PROJECT REPORT

INSTRUMENT LANDING SYSTEM AND RUNWAY LIGHTS

Submitted in partial fulfillment of the award of the

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Affiliated to University of Mumbai

By

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DECLARATION

I, AKSHAY BHARAT LOHAR **(2017-A-09)** hereby declared that this project report titled**INSTRUMENT LANDING SYSTEM AND RUNWAY LIGHTS** submitted in partial fulfillment of the requirement for the award of **"BACHALOR OF SCIENCE –in AERONAUTICS(** AVIONICS) is my original work and it has not formed the basis for the award of any other degree.

AKSHAY BHARAT LOHAR

Place:

Date:

ACKNOWLEDGEMENT

It is my pleasure to be indebted to various people, who directly or indirectly contributed in the development of this work and who influenced my thinking, behavior, and acts during the course of study.

I express my sincere gratitude to my Project Guide **Dr.M Suresh Kumar** for providing me an opportunity to work under him. I am thankful to him for his support, cooperation and motivation provided to me during the project for constant inspiration, presence and blessings.

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AKSHAY BHARAT LOHAR

(2017-A-09)

Date: _______/______/_________ .

PROJECT NAME

INSTRUMENT LANDING SYSTEM
&
RUNWAY LIGHT

PROJECT RECORD

BOOK

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INTRODUCTION.

Instrument Landing Systems (ILS) are designed to guide an aircraft in its final

approach and landing.

•Three distinct sub systems are used:

–Localiser

–GlideSlope

–Markers.

Ils components
•Localizer–indicates alignment with runway
•Glideslope–indicates correct descentpath

Outer Marker–Final Approach Fix

•Middle Marker–Missed Approach PoinT

Abstract

Instrument landing system (ILS) are designed to guide an aircraft in its final approach and landing .Three distinct subsystem are used(1)Localizer(2)Glideslope(3)Marker beacon

Localizer :- Consists of a group of transmitter and antenna positioned and thefar end of the runway.The antenna radiation pattern has a 5° beamwidtcentered along the runway.The VHF frequencies use for the localizer are inthe range 108.1 to 111.9 MHz . The useful range of the system is about 40km.

Glideslope :-Consists of a group of transmitter and antenna positionedand the far end of the runway.The antenna radiation pattern has a 1°beamwidth and elevation about 2.5° to 2.75° in the direction of approachThe VHF frequency use for the glide slope are in the range 329.3 to335.0MHz.

Markerbeacon:-Markers are transmitter that radiate continues narrow vertical radio beams The carrier frequency is 75MHz modulated by special tones.

Three types of marker beacons

- (1)Outer marker
- (2)Middle marker
- (3)Inner marker

The Instrument Landing System adds glide-slope, or elevation information. Commonly called the ILS, it is the granddaddy of them all when it comes to getting down close to the ground. In every sense it is a precision approach system and with the most sophisticated equipment it can guide you right down to the runway—zero Decision-Height and zero visibility.

Marker beacon

● MARKER beacons provide a light and a sound indication at a published distance from the runway threshold. They operate at a carrier frequency of 75 MHz and are going to be replaced by a systematic use of a DME coupled to the LOC.

● A **marker beacon** is a particular type of VHF radio beacon used in aviation, usually in conjunction with an instrument landing system (ILS), to give pilots a means to determine position along an established route to a destination such as a runway.

● There are three types of marker beacons that may be installed as part of their most common application—an instrument landing system

