RGPVNOTES.IN

Program : **B.Tech**

Subject Name: **Transportation Engg II**

Subject Code: **CE-502**

Semester: **5th**

CE-502 Transportation Engineering II

Unit V

Airport, Obstructions, Lightning & Traffic control: Zoning regulations, approach area, approach surface- imaginary, conical and horizontal. Rotating beacon, boundary lights, approach lights, runway and taxiway lighting etc. Instrumental landing system, precision approach radar & VOR en-route traffic control.

These airport obstructions basically are those obstructions which are provided on the sites of the airports which are related to the type of the development which has taken place on the sites of the airport and are related mostly with not only with the nature of the development but also with the height of that development.

Airport obstructions are divided into following categories:

- **Imaginary surfaces**
- **Objects with actual heights**

In imaginary surfaces where we assume that there can be any surface which may come up to this level and therefore we have just marked some surfaces on any airport by which the aircrafts should move above of that particular surface only and if it is coming below of that surface then it may be hazardous whereas the other cases with the actual conditions where the type of the development is going in the vertical direction then what is the height of that development and what can be the height in the light of the operation of the aircrafts on any airport.

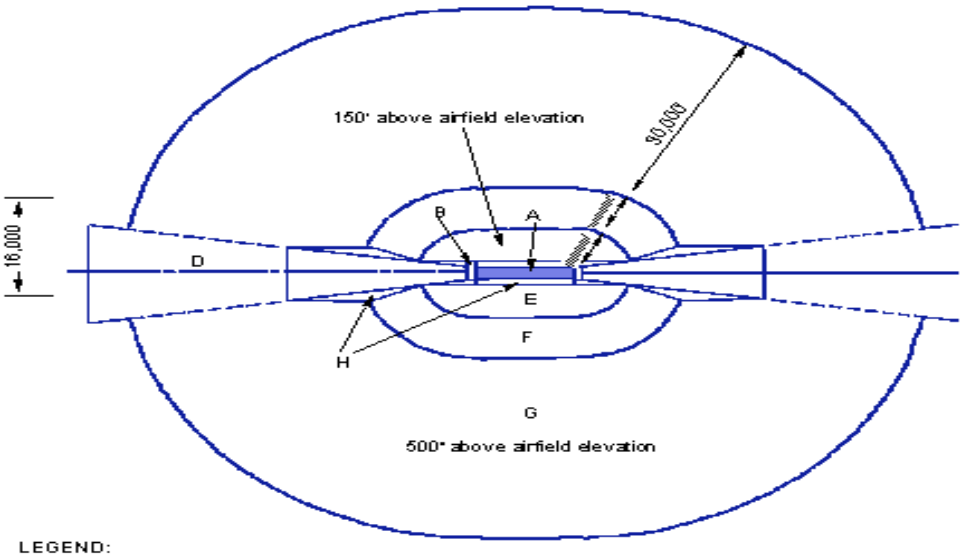
In the case of imaginary surfaces again there are different types of surfaces which we will be looking at and these imaginary surfaces are basically established surfaces in relation to airport and to each runway above which no obstruction should project and for each and every runway on which the aircraft is going to land or from where it is going to take off with respect to that one then we start looking at some of the imaginary locations in space which are assumed to be surfaces and the aircraft follows those surfaces so that there is no obstruction projecting within that much area of navigation and this size of imaginary surface depends upon the category of each runway and the type of approach planned for that runway. So these are the factors basically the creating an effect on what type of imaginary surface of what magnitude of that imaginary surface is to be provided or assumed or any of the runway strips on any airport

Airport obstructions:

