILS during final approach as they provide visual reference. They should not be less than 720 meters in precision approach runways.

Markers are the system that informs the aircraft about the remaining distance to the runway and installed in the direction of the runway. 3 marker beacon stations are established in the instrument landing system. These are: Inner Marker - IM (3000 Hz), Middle Marker - MM (1300 Hz), Outer Marker - OM (400 Hz). Markers can be positioned up to 400 meters (Inner Marker), 1200 meters (Middle Marker) and 7500 meters (Outer Marker) from the beginning of runway [5].

The outer marker usually determines the point where the approaching aircraft at a certain height catch the glide path angle. The carrier frequency is modulated with 400 Hz and hyphen (- - -) switched.

The middle marker usually indicates that the point where the aircraft is located 3500 ft to the beginning of runway and 200 ft above the ground. The modulated carrier frequency is modulated with 1300 Hz and the hyphen-full stop (-.-.-.) switched.

Inner marker indicates that the aircraft is at the decision height point. The carrier frequency is modulated with 3000 Hz and full stop (. . .) switched. At this point, if the pilot sees the runway, the aircraft will continue to descend. Otherwise, it will pass.

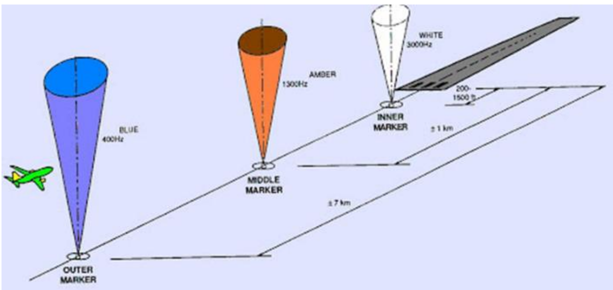

Fig. 6. Marker beacons [7]

3. Working Principle

During instrument descent, the ILS provides accurate approach and landing by providing vertical and horizontal information for the respective runway configuration to be landed. VOR (Very High Frequency Omnidirectional Range) and NDB (Non Directional Beacon) approach systems are generally used as guiding tools in air navigation to approach the ILS sector [8]. DME (Distance Measuring Equipment) system, which calculates the range by using the round-trip time of the signal, is used for distance information with these systems. In military flights, approach is provided with TACAN (Tactical Air Navigation System).

The VOR station produces 360 linear lines called radial at one-degree intervals around itself. The transmitter which broadcasting in all directions in the VHF band informs the user of the aircraft's direction according to magnetic north and position according to the selected radial. The VOR information is free of the flight direction of the aircraft. Using high frequencies minimizes the noise problem caused by meteorological conditions and appears in the NDB.

NDB is the oldest, simplest radio navigation aid in use today which operates within an omnidirectional vertically polarized antenna. Despite the different information in the sources, the NDB ground device is a conventional medium frequency (300 kHz - 3 Hz) transmitter which operates at 200-500 kHz frequency and broadcasts uninterrupted and carrier tuned at regular intervals by the volume button of the radio beacon search signal in the international Morse code. A NDB can be used as an airport or ILS docking station on airlines, or as combination with the VOR or alone in the vicinity of an airport. NDB which used in airlines today is used together with DME to provide simple approach assistance.

DME is a system that gives the distance between the ground station and the aircraft to pilot and broadcasts in the UHF band. It is usually used in conjunction with VOR. Thus, the pilot obtains both direction and distance information at the same time. In such a system, the pilot's VOR frequency selection automatically enables selection of the DME frequency connected to VOR.

TACAN is a radio navigation system used only in military aviation. TACAN provides for military aircraft the direction and distance information that provided by the VOR / DME system for civil aircraft. TACAN's operating frequency is the same as DME (It is around 1 GHz in the UHF band). A DME receiver can receive signals that sent by the TACAN station and use distance information. Therefore, civil aircraft with DME receiver can use the distance information of the TACAN station.

It is more appropriate to use a VORTAC (VOR + TACAN) radio navigation aid, especially in areas where civil and military aircrafts are flying, to avoid interference with the signals of ground stations very close to each other. This system provides direction and distance information at the same time to both of military and civil aircrafts. Civil aircrafts receive direction information from VOR and distance information from TACAN. Military aircrafts receive distance and direction information from TACAN.

Apart from these, with Radar Vector, an approach to the ILS sector can be achieved in line with the climb, heading and descent directions made by the air traffic controller. Radar Vector used to relieve air traffic, reduce risk in adverse weather conditions, save time, etc. used in situations.

During the approach, the pilots must comply with the step-down fix criteria (altitude-range) respectively. Otherwise, the obstacle problem was encountered and may cause accident breakage.

Precision approach is an instrument approach and landing made by aircraft by providing lateral and vertical information according to operational categories. Operational categories differ according to airport approach procedures and are classified based on cloud ceiling and visibility [8]. There are 3 types of ILS operational categories according to their performances. These categories are defined with terms of decision height (DH = Decision Height) and view range (RVR = Runway Visual Range). Values of decision heights and runway visibility distances to be applied in current operational categories are shown in Table 1 below [1].

Table 1. Operation Categories [1]

Operation Categories	Decision Height (DH)	RVR	Visibility
CAT I	60 m and above (>200 ft)	550 m and above	Min. 800 m
CAT II	Between 30 m and 60 m (100 ft-200 ft)	350 m and above	
CAT IIIA	Below 30 m (>100 ft) or without DH	200 m and above	
CAT IIIB	Below 15 m (>50 ft) or without DH	Between 50 m-200 m	
CAT IIIC	Without DH	No RVR limit	

RVR: Runway Visual Range

4. CONCLUSION

ILS (Instrument Landing System) has been used for many years. The ILS landing system aids in safe landing by providing reference to pilots and aircraft even in low visibility conditions. The ILS ensures accurate approach and landing during instrument descent, providing vertical and horizontal information for the respective runway configuration to be landed. For this reason, it is widely used and preferred today.

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References

[1] Mackenzie, D. ICAO: A history of the international civil aviation organization. University of Toronto Press, Toronto; Buffalo; London, 2010.

[2] https://www.servetbasol.com/Articles/Ucuyorum/APH-0843.htm (6 March 2020)

[3] Ürgün, S., Bağcı, O. ve Demirtaş, H. 2016. ILS - Aletli iniş sistemi. VI. Ulusal Havacılık ve Uzay Konferansı, 28-30 Eylül, Kocaeli, Türkiye, UHUK-2016-093.

[4] Conway, E.M. 1998. "Blind landings: The evolution of aircraft landing aids, 1918-1950". Ph. D. thesis, University of Minnesota, Minnesota, U.S.A.

[5] https://www.elektrikport.com/teknik-kutuphane/ucaklarda-aletli-inis-sistemi/14744#ad-image-0 (6 March 2020)

[6] http://avineering.com/gp.html (6 March 2020)

[7] http://navbyvicky.blogspot.com/2015/ (6 March 2020)

[8] Furkan, K. ve Ürgün, S. 2019. Bir hassas yaklaşma prosedürü olarak ILS'in (Instrument Landing System) önemi ve uçuş gecikme maliyetlerine etkisi. Avrupa Bilim ve Teknoloji Dergisi, 15, 333-342.