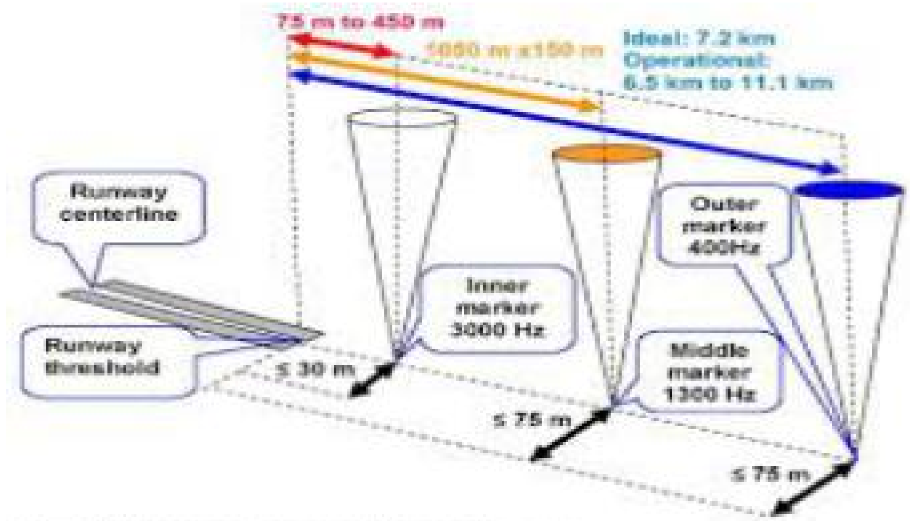


Figure 14: Marker beacon placement with respect to runway

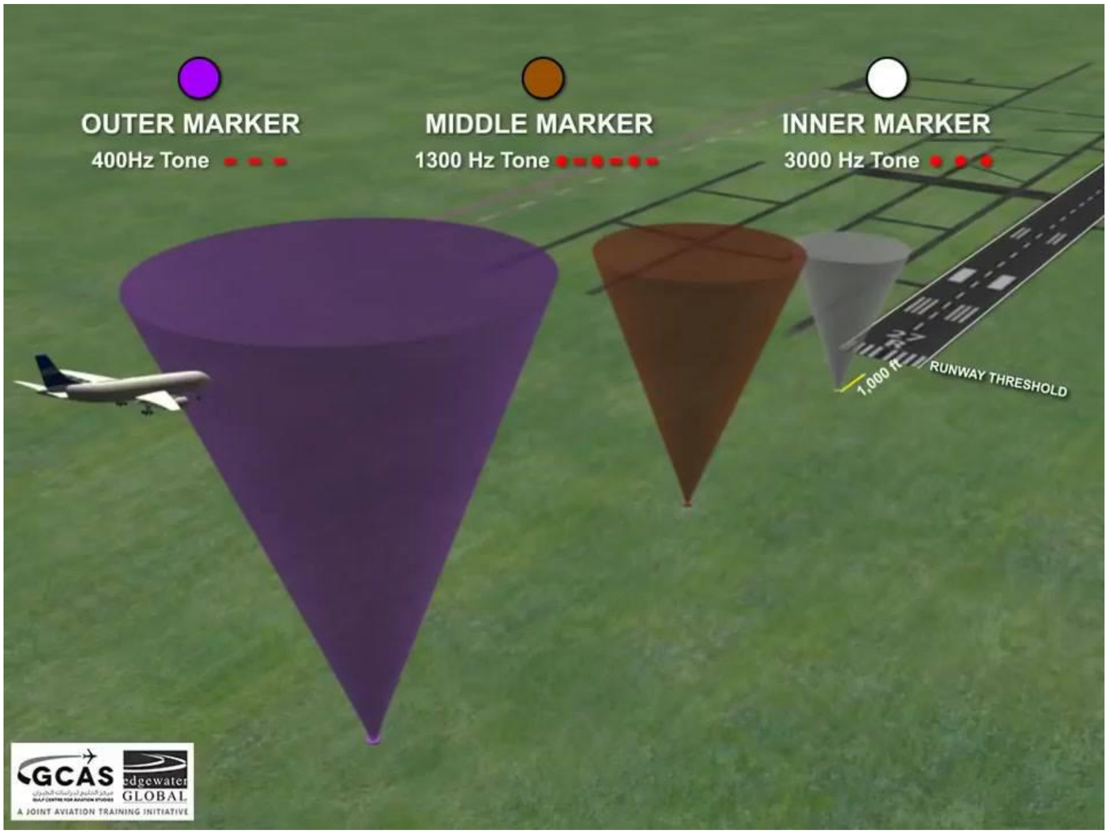
Indications a pilot receives when passing over a marker beacon.

MARKER	CODE	LIGHT	SOUND
OM	_ _ _	BLUE	400 Hz two dashes/second
MM	._._._	AMBER	1300 Hz Alternate dot and dash
IM	. . . .	WHITE	3000Hz only dots

- # Outer marker

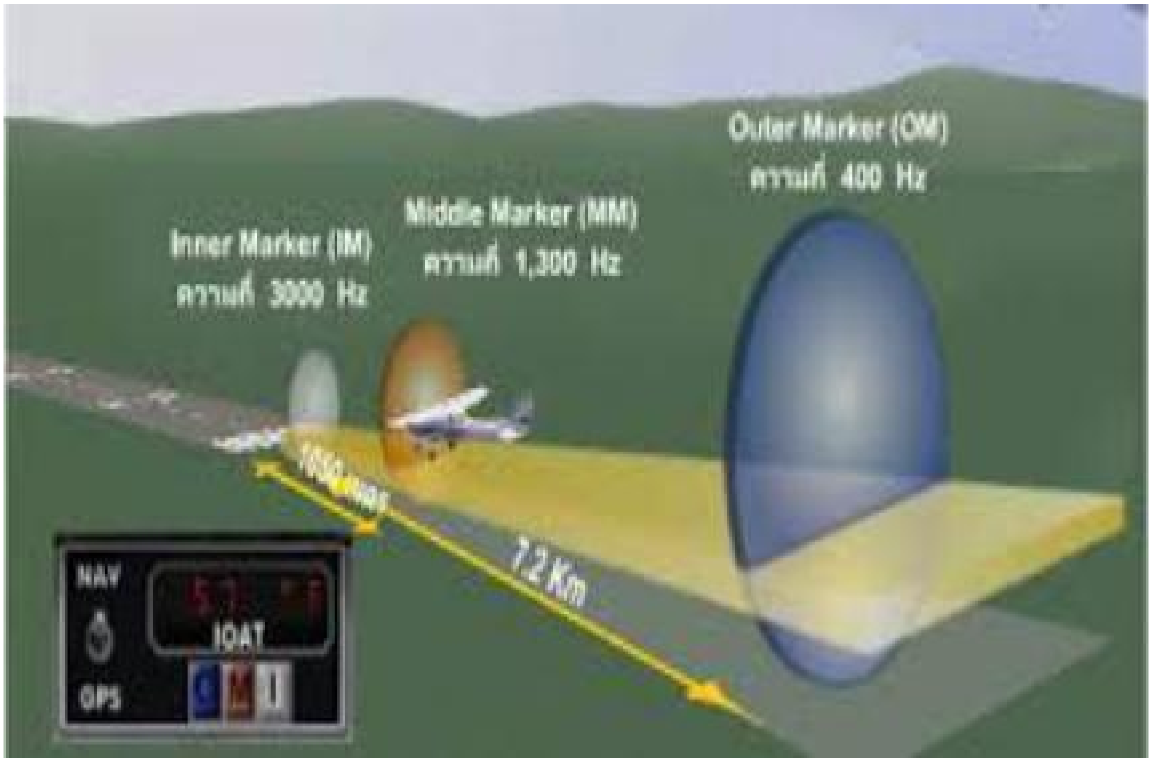
The **outer marker**, which normally identifies the final approach fix (FAF), is situated on the same course/track as the localizer and the runway center-line, four to seven nautical miles[2] before the runway threshold. It is typically located about 1 NM (1.85 km) inside the point where the glideslope intercepts the intermediate altitude and transmits a 400 Hz tone signal on a low-powered (3 watts), 75 MHzcarrier signal. Its antenna is highly directional, and is pointed straight up. The valid signal area is a 2,400 ft (730 m) × 4,200 ft (1,280 m) ellipse (as measured 1,000 ft (300 m) above the antenna.) When the aircraft passes over the outer marker antenna, its marker beacon receiver detects the signal. The system gives the pilot a visual (blinking blue outer marker light) and aural (continuous series of audio tone morse code-like 'dashes') indication.