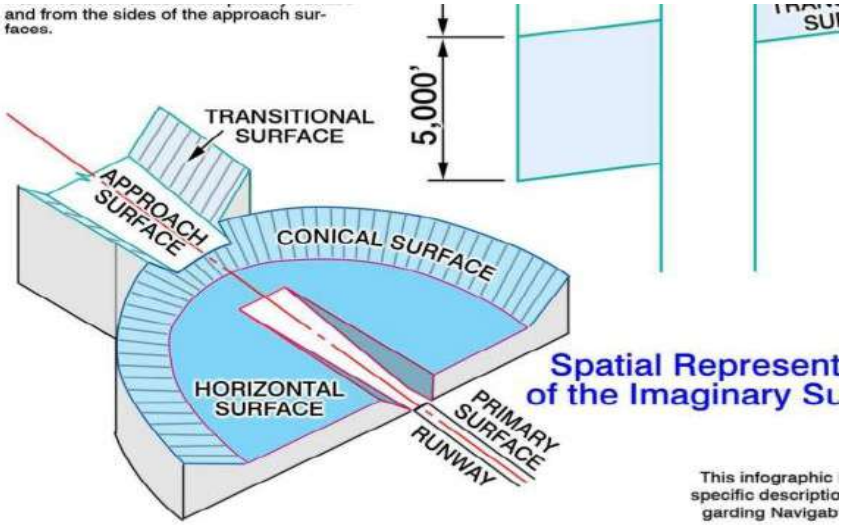
- **Approach surface**
- **Conical surface**
- **Horizontal surface**
- **Take off climb surface**
- **Transitional surface**

Approach surface:

- Provided at the end of the landing side of runway
- Trapezoidal in shape
- Diverging away with upgrade
- Longitudinally centered o the extended center line of runway



LEGEND:
A Primary surface
B Clear-zone surface
C Approach/departure-clearance surface (glide angle)
D Approach/departure-clearance surface (horizontal)
E Inner horizontal surface
F Conical surface
G Outer horizontal surface
H Transitional surface



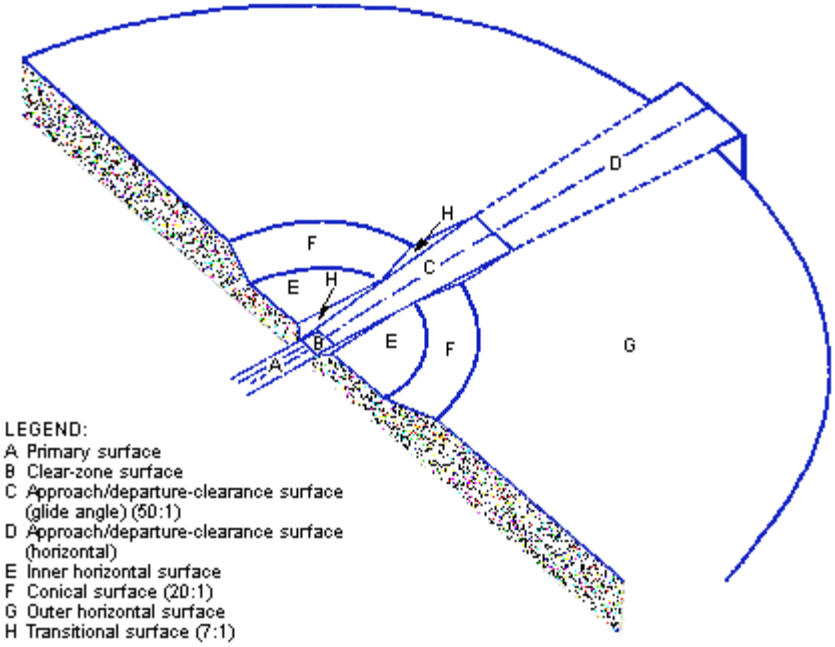


Figure1 : Imaginary surfaces

Take off climb surface:

- Similar to approach surface
- Provided at the take off end of runway
- Trapezoidal in shape

Table 1: Different Runway length, Divergence of side, Length of longitudinal Projection

	A	B	C	D	E
WIDTH NEAR END OF RUNWAY (m)	180	180	180	80	60
DIVERGENCE OF SIDES	12.5%	12.5%	12.5%	10%	10%
LENGTH OF LONGITUDINAL PROJECTION (m)	15000	15000	15000	2500	1600
Longitudinal upgrade	2%	2%	2%	4%	5%

