AirTAP Airport Technical Assistance Program

AirTAP Briefings

University of Minnesota
CTS Center for Transportation Studies

A publication of the Airport Technical Assistance Program of the Center for Transportation Studies at the University of Minnesota

Winter 2006

NAVAIDs: A brief overview

This issue of *Briefings* focuses on one essential element of all airports. Navigation aids, or NAVAIDs as they are more commonly known, are visual or electronic devices, located either on the ground or in the air, that provide point-to-point guidance information or position data to aircraft in flight. As such, NAVAIDs help pilots plan and execute flights from one point to another.

NAVAIDs include:

- Approach lighting systems (ALS)
- Precision approach path indicator (PAPI) systems
- Visual approach slope indicator (VASI) systems
- Runway end identifier lights (REILs)
- Lead-in lighting (LDIN) systems
- Airport beacons
- Instrument landing systems (ILS)
- Nondirectional beacons (NDB)

In addition to the above, automated weather reporting equipment (AWOS) is usually included under the umbrella of NAVAIDs.

The primary navigation systems used during flight are the very high frequency omnirange (VOR) station and the satellite-based Global Positioning System (GPS).

NAVAIDs used during the approach and landing portions of flight are, in order of precision, the instrument landing system (ILS), localizer (LOC), GPS, VOR, and nondirectional beacon (NDB).

In addition to electronic or satellite systems, a pilot can use several types of approach lighting systems for assistance in the landing phase after he or she has located the airport and is making the approach to the runway.

The terms "precision" and "nonprecision" differentiate between navigational facilities that provide combined azimuth and glide slope guidance to a runway (precision) and those that do not (nonprecision). Nonprecision refers to facilities without a glide slope and does not imply an unacceptable quality of course guidance.

Following is a description of some of the more regularly used NAVAIDs. Other NAVAIDs, which are not discussed in this article, include distance-measuring equipment (DME), centerline lighting, distance-to-go sign (DTG), and surface movement guidance signs. [Note: this information has been taken from FAA Order 6850.2A, dated December 17, 1981.]

Approach lighting system (ALS)

An approach lighting system (ALS) is a configuration of signal lights placed symmetrically about the extended runway centerline, starting at the landing threshold and extending straight outward into the approach zone. This system provides visual information on runway alignment, height perception, roll guidance, and horizon references. The system used for precision approaches, in conjunction with an electronic aid such as an ILS, is normally 2,400 feet long when the glide slope is 2.75 degrees or greater, and 3,000 feet long when the glide slope is less than 2.75 degrees. When installation of a 2,400-foot system is not possible, a system 1,400 feet long may be installed on nonprecision runways.

The ALS is classified as a high-intensity or medium-intensity system, depending on the type of lamps and equipment used:

Medium-intensity approach lighting system (MALS)—an economy-type system for nonprecision approaches.

Medium-intensity approach lighting system with sequenced flashers (MALSF)—same as MALS, but equipped with three sequenced flashers at locations where approach-area identification problems exist.

Medium-intensity approach lighting system with runway alignment (MALSR)—an economy-type system used as the FAA standard for Category I precision runways.

Simplified short approach lighting system with runway alignment (SSALR)—Used the same as MALSR. Generally, the SSALR is not to be installed as a new system. It is used when Category I conditions exist on Category II-designated runways with a dual-mode approach lighting system.

High-intensity approach lighting system with sequenced flashers (MALS)—used on Category II and III precision approach runways.

Omnidirectional approach lighting system (ODALS)—a configuration of seven omnidirectional sequenced flashing lights located in the runway approach area. The ODALS provide circling, offset, and straight-in visual guidance for nonprecision approach runways.

Precision approach path indicators (PAPIs)

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A precision approach path indicator, or PAPI, is designed to furnish a pilot with visual approach slope information to provide guidance for safe descent and landing. The system, intended primarily for use during visual flight rule (VFR) weather conditions, works with remote on and off control (controlled by the pilot through the aircraft radio). Two light intensity settings—day and night—are provided and are controlled photoelectrically.

A PAPI system provides a definite white and red light projection pattern along the desired descent path to the touchdown

Continued on back

point. The lamp housing assemblies are arranged on a single bar on a line perpendicular to the runway centerline.

