Introduction of Airport Configurations

- A major determinant of airport capacity is the overall layout and design of the system
- Airport configuration is the most important factor and defined as the general arrangement of the various parts or components of the airport system

Airport Configuration

- Airport configuration is defined as the number and orientation of runways and the location of the terminal area relative to the runways.
  - Number of runways depends on air traffic volume.
  - Orientation of runways depends on the direction of wind, size and shape of the area and land use and airspace use restrictions in the vicinity of airport.
  - The terminal building should be located so as to provide easy and timely access to runways.

Analysis of Wind for Orienting Runways

- Runways are oriented in the direction of prevailing winds.
- The data on the parameters of wind namely, intensity (speed), direction and duration are essential to determine the orientation of runways.
  - High intensity winds perpendicular to the direction of runway cause problems during landing and takeoff of aircrafts.
  - Smaller aircrafts are particularly effected by these crosswinds.

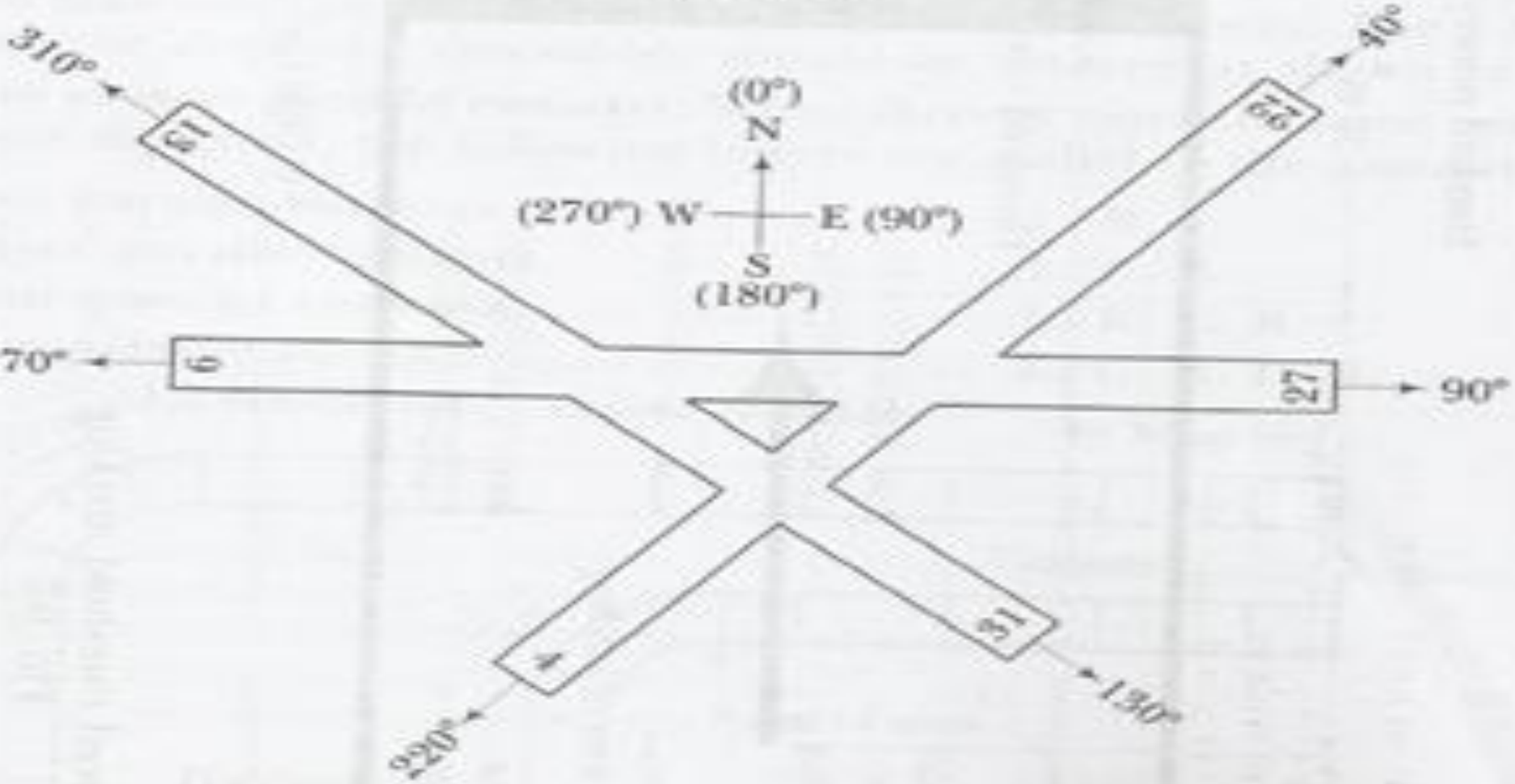
Runway numbering

- The end of each runway is marked with a number which indicates the magnetic azimuth (i.e. the angle measured in a clockwise direction from the north of the runway in the direction of landing).

- Thus the east end of an east-west runway would be marked 27 (for 270°) and the west end 9 (for 90°)