Horizontal surface:

- Extends from upper edge of transition surface and ends at lower or inner circular edge of conical surface
- The height of outer horizontal surface extends from 150m (above the ARP elevation) to 9900m (for airports with length of runway between 900m & 1500m) or to 15000m (for airports having runway length more than 1500m) above elevation of airport reference point.
- The shape of horizontal imaginary surface may or may not be circular

- The radius of outer limit measured from the ARP
- Not provided for the airports having runway length less than 900m

Transition surface:

- Trapezoidal in shape
- Extends along the landing strip
- Slopes upward & outward to the inner horizontal surface

Conical surface:

- Extends upward & outward inner horizontal surface to a point which is at some height above the horizontal surface.
- Circular in shape

Table 2: Standard data for design

Runway code	Side slope transitional surface	% of conical surface	Height of outer or upper circular edge of the conical surface above HS (m)	Radius of inner circular edge conical surface with ARP (m)
A	14.3	5	100	4000
B	14.3	5	100	4000
C	14.3	5	75	4000
D	20	5	55	2500
E	20	5	35	2000

Objects with actual heights:

- Any object which exceeds certain limiting height above the ground is considered to be an obstruction to the air navigation.
- An object within 4.5km distance from the runway end is considered is considered as the obstruction if its actual height is more than 30m above the ground or above the level of approach end of runway whichever is higher.
- Any object which is located beyond a distance of 4.5km from the runway end is considered as an obstruction if its height is above 30m increases by more than 7.5m for each additional of 1.5km distance from the runway.
- When we reach 15km from runway end it should not exceed 75m
- Any object which projects above the minimum approach flight altitude or whose height exceeds 150m above the ground is also to be considered as obstruction.

Airport lighting:

FACTORS AFFECTING AIRPORTLIGHTING:

- **Airport classification**
- **Amount of traffic**
- **Availability of power**
- **Nature of aircraft using the airport**
- **Type of night operation plans**
- **Type of landing surfaces provided**
- **Weather condition**

To achieve uniformity and to guide pilots for unfamiliar airports, colours and general arrangement of airport lights are standardized. Airport lights are kept clean, well-maintained, checked regularly for faulty bulbs and replacement. Tough and laborious job, major airport contains 30,000 lights. Provision of emergency power supplies, which can take over in seconds in case of any power failure.

ELEMENTS OF AIRPORT LIGHTING:

- **Airport beacon**
- **Approach lighting**
- **Apron**
- **Hangar lighting**
- **Boundary lighting**
- **Lighting of landing direction indicator**
- **Lighting of wind direction indicator**
- **Runway lighting**
- **Taxiway lighting**
- **Threshold lighting**

AIRPORT BEACON: Beacon- strong beam of light- used to indicate any geographical location- situated slightly above the horizontal- rotated to produce flashing light to an observer. It gives out white and green flashes in the horizontal directions 180◦ apart. Flashes are visible for the pilot from any direction of approach and it indicates the approximate situation of an airport equipped for the night operations. Rotates at six revolutions per minute- mounted at top of terminal building or hangar. Obstruction not cleared yet- then separate tower is provided for installation of rotating beacon.

APPROACH LIGHTING: Before runway begins- sequence of high-intensity lighting arrangement for a length of 900m. Helps pilots to check if the aircraft is centered correctly or not and gives way to touch down zone lights from threshold of the runway. Normally mounted on pedestals-varying heights-to accommodate any irregularities in ground- ensuring the lights themselves are in level. Arrangements adopted for approach lightings:

- **Calvert system**

- ICAO system

APRON AND HANGAR LIGHTING: These areas for are flood lit for the convenience in servicing and loading. Flood-lighting system: constitutes a projector designed to be arranged to illuminate a surface. Mounted such a way that they do not cause a glare in the eyes of the pilots, passengers and service personnel. Recommendation: flood lights should be placed at a height of not less than 12m above the pavement.

