UNIT V	VISUAL AIDS FOR NAVIGATION, VISUAL AIDS FOR DENOTING OBSTACLES EMERGENCY AND OTHER SERVICES
Visual aids for navigation Wind direction indicator – Landing direction indicator – Location and characteristics of signal area – Markings, general requirements – Various markings – Lights, general requirements – Aerodrome beacon, identification beacon – Simple approach lighting system and various lighting systems – VASI & PAPI - Visual aids for denoting obstacles; object to be marked and lighter – Emergency and other services.	

Segmented Circle Airport Marker System

This provides for a minimum installation consisting of a segmented circle located OFF the traffic area with a conventional wind cone located at its center. To this minimum installation, other pilot aids and traffic control devices are added as required to meet the conditions existing at a particular airport. The types of devices to be used, the purpose they must serve, and their construction and installation must be as described below and shown on figure.

Segmented Circle

The segmented circle is the basic element of the system. Segmentation of the circle is necessary so that from a reasonable distance it can be readily distinguished from a solid circle, which is sometimes used to mark the center of a landing area. The segmented circle performs two functions; it aids the pilot in locating obscure airports and it provides a centralized location for such indicators and signal devices as may be required on a particular airport. Install the circle in a position affording maximum visibility to pilots in the air and on the ground. Consideration should also be given to accessibility for ground operations.

Wind Direction Indicator

Install a conventional wind cone, as located on the drawing, to be used as the wind direction indicator.

Landing Direction Indicator

When conditions at an airport warrant its use, install a landing direction indicator, as located on the drawing, for the purpose of showing pilots in the air and on the ground the direction in which landings and takeoffs are to be made. This indicator may be so designed that it can be made free-swinging when left unattended.

Landing Strip Indicators

Landing strip indicators are used to show the orientation of landing strips and/or to give a positive indication of the strip specified for use. When used, they must be arranged in pairs as shown on the drawing.

Traffic Pattern Indicators

Install these indicators for the purpose of controlling the direction of the traffic pattern when there is any variation from the normal left-hand pattern. When the traffic pattern indicators are included in an installation, they must be arranged in pairs in conjunction with landing strip indicators.

Right-Turn Indicators

The use of the segmented circle airport marker system is encouraged. Only the "L" shaped indicators, formed by using the landing strip and traffic pattern indicators referred to above, are required for compliance with Title 14 CFR part 91, *General Operating And Flight Rules*, AND ARE USED ONLY ON RUNWAYS USING RIGHT-HAND TRAFFIC PATTERNS. Where only these

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indicators are used, the airport operator is encouraged to locate them so that the segmented circle and other visual aids can be added later. However, if this is undesirable or impracticable, they may be constructed in any practicable manner near the end of the runway. Locate any raised type of indicator so as not to become a hazard to the operation of aircraft.

Closed Field Signal

Place panels in the center of the circle in the form of a cross to signify that a field is permanently closed to all traffic. When this signal is used, the wind cone and the landing direction indicator are removed from the circle. Other indicators may remain in place.

Pilot Familiarization

Post the information contained in the foregoing paragraphs of these "General Requirements", together with a copy of the "Segmented Circle Airport Marker System", figure 1, and in a diagram showing the application of the system to the particular airport on all airport bulletin boards.

