

ILS – INSTRUMENT LANDING SYSTEM GROUND-BASED INSTRUMENT APPROACH SYSTEM

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Summary: The article focuses on ILS – Instrument Landing System with emphasis on its use in air travel. Part of the article focuses on general characteristic and function of ILS system in air travel.

Key words: Instrument Landing System, navigation, airport, air lane, landing, signal

1. INTRODUCTION

The ILS system for precision guidance system for aircraft landing is one that is most widely known among all navigation systems. The ILS was developed in the 1940s and in 1949 it was approved by the ICAO to be commissioned. And to this day it is used at most of the airports around the world practically without modifications. The main reason for the expansion of ILS is its exceptional operational reliability and low demand on aircraft instrumentation, which in addition can also be used by other navigation systems. ILS is highly durable against atmospheric disturbances. [3]

2. ILS PURPOSE AND FUNCTION

Precise approaches have a property, where in the final phase of approach to the airport they provide the pilot with information not only on directional aircraft guidance, but also on its vertical position. The pilot is thus continuously informed on the aircraft's position relative to the desired approach trajectory and therefore can perform instant adjustments. As far as the ILS system, its purpose is to inform the pilot of instant deviations during approach on two levels:

- **horizontal** - (whether he is in the descent axis or whether he is deviating to any one side from the course),
- **vertical** - whether the aircraft is approaching the runway touchdown zone along the plane of descent or whether it is above or below the plane of descent.

ILS enables aircraft to safely descent under the conditions of IMC (Instrumental Meteorological Conditions), i.e. fulfillment of meteorological conditions for flying by instrumentation up to altitude as decided (given category), in which the pilot in order to complete the landing process must make visual contact (with land, runway lights or approach

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lighting system). A minimum visibility and minimum cloud cover base altitude is required for each ILS category. An exception to this is the ILS CAT III C.²

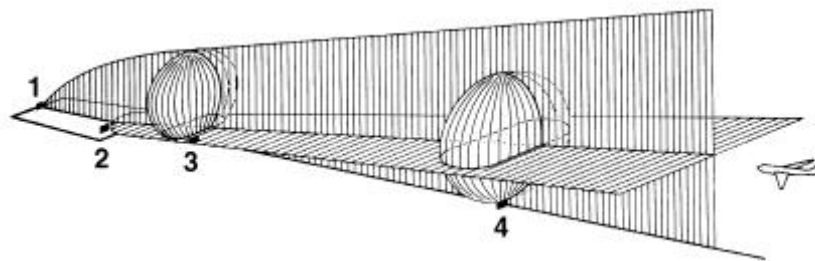
ILS equipment is comprised of two operating units:

- airport ground equipment,
- onboard aircraft equipment.

3. AIRPORT GROUND EQUIPMENT

Ground part of the traditional ILS system contains 3 basic parts:

- localizer antenna array or localizer (no.1 on figure 1),
- glide-slope array (no. 2 on figure 1),
- marker beacon, possibly beacons (no. 3 and 4 on figure 1). These can be substituted by data on distance collected on board the aircraft from the distance measuring equipment (DME)



Source: [4]

Fig. 1 - Basic parts of the ground ILS equipment and their guidance
(1. localizer antenna array, 2. glide-slope array, 3. & 4. marker beacons)

3.1. Localizer antenna array

Localizer antenna array or simply localizer (LLZ) operating at a frequency 108 – 112 MHz is a piece of equipment that with the help of radio waves creates a so called course plane in the direction of the aircraft approach within a distance 30NM from the runway touchdown zone. The antenna system is able to transmit a carrier frequency f_n and two side amplitude modulated frequencies, one being 90 Hz (left of the landing direction) and the other 150Hz (right of the landing direction). The dual-frequency localizers are extremely precise and can be used for the ILS categories II/III.

3.2. Glide-slope array

Glide-slope array (also called Glide Slope) forms an electromagnetic field to guide the aircraft in vertical direction and in the approach direction. Glide-slope array must provide sufficient signal to guide the aircraft, which is equipped with a standard ILS installation, through a system of amplitude modulated signals along both sides of the ILS descent line, at

² CAT III C: precise instrumental approach and landing without defined altitude limitations and runway visibility.

least 18.5 km distant from runway. The ILS descent line, so called Glide Path is formed by a ground UHF transmitter and its antenna system operating on a principle very similar to the localizer. The glide-slope array operates at a frequency range of 328.6MHz to 335.4MHz, which is approximately a threefold higher frequency than LLZ³ (higher frequency also generally offers higher precision).