In the United States, the outer marker has often been combined with a non-directional beacon (NDB) to make a **locator outer marker** (**LOM**). An LOM is a navigation aid used as part of an instrument landing system (ILS) instrument approach for aircraft. Aircraft can navigate directly to the location using the NDB as well as be alerted when they fly over it by the beacon



- Middle Marker

A **middle marker** works on the same principle as an outer marker. It is normally positioned 0.5 to 0.8 nautical miles (1 km) before the runway threshold. When the aircraft is above the middle marker, the receiver's amber middle marker light starts blinking, and a repeating pattern of audible morse code-like dot-dashes at a frequency of 1,300 Hz in the headset. This alerts the pilot that the CAT I missed approach point (typically 200 feet (60 m) above the ground level on the glideslope) has been passed and should have already initiated the missed approach if one of several visual cues has not been spotted

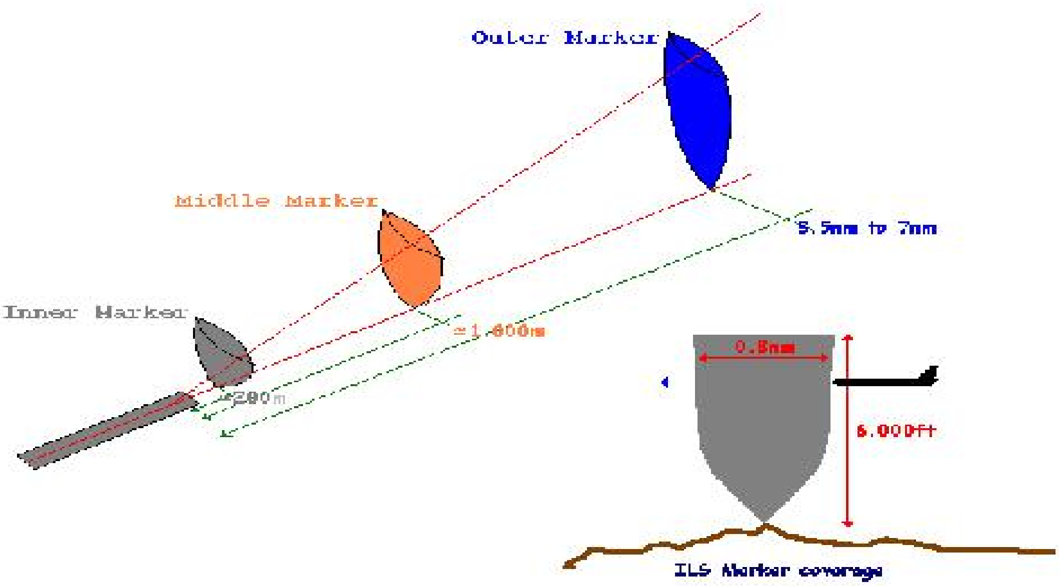


● Inner Marker

Similar to the outer and middle markers, a **inner marker** located at the beginning (threshold) of the runway on some ILS approach systems (usually Category II and III) having decision heights of less than 200 feet (60 m) AGL. Triggers a flashing white light on the same marker beacon receiver used for the outer and middle markers; also a series of audio tone 'dots' at a frequency of 3,000 Hz in the headset.

On some older marker beacon receivers, instead of the "O", "M" and "I" indicators (outer, middle, inner), the indicators are labeled "A" (or FM/Z), "O" and "M" (airway or Fan and Z marker, outer, middle). The airway marker was used to indicate reporting points along the centerline of now obsolete "Red" airways; this was sometimes a "fan" marker, whose radiated pattern was elongated at right angles across the airway course so an aircraft slightly off course would still receive it

A "Z" marker was sometimes located at low- or medium-frequency range sites to accurately denote station passage. As airway beacons used the same 3,000 Hz audio frequency as the inner marker, the "A" indicator on older receivers can be used to detect the inner marker.



LOCALIZER

In aviation, a **localizer** is the lateral component of the *instrument landing system* (ILS) for the runway centerline when combined with the vertical glide slope, not to be confused with a locator, although both are parts of aviation navigation systems.