Runway numbering of a single runway

FIG. 9-4

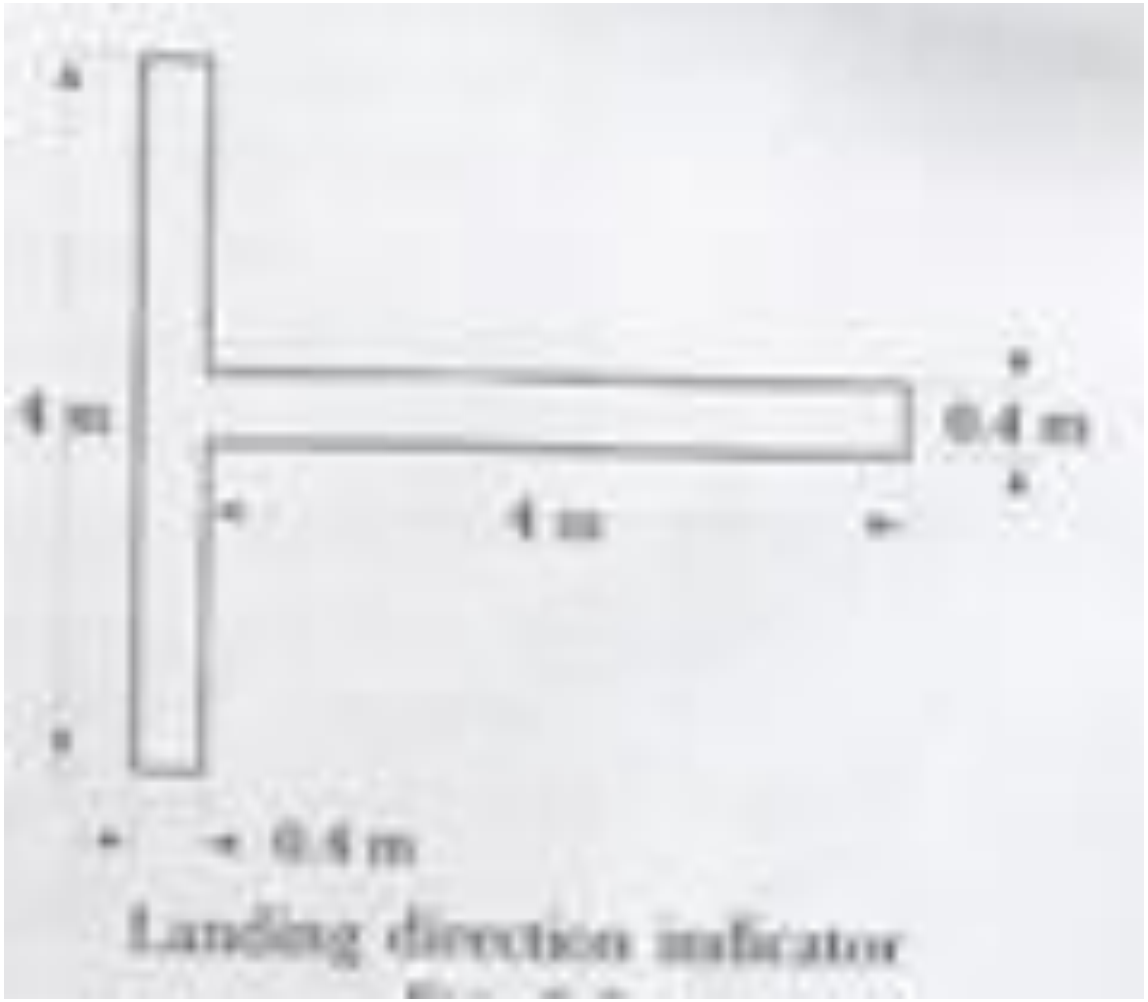


Runway numbering of a system of three intersecting runways

Landing Direction Indicator

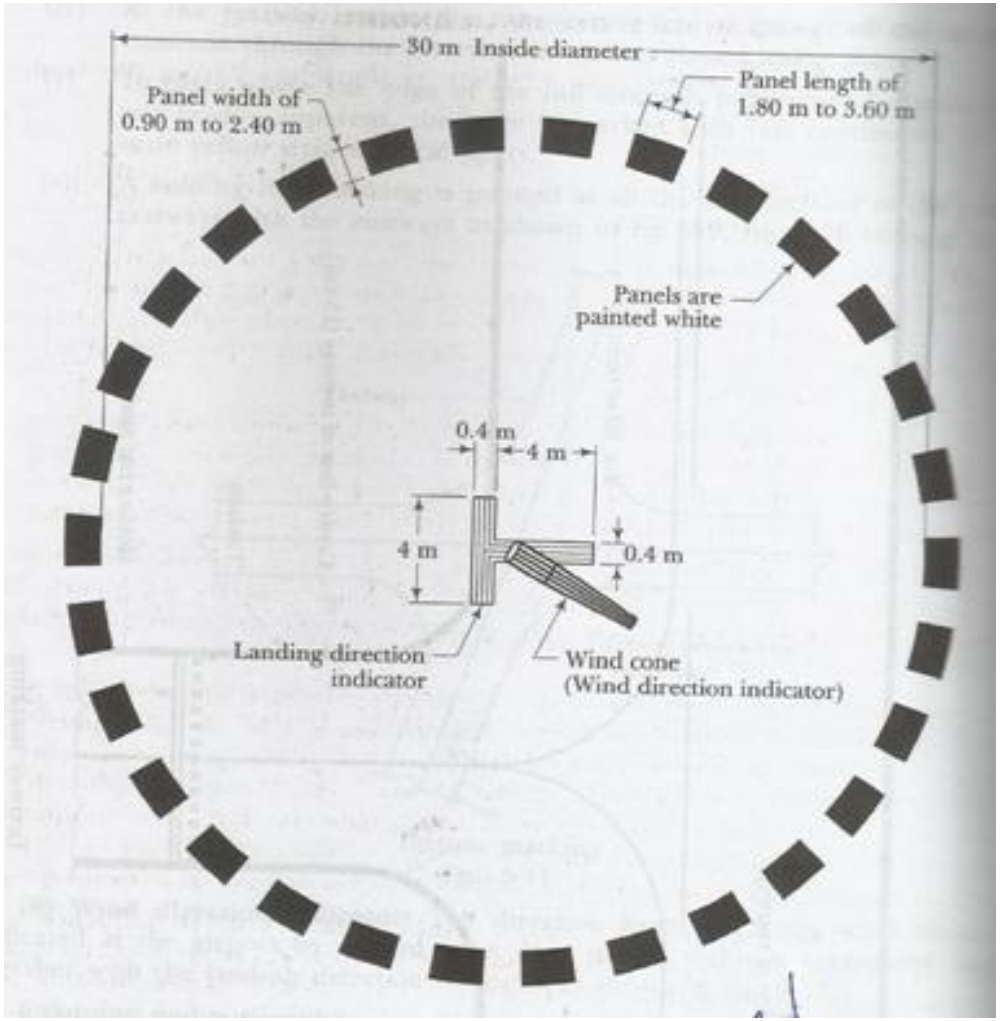
- To indicate the landing direction, an arrow or a tee is placed at the centre of a segmented circle.
- It indicates to the pilot the direction of the active runway of the airport.
- It is painted by orange or white color for being spotted with during day time and is lighted during night time.
- It is fixed at a distinct place.