Visual approach slope indicator (VASI)
A visual approach slope indicator (VASI) system provides visual approach slope information by projecting a definite white and red light beam along the desired descent path to the touchdown point. The light units are arranged in bars, with the light units in each bar located on a line perpendicular to the runway centerline. Each light unit projects a split beam of light; the upper segment is white and the lower is red. The transition from red to white, or vice versa, occurs over a vertical angle of approximately one-quarter degree, with the light in this area pink. The system produces a well-defined corridor or corridors of light consisting of red and white beams.

VASI systems can be two- or three-bar:

- The **two-bar system** uses light units arranged into an upwind and downwind bar. The downwind bar is the one nearest to the runway threshold and the upwind bar is the farthest from the threshold. When on the proper glide path, the downwind bar appears white and the upwind bar appears red. If the approach is too low, both bars will appear red.
- The **three-bar system** was developed to provide dual glide paths to accommodate aircraft of varying wheel-to-cockpit heights. The three-bar VASI is installed at only those locations having 747, C5A, or other similar long-bodied aircraft operations. The three-bar system uses light units arranged in bars called the upwind, middle, and downwind bar. The downwind bar is the one nearest to the runway threshold and the upwind bar is the farthest, with the middle bar in between. Two glide paths are projected by the three-bar system.

Runway end identifier lights (REILs)
The primary function of the runway end identifier lights (REILs) is to provide rapid and positive identification of the end of a runway. The system consists of two synchronized flashing lights, unidirectional or omnidirectional, on each side of the runway landing threshold; unidirectional flashing lights face the approach area. The flashing feature of the lights provides an attracting characteristic, making the REIL effective for identifying a runway surrounded by other lighting or one lacking contrast with surrounding terrain.


Runway end identifier lights (REILs)

Typically PAPIs and VASIs are set for a 3-degree visual approach angle. Their placement along the runway edge is determined by the classification of aircraft using the airport, runway length, and obstructions within the approach. VASIs and PAPIs are sited to provide a minimum of 1-degree clearance over obstructions in the approach.

Lead-in lighting system (LDIN)
The lead-in lighting system, or LDIN, provides positive visual guidance along an approach path, either curving or straight, where special problems exist with hazardous terrain, obstructions, or noise abatement procedures. An LDIN consists of one or more series of flashing lights installed along the approach path at or near ground level. The series or groups of lights are positioned and aimed so as to be conveniently sighted and followed from the approaching aircraft under conditions at or above approach minimums.

Each light group contains at least three flashing lights in a linear or cluster configuration and may be augmented by steady-burning lights if required. Where practical, lights in one group flash in sequence toward the runway. The light groups are spaced close enough to provide continuous lead-in guidance along each segment of the approach course (approximately one mile). The FAA recommends sequencing successive light groups. The LDIN may be terminated at any approved approach lighting system, or it may be terminated at a distance from the threshold compatible with authorized visibility minimums permitting visual reference to the runway environment.

Instrument landing system (ILS)
The cockpit of an aircraft on an instrument landing approach uses computerized instrument landing equipment to receive and interpret signals sent from strategically placed stations on the ground near the runway. This system includes a localizer beam that uses the VOR indicator with only one radial aligned with the runway. The localizer beam's width ranges from 3 degrees to 6 degrees. It also uses a second beam called a glide slope beam that provides vertical information to the pilot. The glide slope is usually 3 degrees wide and 1.4 degrees high.

A horizontal needle on the VOR/ILS head indicates the aircraft's vertical position. Three marker beacons (outer, middle, and inner) are located in front of the landing runway and indicate their distances from the runway threshold. The outer marker (OM) is located four to seven miles from the runway. The middle marker (MM) is located about 3,000 feet from the landing threshold, while the inner marker (IM) is located between the middle marker and the runway threshold where the landing aircraft would be 100 feet above the runway.

The VOR indicator for an ILS system uses a horizontal needle in addition to the vertical needle. When the appropriate ILS frequency is entered into the navigation radio, the horizontal needle indicates where the aircraft is in relation to the glide slope. If the needle is above the center mark on the dial, the aircraft is below the glide slope. If the needle is below the center mark on the dial, the aircraft is above the glide slope.

AirTAP was developed through the joint efforts of the Minnesota Department of Transportation (Mn/DOT), the Minnesota Council of Airports (MCOA), and the Center for Transportation Studies (CTS).

Briefings is published as a quarterly insert of the MCOA newsletter. Please direct comments to:
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