A localizer (like a glideslope) works as a *cooperation* between the transmitting airport runway and the receiving cockpit instruments. An older aircraft without an ILS receiver cannot take advantage of any ILS facilities at any runway, and much more importantly, the most modern aircraft have no use of their ILS instruments at runways which lack ILS facilities. In parts of Africa and Asia large airports may lack any kind of transmitting ILS system. Some runways have ILS only in one direction, this can however still be used (with a lower precision) known as *back beam* or "Back Course" which is not associated with a glide slope.

Localizer (LOC) and *glide slope (G/S)* carrier frequencies are paired so that the navigation radio automatically tunes the G/S frequency which corresponds to the selected LOC frequency. The LOC signal is in the 110 MHz range while the G/S signal is in the 330 MHz range

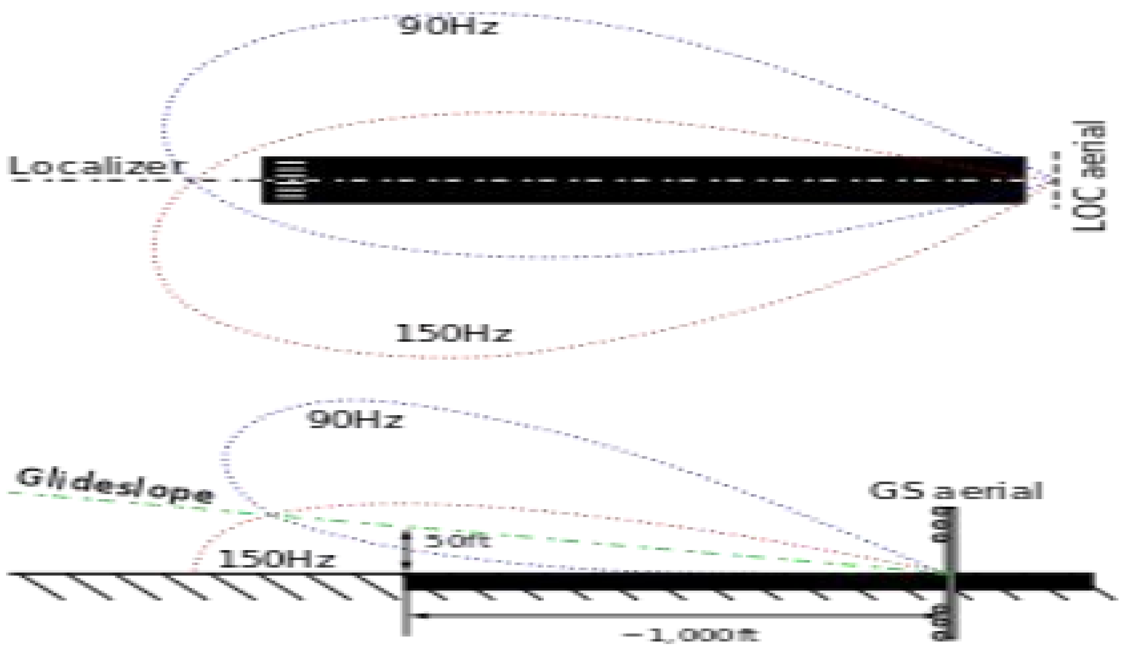
LOC carrier frequencies range between 108.10 MHz and 111.95 MHz (with the 100 kHz first decimal digit always odd, so 108.10, 108.15, 108.30, etc., are LOC frequencies and are not used for any other purpose). See Instrument Landing System (ILS) Frequencies on even-numbered TACAN channels from 18X to 56Y

Glide slope

Instrument landing system glide path, commonly referred to as a **glide path** (**G/P**) or **glide slope** (**G/S**), is "a system of vertical guidance embodied in the instrument landing system which indicates the vertical deviation of the aircraft from its optimum path of descent", according to *Article 1.106* of the ITU Radio Regulations (ITU RR).[1]

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

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 (i.e. it provides vertical guidance).



Distance measuring equipment DME

Distance measuring equipment (DME) is a radio navigation technology that measures the slant range (distance) between an aircraft and a ground station by timing the propagation delay of radio signals in the frequency band between 960 and 1215 megahertz (MHz). Line-of-visibility between the aircraft and ground station is required. An interrogator (airborne) initiates an exchange by transmitting a pulse pair, on an assigned 'channel', to the transponder ground station. The channel assignment specifies the carrier frequency and the spacing between the pulses. After a known delay, the transponder replies by transmitting a pulse pair on a frequency that is offset from the interrogation frequency by 63 MHz and having specified separation

Distance Measuring Equipment Function: 1 DME Slant Range Distance 2 Paired pulses at specific spacing (interrogation) are sent to a ground station from the aircraft via the antenna 3 The ground station (transponder) sends the same pulses back to the aircraft at a different frequency Time time it takes is interpreted as the distance, usually in Nautical Miles (NM) More items

Distance measuring equipment (**DME**) is a radio navigation technology that measures the slant range (distance) between an aircraft and a ground station by timing the propagation delay of radio signals in the frequency band between 960 and 1215 megahertz (MHz). Line-of-visibility between the aircraft and ground station is required. An interrogator (airborne) initiates an exchange by transmitting a pulse pair, on an assigned 'channel', to the transponder ground station. The channel assignment specifies the carrier frequency and the spacing between the pulses. After a known delay, the transponder replies by transmitting a pulse pair on a frequency that is offset from the interrogation frequency by 63 MHz and having specified separation