Landing Direction Indicator



Landing direction indicator

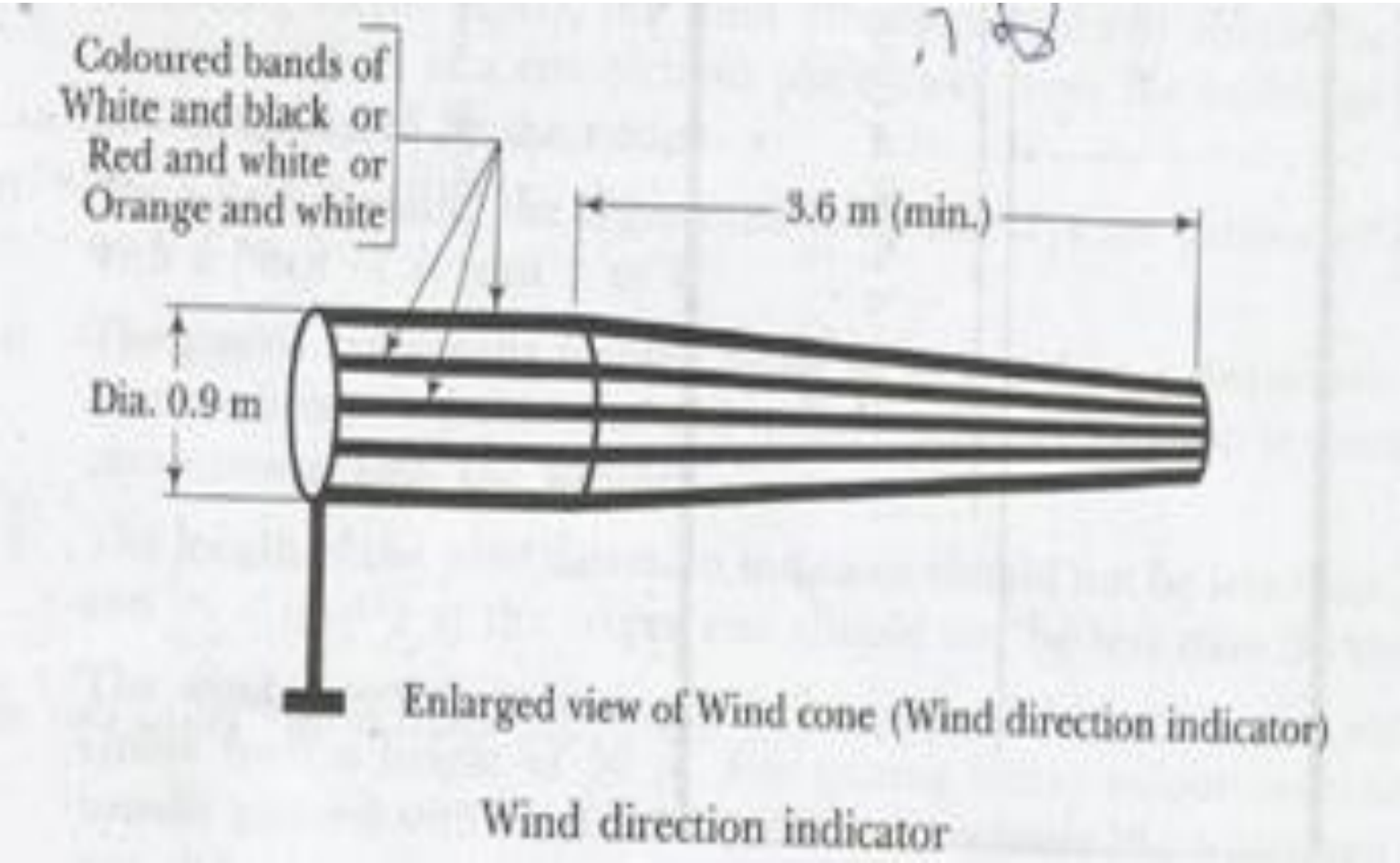
Landing Direction Indicator along with Wind Direction Indicator



Wind Direction Indicator

- The direction from which the wind blows is indicated at the airport by a wind cone.
- It is placed with in a segmented circle together with landing direction indicator.
- Wind cone length should not be less than 3.6m and its diameter should not be less than 90 cm.