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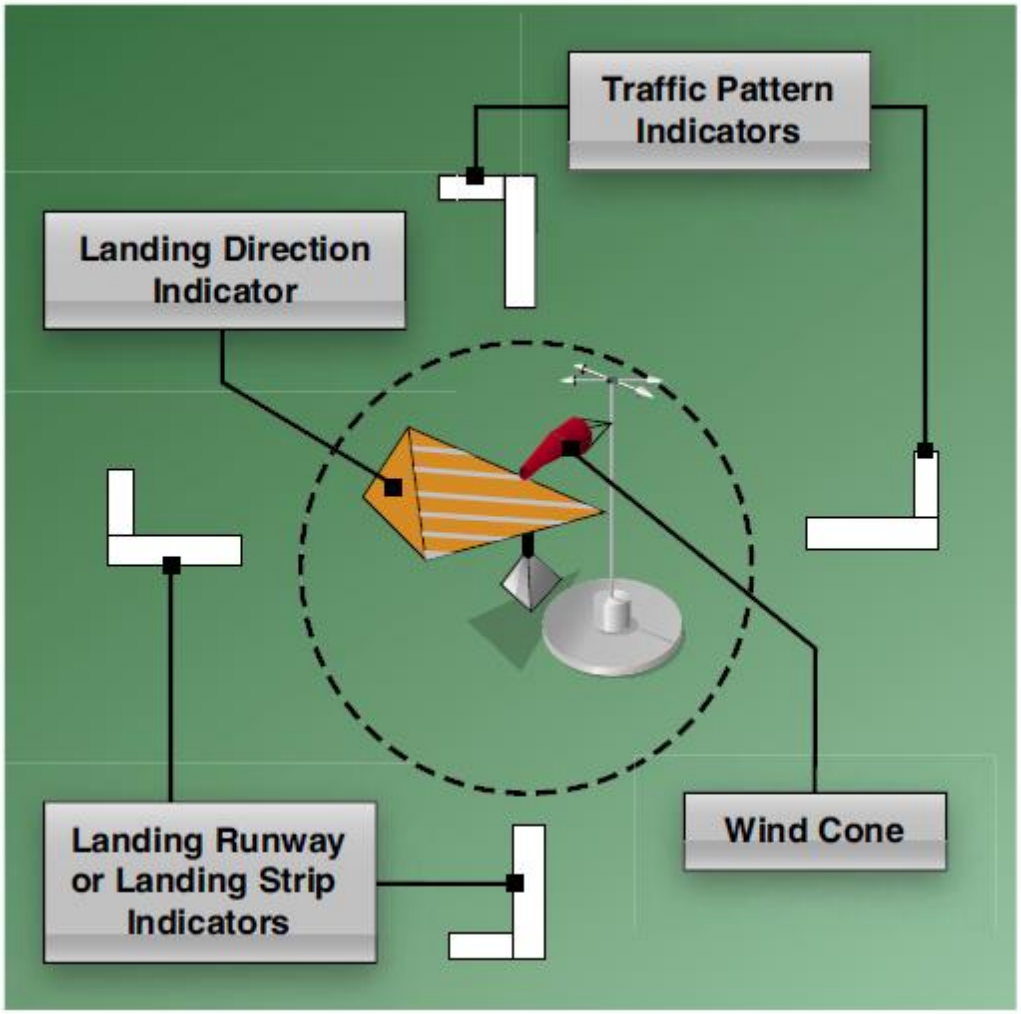
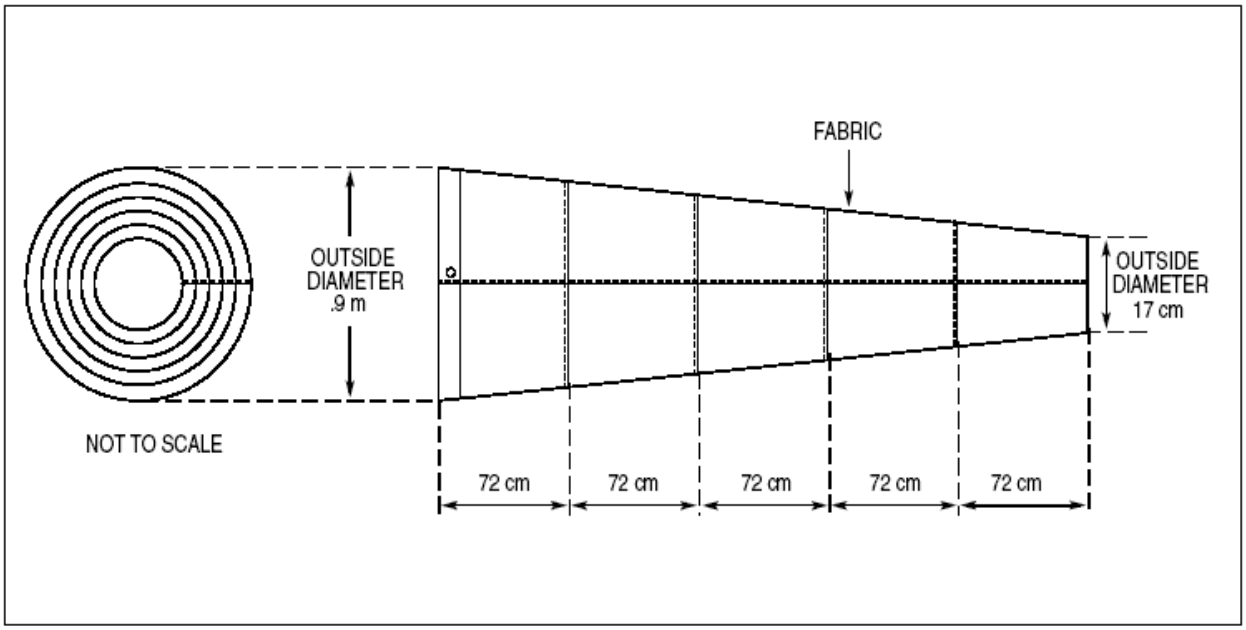