While stand-alone DME transponders are permitted, DME transponders are usually paired with an azimuth guidance system to provide aircraft with a two-dimensional navigation capability. A common combination is a DME colocated with a VHF omnidirectional range (VOR) transmitter in a single ground station. When this occurs, the frequencies of the VOR and DME equipment are paired.[1] Such a configuration enables an aircraft to determine its azimuth angle and distance from the station. A VORTAC (a VOR co-located with a TACAN) installation provides the same capabilities to civil aircraft but also provides 2-D navigation capabilities to military aircraft

Low-power DME transponders are also associated with some instrument landing system (ILS), ILS localizer and microwave landing system (MLS) installations. In those situations, the DME transponder frequency/pulse spacing is also paired with the ILS, LOC or MLS frequency

Developed in Australia, DME was invented by James "Gerry" Gerrand[5] under the supervision of Edward George "Taffy" Bowen while employed as Chief of the Division of Radiophysics of the Commonwealth Scientific and Industrial Research Organisation (CSIRO). Another engineered version of the system was deployed by Amalgamated Wireless Australasia Limited in the early 1950s operating in the 200 MHz VHF band. This Australian domestic version was referred to by the Federal Department of Civil Aviation as DME(D) (or DME Domestic), and the later international version adopted by ICAO as DME(I).

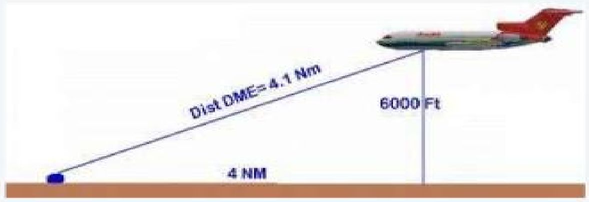
DME is similar in principle to secondary radar ranging function, except the roles of the equipment in the aircraft and on the ground are reversed. DME was a post-war development based on the identification friend or foe (IFF) systems of World War II. To maintain compatibility, DME is functionally identical to the distance measuring component of TACAN

In its first iteration, a DME-equipped airplane used the equipment to determine and display its distance from a land-based transponder by sending and receiving pulse pairs. The ground stations are typically collocated with VORs or VORTACs. A low-power DME can be collocated with an ILS or MLS where it provides an accurate distance to touchdown, similar to that otherwise provided by ILS marker beacons (and, in many instances, permitting removal of the latter).

A newer role for DMEs is DME/DME area navigation (RNAV).[6][7] Owing to the generally superior accuracy of DME relative to VOR, navigation using two DMEs (using trilateration/distance) permits operations that navigating with VOR/DME (using azimuth/distance) does not. However, it requires that the aircraft have RNAV capabilities, and some operations also require an inertial reference unit.

A typical DME ground transponder for en-route or terminal navigation will have a 1 kW peak pulse output on the assigned UHF channel

DME : Distance Measuring Equipment



- Aircraft use DME to determine their distance from a land-based transponder

RUNWAY LIHGT

Runway Lights Color & Spacing Explained 1 Colors Found In The Runway Edge Lighting. According to the FAA's most up-to-date airfield Standards publication. ... 2 Runway Edge light Spacing and Color. Both High-Intensity Runway Lights (HIRLs) and Medium Intensity Runway Lights (MIRLs) require a maximum spacing of two hundred feet between each runway edge light. 3 Runway centerline Lighting and Color. Runway centerline lights and touchdown zone lights are required for CAT II and CAT III runways, and for CAT I runways used for landing operations

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Approach lights at Jyväskylä Airport, Finland

The approach lighting system of Bremen Airport

Approach lighting at Love Field, Dallas

An **approach lighting system**,[1] or **ALS**, is a lighting system installed on the approach end of an airport runway and consisting of a series of lightbars, strobe lights, or a combination of the two that extends outward from the runway end. ALS usually serves a runway that has an instrument approach procedure (IAP) associated with it and allows the pilot to visually identify the runway environment and align the aircraft with the runway upon arriving at a prescribed point on an approach

Modern approach lighting systems are highly complex in their design and significantly enhance the safety of aircraft operations, particularly in conditions of reduced visibility

The required minimum visibilities for instrument approaches is influenced by the presence and type of approach lighting system. In the U.S., a CAT I ILS approach without approach lights will have a minimum required visibility of 3/4 mile, or 4000 foot runway visual range. With a 1400-foot or longer approach light system, the minimum potential visibility might be reduced to 1/2 mile (2400 runway visual range), and the presence of touchdown zone and centerline lights with a suitable approach light system might further reduce the visibility to 3/8 mile (1800 feet runway visual range

The runway lighting is controlled by the air traffic control tower. At non-towered airports, pilot-controlled lighting may be installed that can be switched on by the pilot via radio. In both cases, the brightness of the lights can be adjusted for day and night operations.

Depth perception is inoperative at the distances usually involved in flying aircraft, and so the position and distance of a runway with respect to an aircraft must be judged by a pilot using only two-dimensional cues such as perspective, as well as angular size and movement within the visual field. Approach lighting systems provide additional cues that bear a known relationship to the runway itself and help pilots to judge distance and alignment for landing.