BOUNDARY LIGHTING: Entire boundary of the airfield is provided with lights at a c/c distance of about 90m with height of about 75cm from the ground. If fence is provided along the boundary, then these lights should be placed inside the fence at a distance of about 3m. For indicating hazardous approach, the boundary lights are provided with red marker lights.

LIGHTING OF LANDING DIRECTION INDICATOR: The landing direction indicator is illuminated with suitable lighting arrangement so that the airport can be used at night also.

LIGHTING OF WIND DIRECTION INDICATOR: The wind direction indicator is illuminated by four 200 watts angle reflectors placed 1.8m above the top of the cone for providing a continuous lighting at any position of the cone. This arrangement grants the use of wind direction indicator at night and during bad weathers.

RUNWAY LIGHTING: After crossing the threshold, the pilot must complete a touchdown and roll out on the runway. The planning of runway lighting is carried out in such a way that the pilot gets enough information on alignment, lateral displacement, roll and distance. The lights are so arranged so that they form a visual pattern which the pilot can interpret easily. During night landings, flood lights were used in olden days. But now runway edge lights are adopted. Narrow gauge pattern- the most precise runway alignment which is widely used. It makes use of centre-line and touchdown zone lights for operations in very poor visibility.

Black hole effect: As the pilot crosses the threshold, and continues to look along the centre-line, the principal source of guidance, namely, the edge lights has moved far to each side in the peripheral vision. As a result, the central area appears black and the pilot is virtually flying blind for the peripheral reference information. This can be eliminated by adopting the narrow gauge pattern of the runway lighting, the central portion gets illuminated and the black hole effect is partly eliminated. The narrow gauge pattern forms a channel of light of 18m width up to 1140m from the threshold and beyond this distance, the closely spaced lights are placed along the centre-line of the runway extending up to the other end of the runway. All the lights provided on the runway are white in color and of flush type, i.e. they do not protrude more than 1cm above the surface of pavement. The runway edge lights are of elevated type and they are white color except for the last 400m if an instrument runway facing the pilot which are of yellow color to indicate a caution zone.

TAXIWAY LIGHTING: The pilots have to man oeuvre the aircrafts on a system of taxiways to and from the terminal and hangar areas either after landing or on the way to take off. The taxiway system is much complicated on large airports and therefore it is necessary to provide adequate lighting at night and at daytime when the visibility is very poor.

Design considerations to be applied to the visual aids for the taxiways:

- **For normal exits- centerline terminated at the edge of the runway**
- **At taxiway intersections, the lights continue across the intersection. They are placed at a distance of 6m to 7.5m along the straight length and 3m to 3.6m along the curves**
- **The complete route from the runway to the apron should be easily identified.**
- **The edge lights should not extend more than 75cm above the pavement surface.**
- **The exits from the runways should be so lighted that the pilots are able to locate the exits 360m to 400m ahead of the point of turn**
- **The intersection of taxiways and runways-taxiway crossings should be clearly marked.**
- **The lights on the tangent portion are placed not more than 60m apart and the distance from the edge along the curves and the intersections to facilitate easy identification. The spacing varies from 6m for curve of radius 4.5m to 60m for a curve of 300m.**
- **There should be adequate guidance along the taxiway**
- **The taxiway edge lights are blue and the taxiway centre lights are green.**
- **The taxiway should be clearly identified so that they are not confused with the runways.**

THRESHOLD LIGHTING: Identification of threshold- a major factor for decision of the pilot to land or not to land. For this reason, the region near the threshold is given with special lighting treatment. At large airports: threshold is identified by a complete line of green lights extending across the entire width of the runway. They must be of semi-flash type, i.e. protruding not more than 12cm above the surface.

At small airports, the threshold is identified by four lights on each side of the threshold. They can be of elevated type, i.e. protruding more than 12cm above the surface. The threshold lights in the direction if landing are green and in the opposite direction, they are red to indicate the end of the runway.