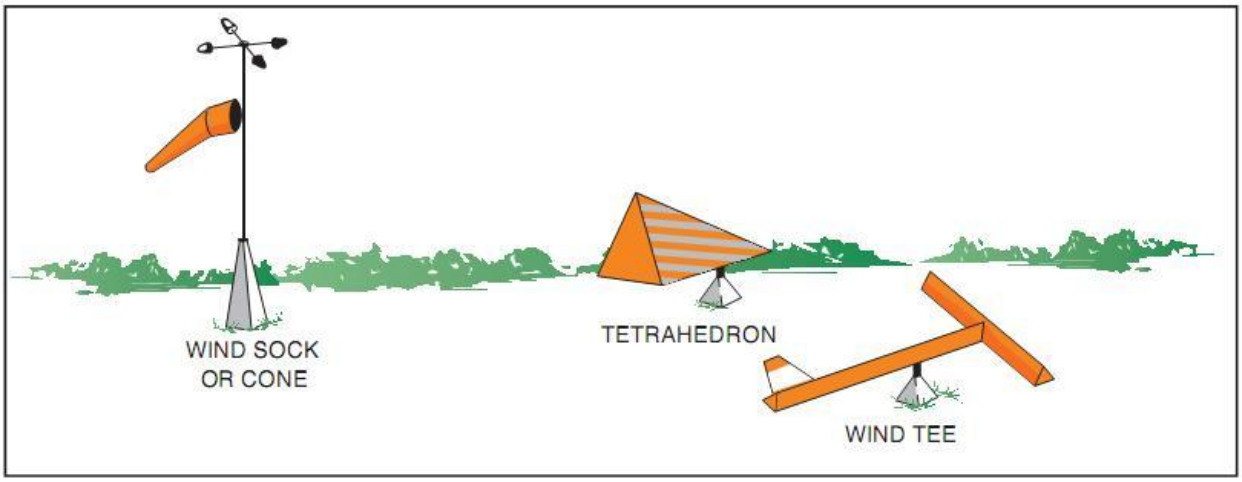
WIND DIRECTION INDICATORS

Wind direction indicators include a wind sock, wind tee, or tetrahedron. These are usually located in a central location near the runway and may be placed in the center of a segmented circle which will identify the traffic pattern direction if it is other than the standard left-hand pattern. The wind sock is a good source of information since it not only indicates wind direction, but allows the pilot to estimate the wind velocity and gust. The wind sock extends out straighter in strong winds and will tend to move back and forth when the wind is gusty. Wind tees and tetrahedrons can swing freely, and will align themselves with the wind direction.

The wind tee and tetrahedron can also be manually set to align with the runway in use, therefore a pilot should also look at the wind sock if available.

It is important for a pilot to know the direction of the wind. At facilities with an operating control tower, this information is provided by ATC. Information may also be provided by FSS personnel located at a particular airport or by requesting information on a common air traffic frequency (CTAF) at airports which have the capacity to receive and broadcast on this frequency. When none of these services are available, it is possible to determine wind direction and runway in use by visual wind indicators. A pilot should check these wind indicators even when information is provided on the CTAF at a given airport because there is no assurance that the information provided is accurate.





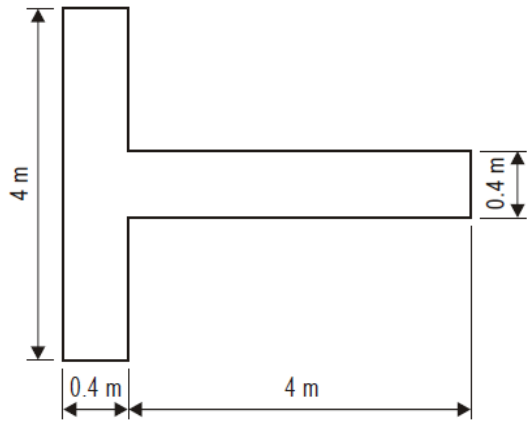
Landing direction indicator

A landing direction indicator shall be located in a conspicuous place on the aerodrome or in signal area where provided.

The landing direction indicator shall be in the form of a "T".

The shape and minimum dimensions of a landing "T" shall be as shown in Figure.

The colour of the landing "T" shall be either white or orange, the choice being dependent on the colour that contrasts best with the background against which the indicator will be viewed. Where required for use at night the landing "T" shall either be illuminated or outlined by white lights.



A tetrahedron is installed when conditions at the airport warrant its use. It may be used to indicate the direction of landings and takeoffs. A tetrahedron may be located at the center of a segmented circle and may be lighted for night operations. The small end of the tetrahedron points in the direction of landing. Pilots are cautioned against using a tetrahedron for any purpose other than as an indicator of landing direction. Further, pilots should use extreme caution when making runway selection by use of a tetrahedron in very light or calm wind conditions as the tetrahedron may not be aligned with the designated calm-wind runway. At airports with control towers, the tetrahedron should only be referenced when the control tower is not in operation. Tower instructions supersede tetrahedron indications.

Landing strip indicators are installed in pairs as shown in *Figure 13-13* and are used to show the alignment of landing strips. Traffic pattern indicators are arranged in pairs in conjunction with landing strip indicators and used to indicate the direction of turns when there is a variation from the normal left traffic pattern. (If there is no segmented circle installed at the airport, traffic pattern indicators may be installed on or near the end of the runway.)

Signalling lamp

A signalling lamp shall be provided at a controlled aerodrome in the aerodrome control tower.

A signalling lamp shall be capable of producing red, green and white signals, and of:

- being aimed manually at any target as required;
- giving a signal in any one colour followed by a signal in either of the two other colours; and
- Transmitting a message in any one of the three colours by Morse Code up to a speed of at least four words per minute.

When selecting the green light, use shall be made of the restricted boundary of green. The beam spread shall be not less than 1° nor greater than 3°, with negligible light beyond 3°. When the signalling lamp is intended for use in the daytime the intensity of the coloured light shall be not less than 6 000 cd.

The signal area shall be located so as to be visible for all angles of azimuth above an angle of 10° above the horizontal when viewed from a height of 300 m. The signal area shall be an even horizontal surface at least 9 m square. The colour of the signal area shall be chosen to contrast with the colours of the signal panels used, and it shall be surrounded by a white border not less than 0.3 m wide.

Airport Markings and Signs

There are markings and signs used at airports, which provide directions and assist pilots in airport operations. Some of the most common markings and signs are discussed.

Runway Markings

Runway markings vary depending on the type of operations conducted at the airport. *Figure* shows a runway that is approved as a precision instrument approach runway and some other common runway markings. A basic VFR runway may only have centerline markings and runway numbers.

Since aircraft are affected by the wind during takeoffs and landings, runways are laid out according to the local prevailing winds. Runway numbers are in reference to magnetic north. Certain airports have two or even three runways laid out in the same direction. These are referred to as parallel runways and are distinguished by a letter added to the runway number (e.g., runway 36L (left), 36C (center), and 36R (right)).