Runway edge lighting are used to outline the edges of runways during periods of darkness or restricted visibility conditions. These light systems are classified according to the intensity they are capable of producing:

- High intensity runway lights (HIRL)
- Medium intensity runway lights (MIRL)
- Low intensity runway lights (LIRL)[1]

Many HIRL and MIRL systems have variable intensity controls, whereas the LIRLs normally have one intensity setting. At airports where there is a control tower, the tower will manage the lights to account for visibility and pilot preference, but some airports do not have control towers. These airports will have Pilot Controlled Lighting, or PCL, where pilots can adjust the lighting themselves by keying a microphone button a certain number of times.[1]

The majority of runway edge lights are clear or white[2], but there are some exceptions to provide additional information to pilots in certain circumstances.

When an instrument runway lighting is designed, the last 600 metres (2,000 ft), or one-half of the runway length available (whichever is less), are bi-directional. They look white to the pilot approaching from the short end of the runway, but to a pilot approaching from the other end, who would be landing or taking off in that direction, they are yellow to indicate that the runway is nearing the end.[1][3]

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Runway end identifier lights

Approach lighting systems

Runway end identifier lights (**REIL**[1]) (ICAO identifies these as Runway Threshold Identification Lights) are installed at many airports to provide rapid and positive identification of the approach end of a particular runway. The system consists of a pair of synchronized flashing lights located laterally on each side of the runway threshold. REILs may be either omnidirectional or unidirectional facing the approach area.[2] They are effective for:[2]

- Identification of a runway surrounded by a preponderance of other lighting
- Identification of a runway which lacks contrast with surrounding terrain
- Identification of a runway during reduced visibility

The International Civil Aviation Organization (ICAO) recommends that:[3]

- Runway threshold identification lights should be installed:
    - at the threshold of a non-precision approach runway when additional threshold conspicuity is necessary or where it is not practicable to provide other approach lighting aids; and
    - where a runway threshold is permanently displaced from the runway extremity or temporarily displaced from the normal position and additional threshold conspicuity is necessary.
- Runway threshold identification lights shall be located symmetrically about the runway centre line, in line with the threshold and approximately 10 meters outside each line of runway edge lights.
- Runway threshold identification lights should be flashing white lights with a flash frequency between 60 and 120 per minute.
- The lights shall be visible only in the direction of approach to the runway

Taxiway

A taxiway is a path for aircraft at an airport connecting runways with aprons, hangars, terminals and other facilities. They mostly have a hard surface such as asphalt or concrete, although smaller general aviation airports sometimes use gravel or grass. Most airports do not have a specific speed limit for taxiing (though some do). There is a general rule on safe speed based on obstacles. Operators and aircraft manufacturers might have limits. Typical taxi speeds are 20–30 knots (37–56 km/h; 23–35 mph).

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- **Normal Centerline** A single continuous yellow line, 15 centimetres (6 in) to 30 centimetres (12 in) in width.
- **Enhanced Centerline** The enhanced taxiway center line marking consists of a parallel line of yellow dashes on either side of the taxiway centerline. Taxiway centerlines are enhanced for 150 feet (46 m) before a runway holding position marking. The enhanced taxiway centerline is standard[3] at all FAR Part 139 certified airports in the USA.
- **Taxiway Edge Markings** Used to define the edge of the taxiway when the edge does not correspond with the edge of the pavement.
    - Continuous markings consist of a continuous double yellow line, with each line being at least 15 centimetres (6 in) in width, spaced 15 centimetres (6 in) apart. They divide the taxiway edge from the shoulder or some other abutting paved surface not intended for use by aircraft.