INSTRUMENT LANDING SYSTEM (ILS): Radio beam transmitter that provides a direction for approaching aircraft that tune their receiver to the ILS frequency.

The Uses of ILS:

• To guide the pilot during the approach and landing. –Very helpful when visibility is limited

• To provide an aircraft with a precision final approach.

• To provide an aircraft guidance to the runway both in the horizontal and vertical planes.

ILS Components: ILS consists of Ground Installations and Airborne Equipments. There are 3 equipments for Ground Installations, which are:

1. Ground Localizer (LLZ) Antenna – To provide horizontal navigation

2. Ground Glide path (GP) Antenna – To provide vertical navigation

3. Marker Beacons – To enable the pilot cross check the aircraft's height.

There are 2 equipments for Airborne Equipments, which are:
1. LLZ and GP antennas located on the aircraft nose.
2. ILS indicator inside the cockpit

Localizer: Localizer is the horizontal antenna array located at the opposite end of the runway. Localizer operates in VHF band between 108 to 111.975 MHz. Transmit two signals which overlap at the centre. The left side has a 90 Hz & right has a 150 Hz modulation. The overlap area provides the on-track signal. Right Left How Localizer Works. Localizer Needle indicates direction of runway. Centered Needle = Correct Alignment.
Glide Path Antenna Array
• Glide Path is the vertical antenna located on one side of the runway about 300 m to the end of runway.
• Glide Path operates in UHF band between 329.15 and 335 MHz. Glide path produces two signals in the vertical plane. The upper has a 90 Hz modulation and the bottom has a 150 Hz modulation.
Marker Beacons: Marker beacons operating at a carrier frequency of 75 MHz are provided. When the transmission from a marker beacon is received it activates an indicator on the pilot's instrument panel. The correct height the aircraft should be at when the signal is received in an aircraft.

Types of Runway Approach 1.Non-Instrument Runway (NI) – A runway intended for the operation of aircraft using visual approach procedure 2. Instrument Runway – A runway intended for the operation of aircraft using instrument approach procedures a) Non-Precision Runway (NP)
• An instrument runway served by visual aids and a non-visual aid providing at least lateral guidance adequate for a straight-in approach b) Precision Runway (P)
• Allow operations with a decision height and visibility

How ILS works:
Ground localizer antenna transmit VHF signal in direction opposite of runway to horizontally guide aircraft to the runway centre line.
• Ground Glide Path antenna transmit UHF signal in vertical direction to vertically guide aircraft to the touchdown point.
• Localizer and Glide Path antenna located at aircraft nose receives both signals and sends it to ILS indicator in the cockpit.
• These signals activate the vertical and horizontal needles inside the ILS indicator to tell the pilot either go left/right or go up/down.
• By keeping both needles centered, the pilot can guide his aircraft down to end of landing runway aligned with the runway center line and aiming the touchdown.
taxiway lighting and markings
The most important rule to remember is that any sign that has white letters on red is mandatory. Usually they mark points that must not be passed without permission from air traffic control.
Taxiways should have centerline markings and runway holding position markings whenever they intersect a runway. Taxiway edge markings are present whenever there is a need to separate the

taxiway from a pavement that is not intended for aircraft use or to delineate the edge of the taxiway. Taxiways may also have shoulder markings and holding position markings for Instrument Landing System/Microwave Landing System (ILS/MLS) critical areas, and taxiway/taxiway intersection markings.
The taxiway centerline is a single continuous yellow line, 6 inches (15 cm) to 12 inches (30 cm) in width. This provides a visual cue to permit taxiing along a designated path. Ideally the aircraft should be kept centred over this line during taxi to ensure wing-tip clearance.
Taxiway Edge Markings. Taxiway edge markings are used to define the edge of the taxiway. They are primarily used when the taxiway edge does not correspond with the edge of the pavement. There are two types of markings depending upon whether the aircraft is suppose to cross the taxiway edge:

1. Continuous Markings. These consist of a continuous double yellow line, with each line being at least 6 inches (15 cm) in width spaced 6 inches (15 cm) apart. They are used to define the taxiway edge from the shoulder or some other abutting paved surface not intended for use by aircraft.