Another feature of some runways is a displaced threshold. A threshold may be displaced because of an obstruction near the end of the runway. Although this portion of the runway is not to be used for landing, it may be available for taxiing, takeoff, or landing rollout. Some airports may have a blast pad/stopway area. The blast pad is an area where a propeller or jet blast can dissipate without creating a hazard. The stopway area is paved in order to provide space for an aircraft to decelerate and stop in the event of an aborted takeoff. These areas cannot be used for takeoff or landing.

At an intersection of two (or more) runways the markings of the more important runway, except for the runway side stripe marking, shall be displayed and the markings of the other runway(s) shall be interrupted. The runway side stripe marking of the more important runway may be either continued across the intersection or interrupted. The order of importance of runways for the display of runway markings shall be as follows:

- 1st — precision approach runway;
- 2nd — non-precision approach runway; and
- 3rd — non-instrument runway.

At an intersection of a runway and taxiway the markings of the runway shall be displayed and the markings of the taxiway interrupted, except that runway side stripe markings may be interrupted.

- Runway markings shall be white.
- Taxiway markings, runway turn pad markings and aircraft stand markings shall be yellow.
- Apron safety lines shall be of red colour.

Taxiway Markings

Aircraft use taxiways to transition from parking areas to the runway. Taxiways are identified by a continuous yellow centerline stripe and may include edge markings to define the edge of the taxiway. This is usually done when the taxiway edge does not correspond with the edge of the pavement. If an edge marking is a continuous line, the paved shoulder is not intended to be used by an aircraft. If it is a dashed marking, an aircraft may use that portion of the pavement. Where a taxiway approaches a runway, there may be a holding position marker. These consist of four yellow lines (two solid and two dashed). The solid lines are where the aircraft is to hold. At some towered airports, holding position markings may be found on a runway. They are used when there are intersecting runways, and ATC issues instructions such as "cleared to land—hold short of runway 30."