3.3. Marker beacons and DME equipment

The purpose of marker beacons is to inform the pilot about the horizontal distance from the runway touchdown zone, where it is deemed to be significant (e.g. aircraft's altitude is checked when passing over the beacon).

All beacon types operate at a carrier frequency of 75.0 MHz and operate in such a way that they vertically transmit a cone of radio waves. The receiver onboard an aircraft is fixed to 75 MHz and will catch the signal during antenna flyover. Traditional ILS installation, besides glide-slope and localizer array, also contains at least two marker beacons, which are generally placed on lots more remote from the airport.

Airports, where it is impossible to provide marker beacons as part of the ILS, can have an acceptable substitute in the form of an appropriately placed DME (Distance Measuring Equipment), which was developed in the 1960s. DME contradictory to the marker beacons can be placed directly at the airport and in addition they provide the pilot with more complex information on distance. A separate DME receiver must be installed in an aircraft in order to utilize the DME transmission information, because the DME system is not part of ILS. DME is currently installed in most commercial airliners and operates at a frequency range of 960 – 1215 MHz. [1]

4. AIRCRAFT'S ONBOARD EQUIPMENT

Onboard ILS equipment in an airplane contains the following:

- Localizer signal receiver,
- Glide Slope signal receiver,

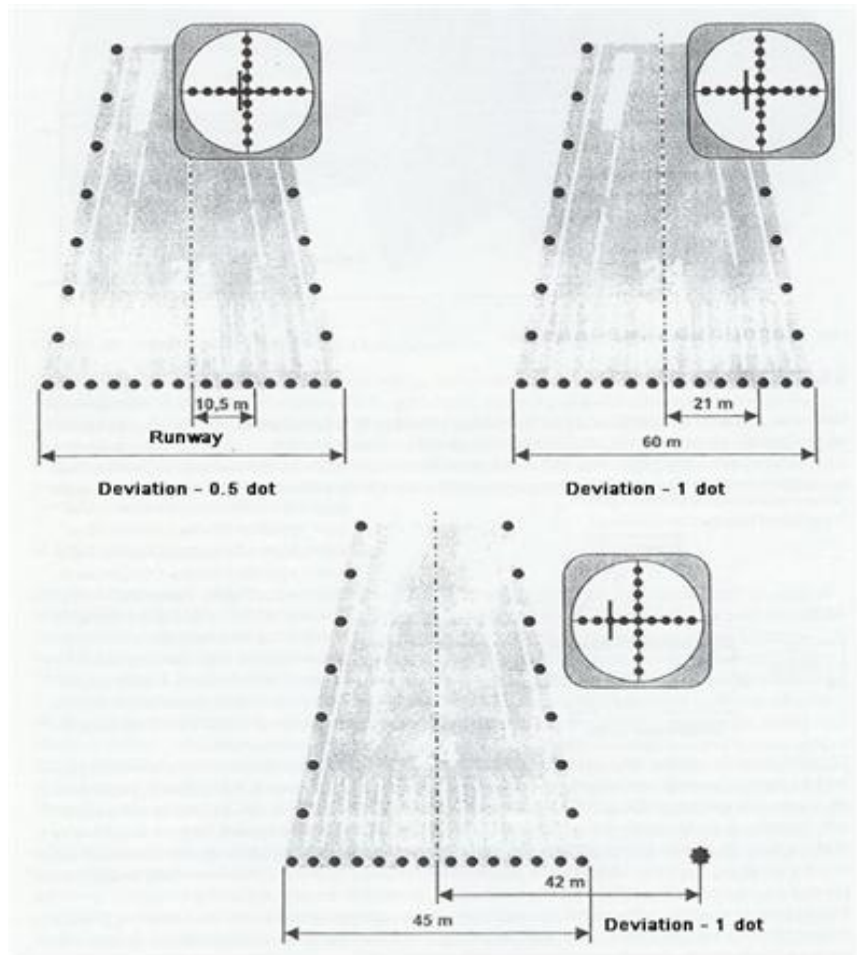
4.1. Localizer signal receiver

This equipment enables to receive the localizer signal, process it and to display the aircraft's position on an onboard indicator against an axis (azimuth) and according to this to guide the aircraft into the path axis. The information provided is on the aircraft's position toward the axis position, not the path of the plane to the axis direction. In the end the displayed information on the position is similar like for example with VOR equipment (VOR enables to select the course), but it provides information on only a single specific course, that is the axis path. However, information from both systems is displayed for the pilot with the help of the same onboard equipment, only the graphic interpretation is different.