2. Dashed Markings. These markings are used when there is an operational need to define the edge of a taxiway or taxi-lane on a paved surface where the adjoining pavement to the taxiway edge is intended for use by aircraft. e.g. an apron. Dashed taxiway edge markings consist of a broken double yellow line, with each line being at least 6 inches (15 cm) in width, spaced 6 inches (15 cm) apart (edge to edge). These lines are 15 feet (4.5 m) in length with 25 foot (7.5 m) gaps.

Taxi Shoulder Markings. Taxiways, holding bays, and aprons are sometimes provided with paved shoulders to prevent blast and water erosion. Although shoulders may have the appearance of full strength pavement they are not intended for use by aircraft, and may be unable to support an aircraft. Usually the taxiway edge marking will define this area. Where conditions exist such as islands or taxiway curves that may cause confusion as to which side of the edge stripe is for use by aircraft, taxiway shoulder markings may be used to indicate the pavement is unusable. Taxiway shoulder markings are yellow.

Surface Painted Taxiway Direction Signs. Surface painted taxiway direction signs have a yellow background with a black inscription, and are provided when it is not possible to provide taxiway direction signs at intersections, or when necessary to supplement such signs. These markings are located adjacent to the centerline with signs indicating turns to the left being on the left side of the taxiway centerline and signs indicating turns to the right being on the right side of the centerline.

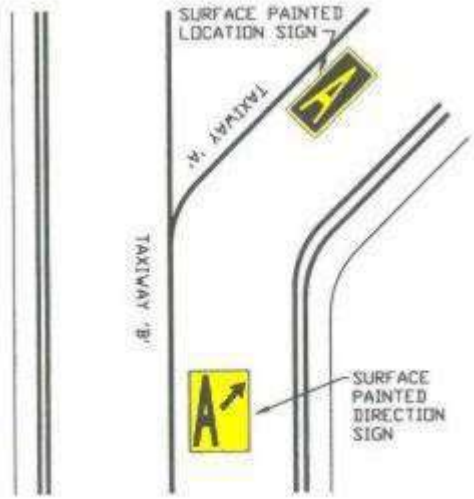


Fig2:-Surface Painted Taxiway Direction Signs

Surface Painted Location Signs: Surface painted location signs have a black background with a yellow inscription. When necessary, these markings are used to supplement location signs located along side 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.

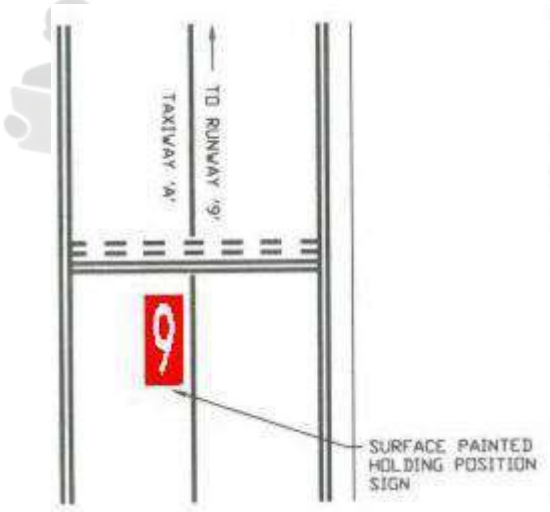


Fig:3-Surface Painted Location Signs

Geographic Position Markings: These markings are located at points along low visibility taxi routes designated in the airport's Surface Movement Guidance Control System (SMGCS) plan. They are used to identify the location of taxiing aircraft during low visibility operations. Low visibility operations are those that occur when the runway visible range (RVR) is below 1200 feet (360m). They are positioned to the left of the taxiway centerline in the direction of taxiing. The geographic position marking is a circle comprised of an outer black ring contiguous to a white ring with a pink circle in the middle. When installed on asphalt or other dark-colored pavements, the white ring and the black ring are reversed, i.e., the white ring becomes the outer ring and the black ring becomes the inner ring. It is designated with either a number or a number and letter. The number corresponds to the consecutive position of the marking on the route.