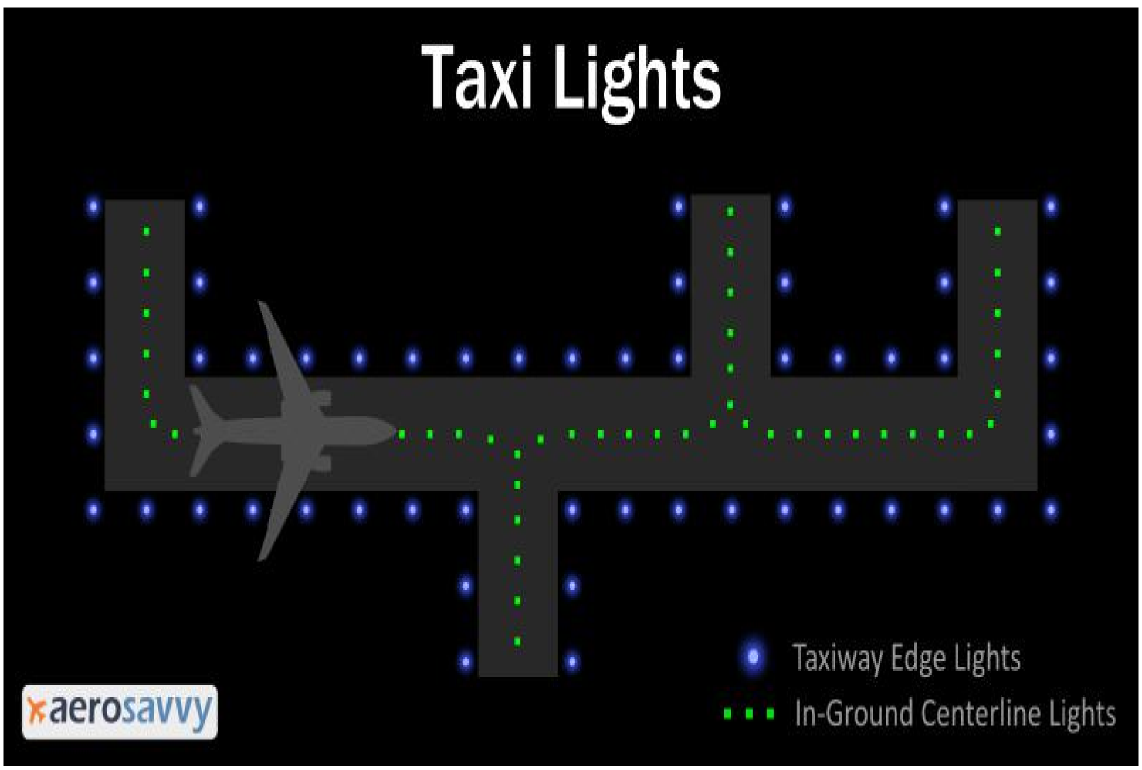
    - Dashed markings define the edge of a taxiway on a paved surface where the adjoining pavement to the taxiway edge is intended for use by aircraft, e.g. an apron. These markings consist of a broken double yellow line, with each line being at least 15 centimetres (6 in) in width, spaced 15 centimetres (6 in) apart (edge to edge). These lines are 15 feet (4.6 m) in length with 25 foot (7.6 m) gaps.
- **Taxi Shoulder Markings** Taxiways, holding bays, and aprons are sometimes provided with paved shoulders to prevent blast and water erosion. Shoulders are not intended for use by aircraft, and may be unable to carry the aircraft load. Taxiway shoulder markings are yellow lines perpendicular to the taxiway edge, from taxiway edge to pavement edge, about 3 metres.
- **Surface Painted Taxiway Direction Signs** Yellow background with a black inscription, provided when it is not possible to provide taxiway direction signs at intersections, or when necessary to supplement such signs. These markings are located on either side of the taxiway.
- **Surface Painted Location Signs** Black background with a yellow inscription and yellow and black border. Where necessary, these markings supplement location signs located alongside the taxiway and assist the pilot in confirming the designation of the taxiway on which the aircraft is located. These markings are located on the right side of the centerline.
- **Geographic Position Markings** These markings are located at points along low visibility taxi routes (when Runway visual range is below 1200 feet (370 m)). They are positioned to the left of the taxiway centerline in the direction of taxiing. Black inscription centered on pink circle with black inner and white outer ring. If the pavement is a light colour then the border is white with a black outer ring.

A newly painted Runway Holding Position Marking at Rocky Mountain Metropolitan Airport (KBJC)

- **Runway Holding Position Markings** These show where an aircraft should stop when approaching a runway from a taxiway. They consist of four yellow lines, two solid and two dashed, spaced six or twelve inches (15 or 30 cm) apart, and extending across the width of the taxiway or runway. The solid lines are always on the side where the aircraft is to hold. There are three locations where runway holding position markings are encountered: Runway holding position markings on taxiways; runway holding position markings on runways; taxiways located in runway approach areas.

- **Holding Position Markings for Instrument Landing System ([ILS](#))** These consist of two yellow solid lines spaced two feet (60 cm) apart connected by pairs of solid lines spaced ten feet (3 metres) apart extending across the width of the taxiway.
- **Holding Position Markings for Taxiway/Taxiway Intersections** These consist of a single dashed line extending across the width of the taxiway.
- **Surface Painted Holding Position Signs** Red background signs with a white inscription to supplement the signs located at the holding position.

The taxiways are given alphanumeric identification. These taxiway IDs are shown on black and yellow signboards along the taxiways.

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Windsock

Windsock

A **windsock** is a conicaltextiletube that resembles a giant sock. Windsocks can be used as a basic guide to wind direction and speed, or as decoration.

Windsocks are used to tell wind speed and the direction of the wind speed itself. Windsocks typically are used at airports to indicate the direction and strength of the wind to pilots and at chemical plants where there is risk of gaseousleakage. They are sometimes located alongside highways at windy locations

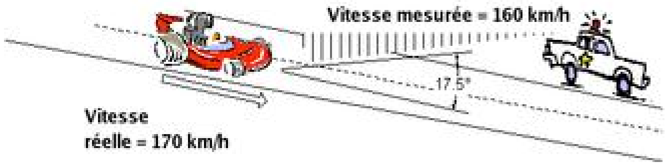
At many airports, windsocks are lit at night, either by floodlights on top surrounding it or with one mounted on the pole shining inside

Wind direction is the opposite of the direction in which the windsock is pointing (note that wind directions are conventionally specified as being the compass point from which the wind originates; so a windsock pointing due north indicates a southerly wind). Wind speed is indicated by the windsock's angle relative to the mounting pole; in low winds, the windsock droops; in high winds it flies horizontally.

Alternating stripes of high visibility orange and white were initially used to help to estimate the speed of wind. Each stripe adds up 3 knots to the estimated wind speed. However, some circle frames mountings cause windsocks to be held open at one end, indicating a velocity of 3 knots, even though anemometers would show no wind speed. A fully extended windsock suggests a wind speed of 15 knots (28 km/h; 17 mph) or greater.[

Doppler Radar Tower

Doppler effect[edit]



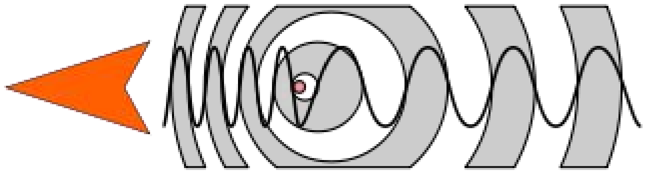
The emitted signal toward the car is reflected back with a variation of frequency that depend on the speed away/toward the radar (160 km/h). This is only a component of the real speed (170 km/h).