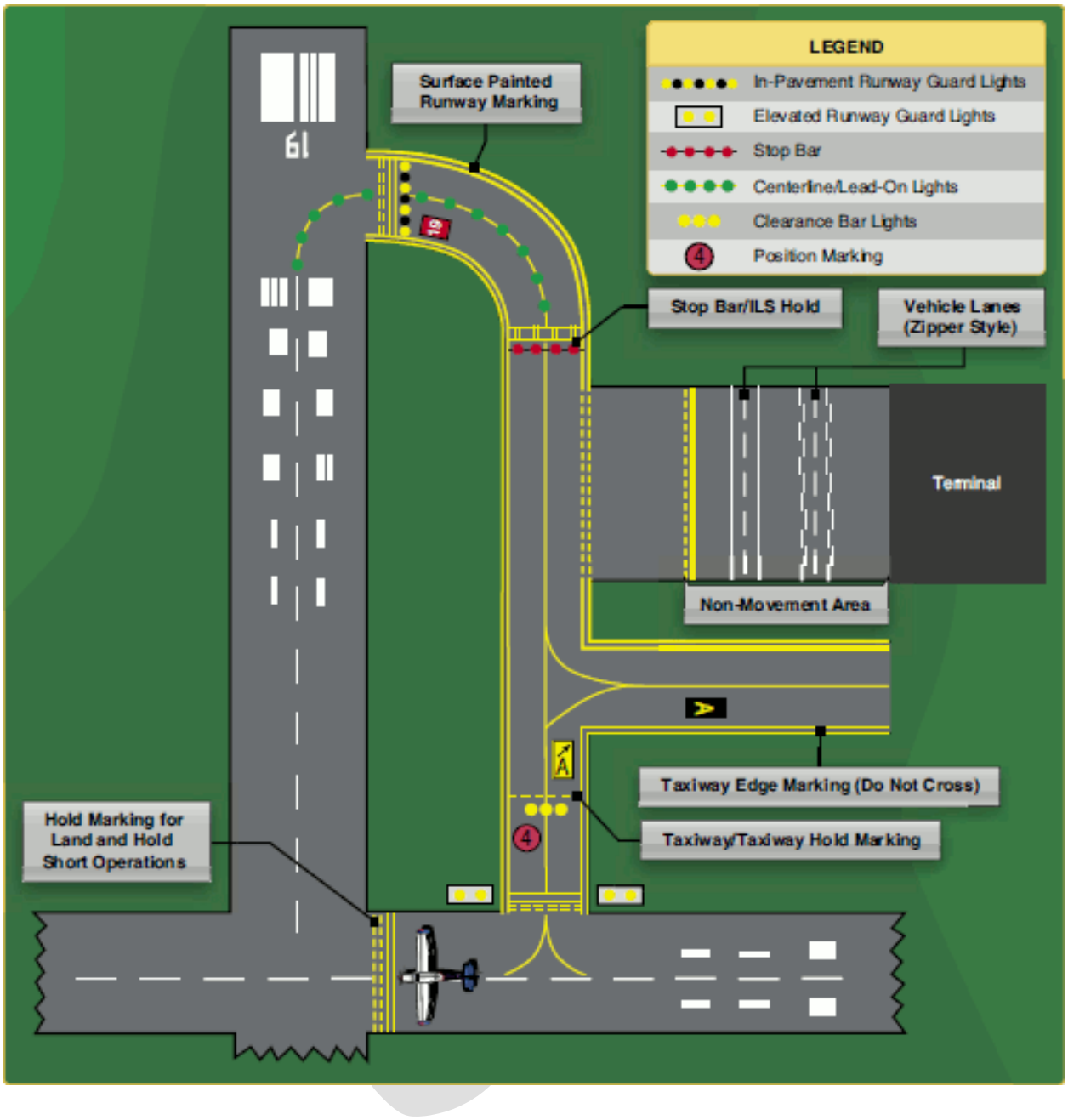


Fig: Airport markings and surface lighting

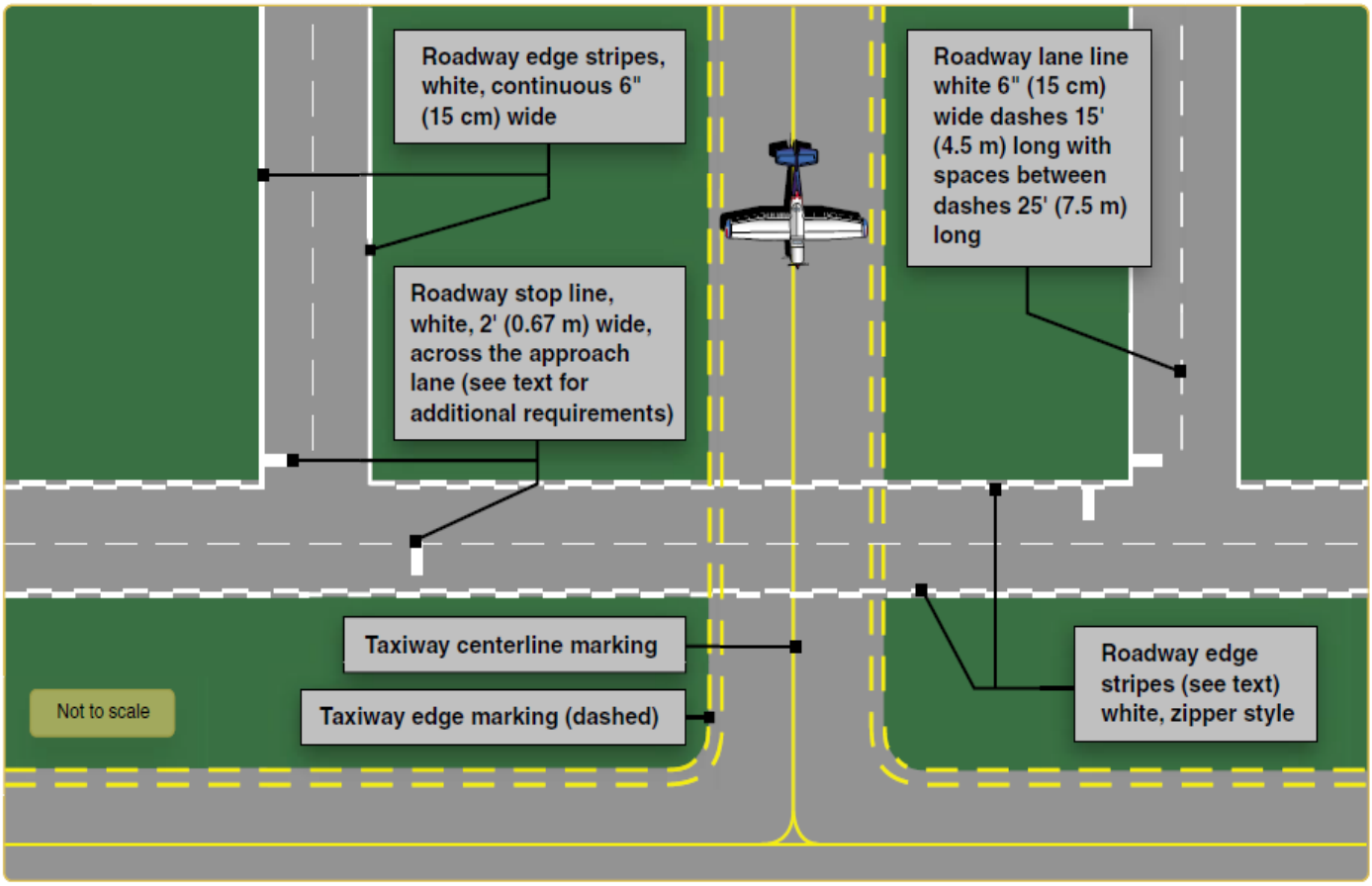
Other Markings

Some other markings found on the airport include vehicle roadway markings, VOR receiver checkpoint markings, and non-movement area boundary markings.

Vehicle roadway markings are used when necessary to define a pathway for vehicle crossing areas that are also intended for aircraft. These markings usually consist of a solid white line to delineate each edge of the roadway and a dashed line to separate lanes within the edges of the roadway. In lieu of the solid lines, zipper markings may be used to delineate the edges of the vehicle roadway.

A VOR receiver checkpoint marking consists of a painted circle with an arrow in the middle. The arrow is aligned in the direction of the checkpoint azimuth. This allows pilots to check aircraft instruments with navigational aid signals.

A non-movement area boundary marking delineates a movement area under ATC. These markings are yellow and located on the boundary between the movement and non-movement area. They normally consist of two yellow lines (one solid and one dashed).



Airport Lighting

The majority of airports have some type of lighting for night operations. The variety and type of lighting systems depends on the volume and complexity of operations at a given airport. Airport lighting is standardized so that airports use the same light colors for runways and taxiways.

General requirements

Light fixtures inset in the surface of runways, stop ways, taxiways and aprons shall be so designed and fitted as to withstand being run over by the wheels of an aircraft without damage either to the aircraft or to the lights themselves.