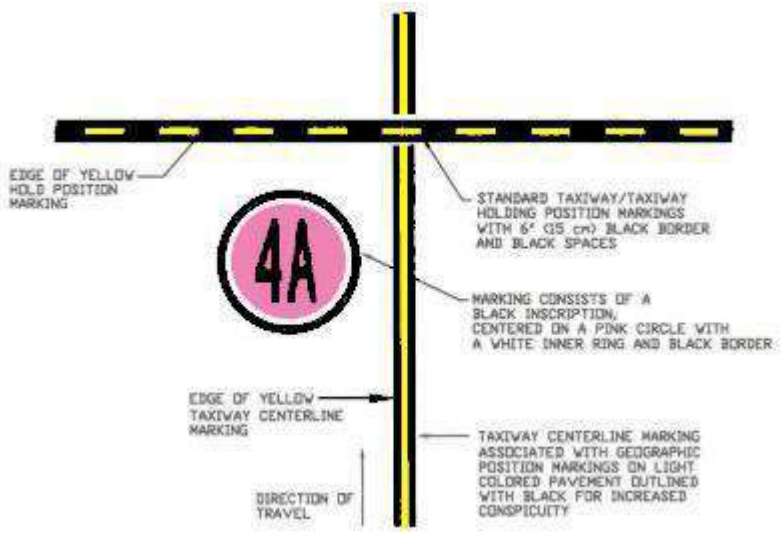


Fig4:-Geographic Position Markings

Holding Position Markings

Runway Holding Position Markings. For runways these markings indicate where an aircraft is supposed to stop. They consist of four yellow lines two solid, and two dashed, spaced six or twelve inches 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: These markings identify the locations on a taxiway where an aircraft is supposed to stop when it does not have clearance to proceed onto the runway. When instructed by ATC "Hold short of (runway "xx")" the pilot should stop so no part of the aircraft extends beyond the holding position marking. When approaching the holding position marking, a pilot should not cross the marking without ATC clearance at a controlled airport or without making sure of adequate separation from other aircraft at uncontrolled airports. An aircraft exiting a runway is not clear of the runway until all parts of the aircraft have crossed the applicable holding position marking.

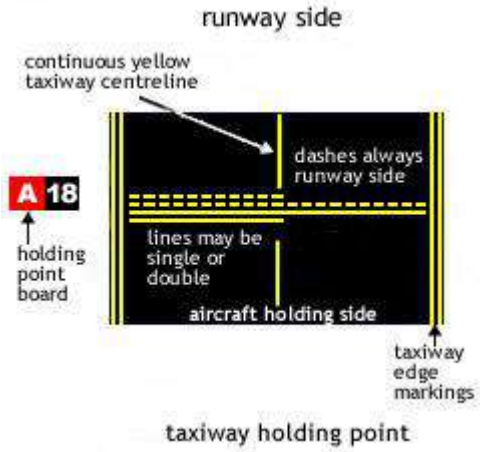


Fig5:- Taxi way holding point

Runway Holding Position Markings on Runways: These markings are installed on runways only if the runway is normally used by air traffic control for "land, hold short" operations or taxiing operations and have operational significance only for those two types of operations. A sign with a white inscription on a

red background is installed adjacent to these holding position markings. (See figure 5) The holding position markings are placed on runways prior to the intersection with another runway, or some designated point. Pilots receiving instructions "cleared to land, runway "xx"" from air traffic control are authorized to use the entire landing length of the runway and should disregard any holding position markings located on the runway. Pilots receiving and accepting instructions "cleared to land runway "xx," hold short of runway "yy"" from air traffic control must either exit runway "xx," or stop at the holding position prior to runway "yy."