The Doppler effect (or Doppler shift), named after Austrian physicist Christian Doppler who proposed it in 1842, is the difference between the observed frequency and the emitted frequency of a wave for an observer moving relative to the source of the waves. It is commonly heard when a vehicle sounding a siren approaches, passes and recedes from an observer. The received frequency is higher (compared to the emitted frequency) during the approach, it is identical at the instant of passing by, and it is lower during the recession. This variation of frequency also depends on the direction the wave source is moving with respect to the observer; it is maximum when the source is moving directly toward or away from the observer and diminishes with increasing angle between the direction of motion and the direction of the waves, until when the source is moving at right angles to the observer, there is no shift.

Imagine a baseball pitcher throwing one ball every second to a catcher (a frequency of 1 ball per second). Assuming the balls travel at a constant velocity and the pitcher is stationary, the catcher catches one ball every second. However, if the pitcher is jogging towards the catcher, the catcher catches balls more frequently because the balls are less spaced out (the frequency increases). The inverse is true if the pitcher is moving away from the catcher. The catcher catches balls less frequently because of the pitcher's backward motion (the frequency decreases). If the pitcher moves at an angle, but at the same speed, the frequency variation at which the receiver catches balls is less, as the distance between the two changes more slowly.

From the point of view of the pitcher, the frequency remains constant (whether he's throwing balls or transmitting microwaves). Since with electromagnetic radiation like microwaves or with sound, frequency is inversely proportional to wavelength, the wavelength of the waves is also affected. Thus, the relative difference in velocity between a source and an observer is what gives rise to the Doppler effect.[4]

Frequency variation[edit]



Doppler Effect: Change of wavelength and frequency caused by motion of the source.

The formula for radar Doppler shift is the same as that for reflection of light by a moving mirror.[5] There is no need to invoke Albert Einstein's theory of special relativity, because all observations are made in the same frame of reference.[6] The result derived with *c* as the speed of light and *v* as the target velocity gives the shifted frequency ( ) as a function of the original frequency ( ) :

Doppler allows the use of narrow band receiver filters that reduce or eliminate signals from slow moving and stationary objects. This effectively eliminates false signals produced by trees, clouds, insects, birds, wind, and other environmental influences. Cheap hand held Doppler radar may produce erroneous measurements.

CW Doppler radar only provides a velocity output as the received signal from the target is compared in frequency with the original signal. Early Doppler radars included CW, but these quickly led to the development of frequency modulated continuous wave (FMCW) radar, which sweeps the transmitter frequency to encode and determine range.

With the advent of digital techniques, Pulse-Doppler radars (PD) became light enough for aircraft use, and Doppler processors for coherent pulse radars became more common. That provides Look-down/shoot-down capability. The advantage of combining Doppler processing with pulse radars is to provide accurate velocity information. This velocity is called range-rate. It describes the rate that a target moves toward or away from the radar. A target with no range-rate reflects a frequency near the transmitter frequency and cannot be detected. The classic zero doppler target is one which is on a heading that is tangential to the radar antenna beam. Basically, any target that is heading 90 degrees in relation to the antenna beam cannot be detected by its velocity (only by its conventional reflectivity).

Ultra-wideband waveforms have been investigated by the U.S. Army Research Laboratory (ARL) as a potential approach to Doppler processing due to its low average power, high resolution, and object-penetrating ability. While investigating the feasibility of whether UWB radar technology can incorporate Doppler processing to estimate the velocity of a moving target when the platform is stationary, a 2013 ARL report highlighted issues related to target range migration.[8] However, researchers have suggested that these issues can be alleviated if the correct matched filter is used.[9]

In military airborne applications, the Doppler effect has 2 main advantages. Firstly, the radar is more robust against counter-measure. Return signals from weather, terrain, and countermeasures like chaff are filtered out before detection, which reduces computer and operator loading in hostile environments. Secondly, against a low altitude target, filtering on the radial speed is a very effective way to eliminate the ground clutter that always has a null speed. Low-flying military plane with countermeasure alert for hostile radar track acquisition can turn perpendicular to the hostile radar to nullify its Doppler frequency, which usually breaks the lock and drives the radar off by hiding against the ground return which is much larger.

PROCEDURE

First we have taken plywood of 3 feet ,3.5 feet for base then done all required marking for runway and taxiway and apron and given a basic point on each component as required .then we drilled on both sides of runway taxiway as well as apron for fixing runway light ,taxiway light ,apron light .then we taken 3 different type of LED lights .3 different light are there they are white, yellow and blue .then we fixed all these LED of white ,yellow and blue color in every hole as per marking and as per requirement and given a connection to all of them. We started to make various types of antenna which ILS antenna VOR antenna localizer antenna and made set up of 3 marker beacon at a fixed distance from each other .marker beacon are outer marker middle marker and inner marker ,then we made ILS antenna with stainless steel pipe of 5mm .then we started making ATC tower we used paper for it .