The temperature produced by conduction or radiation at the interface between an installed inset light and an aircraft tire shall not exceed 160°C during a 10-minute period of exposure.

The intensity of runway lighting shall be adequate for the minimum conditions of visibility and ambient light in which use of the runway is intended, and compatible with that of the nearest section of the approach lighting system when provided.

Where a high-intensity lighting system is provided, a suitable intensity control shall be incorporated to allow for adjustment of the light intensity to meet the prevailing conditions.

Separate intensity controls or other suitable methods shall be provided to ensure that the following systems, when installed, can be operated at compatible intensities:

- approach lighting system;
- runway edge lights;
- runway threshold lights;
- runway end lights;
- runway centre line lights;
- runway touchdown zone lights; and
- taxiway centre line lights.

At an aerodrome provided with runway lighting and without a secondary power supply, sufficient emergency lights shall be conveniently available for installation on at least the primary runway in the event of failure of the normal lighting system.

Aeronautical beacons

An aerodrome beacon or an identification beacon shall be provided at each aerodrome intended for use at night. The operational requirement shall be determined having regard to the requirements of the air traffic using the aerodrome, the conspicuity of the aerodrome features in relation to its surroundings and the installation of other visual and non-visual aids useful in locating the aerodrome.

Aerodrome beacon

An aerodrome beacon shall be provided at an aerodrome intended for use at night if one or more of the following conditions exist:

- aircraft navigate predominantly by visual means;
- reduced visibilities are frequent; or
- it is difficult to locate the aerodrome from the air due to surrounding lights or terrain.

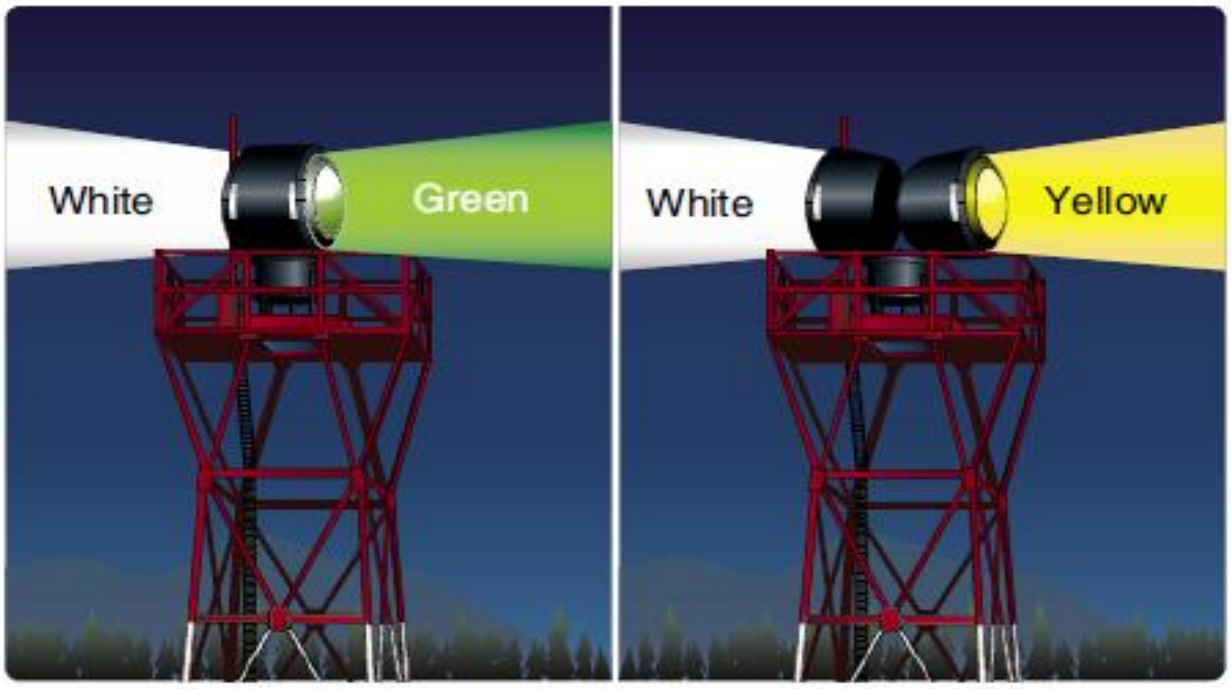
The aerodrome beacon shall be located on or adjacent to the aerodrome in an area of low ambient background lighting.

The location of the beacon should be such that the beacon is not shielded by objects in significant directions and does not dazzle a pilot approaching to land. The aerodrome beacon shall show either coloured flashes alternating with white flashes, or white flashes only. The frequency of total flashes shall be from 20 to 30 per minute. Where used, the coloured flashes emitted by beacons at land aerodromes shall be green and coloured flashes emitted by beacons at water aerodromes shall be yellow. In the case of a combined water and land aerodrome, coloured flashes, if used, shall have the colour characteristics of whichever section of the aerodrome is designated as the principal facility.

- Flashing white and green for civilian land airports;

- Flashing white and yellow for a water airport;
- Flashing white, yellow, and green for a heliport; and
- Two quick white flashes alternating with a green flash identifying a military airport.

The light from the beacon shall show at all angles of azimuth. The vertical light distribution shall extend upwards from an elevation of not more than 1° to an elevation determined by the appropriate authority to be sufficient to provide guidance at the maximum elevation at which the beacon is intended to be used and the effective intensity of the flash shall be not less than 2 000 cd.