Taxiways Located in Runway Approach Areas. These markings are used at some airports where it is necessary to hold an aircraft on a taxiway located in the approach or departure area of a runway so that the aircraft does not interfere with the operations on that runway. This marking is collocated with the runway approach area holding position sign.

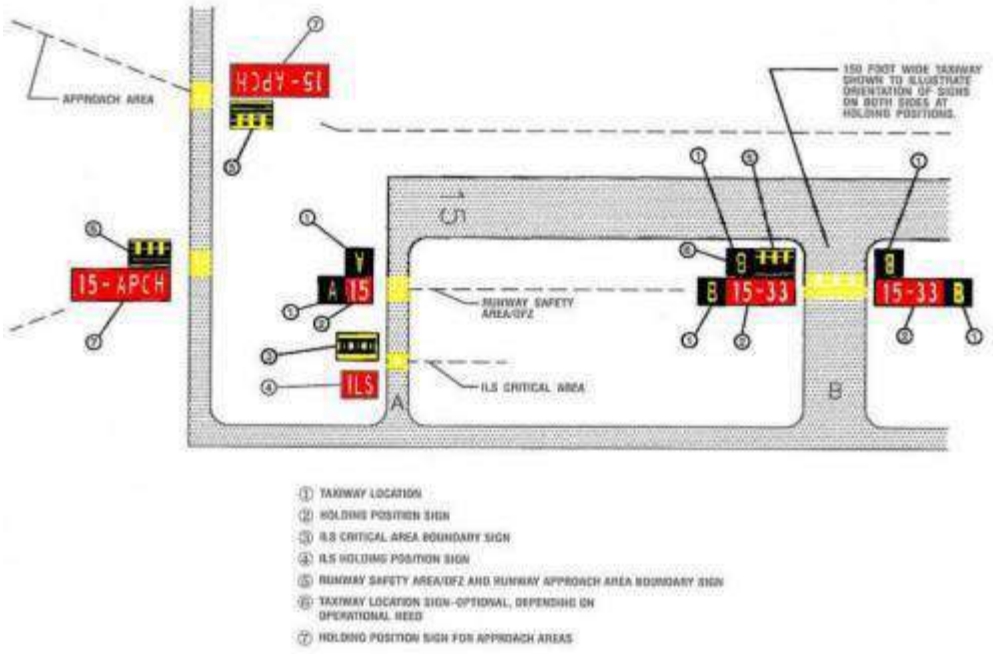


Fig6:-Taxiways Located in Runway Approach Areas

Holding Position Markings for Instrument Landing System (ILS): Holding position markings for ILS/MLS critical areas consist of two yellow solid lines spaced two feet apart connected by pairs of solid lines spaced ten feet apart extending across the width of the taxiway as shown. A sign with an inscription in white on a red background is installed adjacent to these hold position markings. When the ILS critical area is being protected, the pilot should stop so no part of the aircraft extends beyond the holding position marking. When approaching the holding position marking, a pilot should not cross the marking without ATC clearance. ILS critical area is not clear until all parts of the aircraft have crossed the applicable holding position marking.

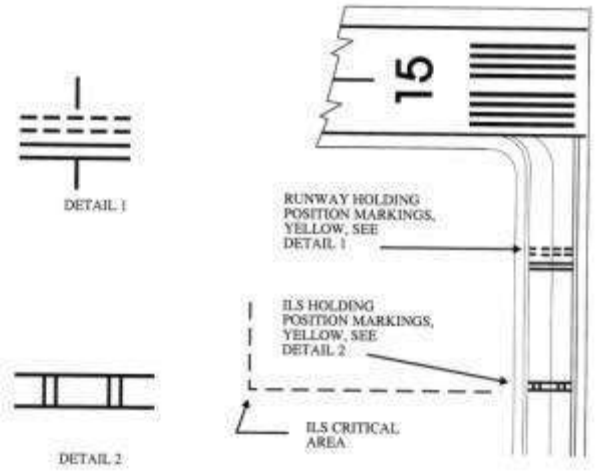


Fig7:- Holding parking marking

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