³ LLZ - Localizer

4.2. Glide Slope signal receiver

Similar to the localizer it receives, processes and displays the signal from the glide-slope array. Glide-slope path display is identical to the localizer indication. Above OM⁴ each dot means a deviation of about 500 ft (150m) in the vertical direction from the prescribed glide-slope path. Absolute deviation size (to a single dot) drops when approaching the runway touchdown zone – above MM⁵ is only 150 ft (45m)/dot, see fig. 2. [4]



Source: [4]

Fig. 2 - Deviation from path above RWY⁶ touchdown zone

5. ILS CATEGORIES

ILS Categories generally characterize the ILS system preciseness and define its options for utilization. The significance of the categories gains in significance especially during low path visibility and low cloud base, so called LVO⁷. The lowest demand on precision, backup and level of ILS airport ground equipment as well as airplane are required by ILS category I. Approach in this category can be performed manually or with the use of autopilot. Other categories (II & III) are then used for the mentioned LVO operation. With

⁴ OM – Outer Marker, usually located generally 6500-11000 m from the runway touchdown zone.

⁵ MM – Middle Marker, usually located generally 1000 m from the runway touchdown zone

⁶ RWY – Runway take-off and landing strip

⁷ LVO – Low Visibility Operation

these categories it is required that the approach is to be performed with an operating autopilot, poss. autopilots (CAT III) and autoland be used in case of CAT III. Categories are common for ILS as well as MLS.⁸ Individual categories are defined as follows:

- **category I:**
precise instrument approach for landing with a decided altitude above 200 ft (60m) and either visibility above 800 m or runway visibility above 550m,
- **category II:**
precise instrument approach for landing with a decided altitude above 100 ft (30m) to 199 ft (60m) and with runway visibility at least 300 m,
- **category III. A:**
precise instrument approach for landing with a decided altitude above under 100ft (30 m) and with runway visibility at least 200 m,
- **category III. B:**
precise instrument approach for landing and landing with a decided altitude under 50 ft (15 m) or without decided altitude limitation and with runway visibility above 200 m.
- **category III. C:**
precise instrument approach for landing and landing without a decided altitude and path visibility. [2]

The above stated decided altitudes are related to the radio navigation device itself, not to the specific approach. Altitudes published for individual categories in maps are relevant for the autopilot. In order to be classified into a specific category the airport must comply with specific criteria relative to lighting and security.

From experience, I state classifications for several select airports around the Czech Republic:

- **Prague Ruzyně Airport LKPR** – has an ILS CAT I system implemented with all 4 directions, CAT II and III A are installed only on runway 24,
- **Airports Pardubice LKPD and Brno Tuřany LKTB** – have an ILS CAT I always with one direction,
- **Vodochody Airport LKVO** – has an ILS CAT I,
- **Ostrava - Mořnov Airport LKMT** – is currently commissioning ILS CAT II.

6. CONCLUSION

In the article I've focused on one element of airline navigation system, specifically the ILS system for precise aircraft approach for landing. It is a well known and highly used navigation system in air commerce around the world.

⁸ MLS – Microwave Landing System enables approach under various descent angles individually for each plane. It is considered to be a possible successor to ILS. MLS is impossible in the near future due to the system's high installation costs at airports and in airplanes.

Some airports in CZ are currently performing optimization of the ILS for the purpose of increasing classification. For example the Vodochody Airport LKVO is working on improving lighting and security conditions to increase conditions from CAT I to CAT II.

ILS is a great example that a simple and reliable idea can survive practically all other navigation systems and at the same it is in the long run able to be competitive with innovative solutions within the aircraft navigation issue.

7. LIST OF ABBREVIATIONS

DME - Distance Measuring Equipment

ILS - Instrument Landing System

LLZ – Localizer

OM - Outer Marker located about 6500-11000m from the runway touchdown zone

RWY - Runway – take off and landing strip

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