Identification beacon

1. An identification beacon shall be provided at an aerodrome which is intended for use at night and cannot be easily identified from the air by other means.

2. The identification beacon shall be located on the aerodrome in an area of low ambient background lighting.
3. The location of the beacon should be such that the beacon is not shielded by objects in significant directions and does not dazzle a pilot approaching to land.
4. An identification beacon at a land aerodrome shall show at all angles of azimuth. The vertical light distribution shall extend upwards from an elevation of not more than 1° to an elevation determined by the appropriate authority to be sufficient to provide guidance at the maximum elevation at which the beacon is intended to be used and the effective intensity of the flash shall be not less than 2 000 cd.
5. An identification beacon shall show flashing green at a land aerodrome and flashing yellow at a water aerodrome.
6. The identification characters shall be transmitted in the International Morse Code.
7. The speed of transmission should be between six and eight words per minute, the corresponding range of duration of the Morse dots being from 0.15 to 0.2 seconds per dot.

Approach Light Systems

Approach light systems are primarily intended to provide a means to transition from instrument flight to visual flight for landing. The system configuration depends on whether the runway is a precision or non precision instrument runway. Some systems include sequenced flashing lights, which appear to the pilot as a ball of light traveling toward the runway at high speed. Approach lights can also aid pilots operating under VFR at night.

Visual Glide slope Indicators

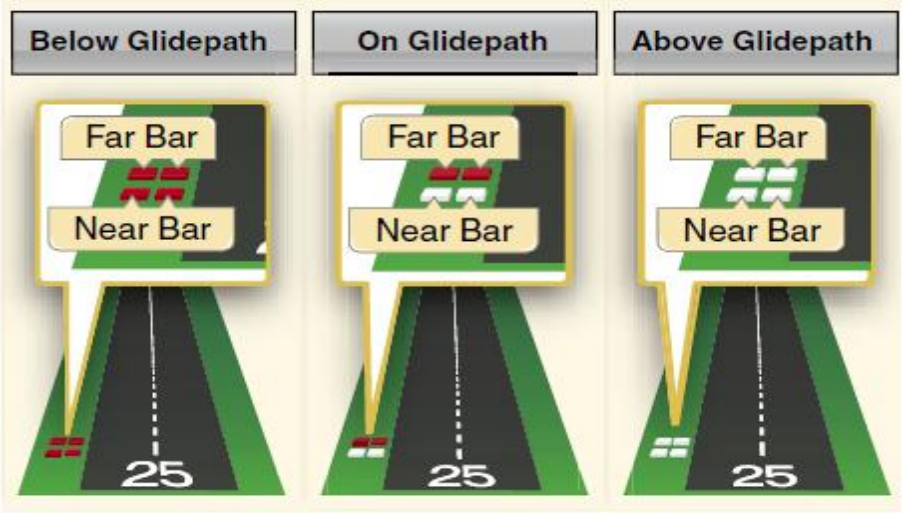
Visual glide slope indicators provide the pilot with glide path information that can be used for day or night approaches. By maintaining the proper glide path as provided by the system, a pilot should have adequate obstacle clearance and should touch down within a specified portion of the runway.

Visual Approach Slope Indicator (VASI)

VASI installations are the most common visual glide path systems in use. The VASI provides obstruction clearance within 10° of the runway extended runway centerline, and to four nautical miles (NM) from the runway threshold.

The VASI consists of light units arranged in bars. There are 2-bar and 3-bar VASIs. The 2-bar VASI has near and far light bars and the 3-bar VASI has near, middle, and far light bars. Two-bar VASI installations provide one visual glide path which is normally set at 3°. The 3-bar system provides two glide paths, the lower glide path normally set at 3° and the upper glide path ¼ degree above the lower glide path.

The basic principle of the VASI is that of color differentiation between red and white. Each light unit projects a beam of light, a white segment in the upper part of the beam and a red segment in the lower part of the beam. The lights are arranged so the pilot sees the combination of lights shown in *Figure 13-7* to indicate below, on, or above the glide path.



Precision approach path indicator (PAPI)

A precision approach path indicator (PAPI) uses lights similar to the VASI system except they are installed in a single row, normally on the left side of the runway.

A tri-color system consists of a single light unit projecting a three-color visual approach path. Below the glidepath is indicated by red, on the glidepath is indicated by green, and above the glidepath is indicated by amber. When descending below the glidepath, there is a small area of dark amber. Pilots should not mistake this area for an "above the glidepath" indication.

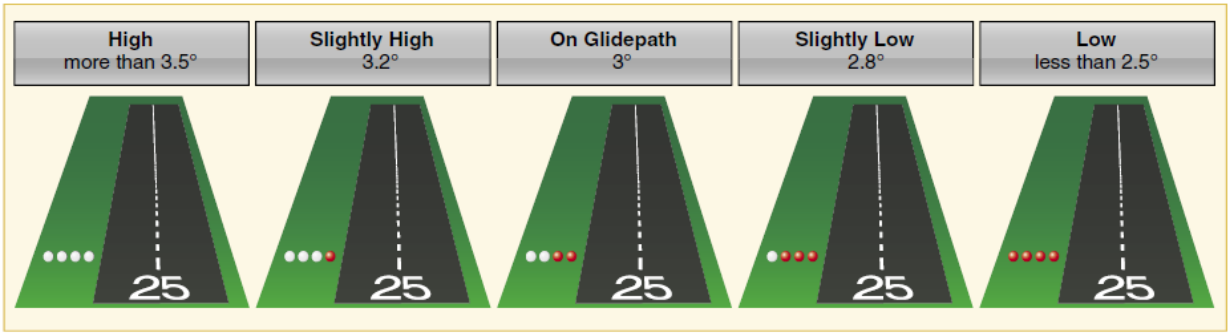


Figure 13-8. *Precision approach path indicator.*

Pulsating visual approach slope indicators normally consist of a single light unit projecting a two-color visual approach path into the final approach area of the runway upon which the indicator is installed. The on glidepath indication is a

steady white light. The slightly below glidepath indication is a steady red light. If the aircraft descends further below the glidepath, the red light starts to pulsate. The above glidepath indication is a pulsating white light. The pulsating rate increases as the aircraft gets further above or below the desired glideslope.

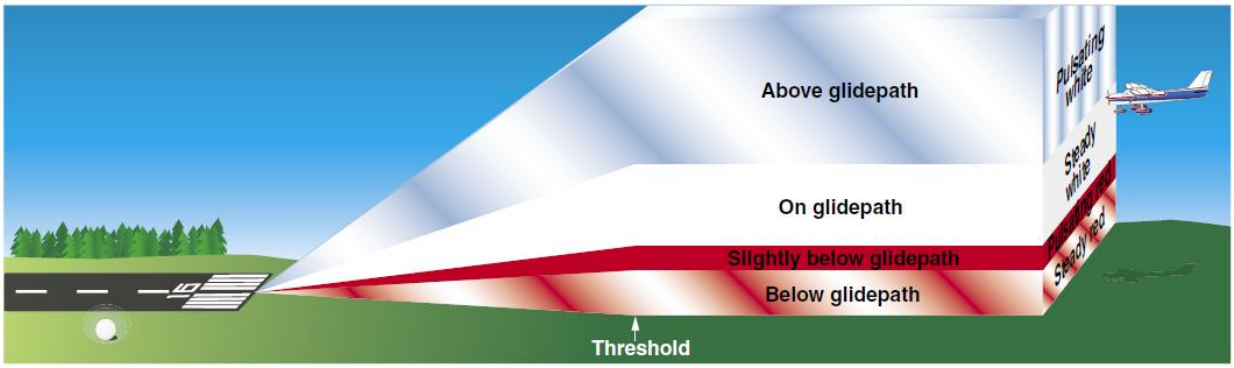


Figure 13-10. *Pulsating visual approach slope indicator.*

VISUAL AIDS FOR DENOTING OBSTACLES

A fixed obstacle that extends above a take-off climb surface within 3,000 m of the inner edge of the take-off climb surface shall be marked and, if the runway is used at night, lighted, except that:

a) Such marking and lighting may be omitted when the obstacle is shielded by another fixed obstacle;

b) the marking may be omitted when the obstacle is lighted by medium-intensity obstacle lights, Type A, by day and its height above the level of the surrounding ground does not exceed 150 m;

c) the marking may be omitted when the obstacle is lighted by high-intensity obstacle lights by day; and

d) the lighting may be omitted where the obstacle is a lighthouse and an aeronautical study indicates the lighthouse light to be sufficient.

A fixed object, other than an obstacle, adjacent to a take-off climb surface shall be marked and, if the runway is used at night, lighted if such marking and lighting is considered necessary to ensure its avoidance, except that the marking may be omitted when:

a) the object is lighted by medium-intensity obstacle lights, Type A, by day and its height above the level of the surrounding ground does not exceed 150 m; or
b) the object is lighted by high-intensity obstacle lights by day.

A fixed obstacle that extends above an approach or transitional surface within 3 000 m of the inner edge of the approach surface shall be marked and, if the runway is used at night, lighted, except that:

a) such marking and lighting may be omitted when the obstacle is shielded by another fixed obstacle;
b) the marking may be omitted when the obstacle is lighted by medium-intensity obstacle lights, Type A, by day and its height above the level of the surrounding ground does not exceed 150 m;
c) the marking may be omitted when the obstacle is lighted by high-intensity obstacle lights by day; and
d) the lighting may be omitted where the obstacle is a lighthouse and an aeronautical study indicates the lighthouse light to be sufficient.

A fixed obstacle above a horizontal surface shall be marked and, if the aerodrome is used at night, lighted except that,

a) such marking and lighting may be omitted when:
   - the obstacle is shielded by another fixed obstacle; or

- for a circuit extensively obstructed by immovable objects or terrain, procedures have been established to ensure safe vertical clearance below prescribed flight paths; or
- an aeronautical study shows the obstacle not to be of operational significance;

c) the marking may be omitted when the obstacle is lighted by medium-intensity obstacle lights, Type A, by day and its height above the level of the surrounding ground does not exceed 150 m;

d) the marking may be omitted when the obstacle is lighted by high-intensity obstacle lights by day; and

e) the lighting may be omitted where the obstacle is a lighthouse and an aeronautical study indicates the lighthouse light to be sufficient.

Vehicles and other mobile objects, excluding aircraft, on the movement area of an aerodrome are obstacles and shall be marked and, if the vehicles and aerodrome are used at night or in conditions of low visibility, lighted, except that aircraft servicing equipment and vehicles used only on aprons may be exempt.

Elevated aeronautical ground lights within the movement area shall be marked so as to be conspicuous by day. Obstacle lights shall not be installed on elevated ground lights or signs in the movement area.