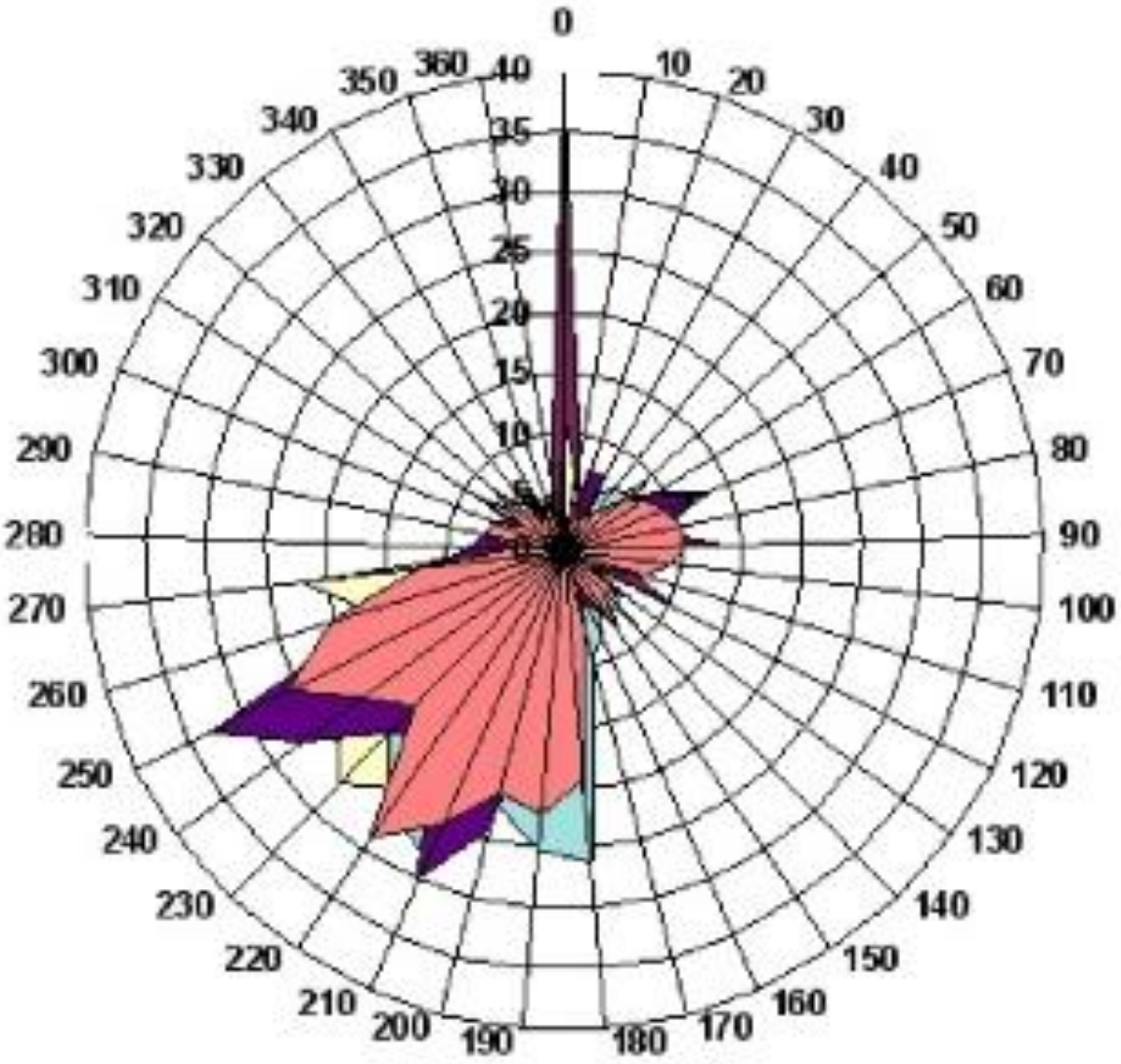
Wind Direction Indicator



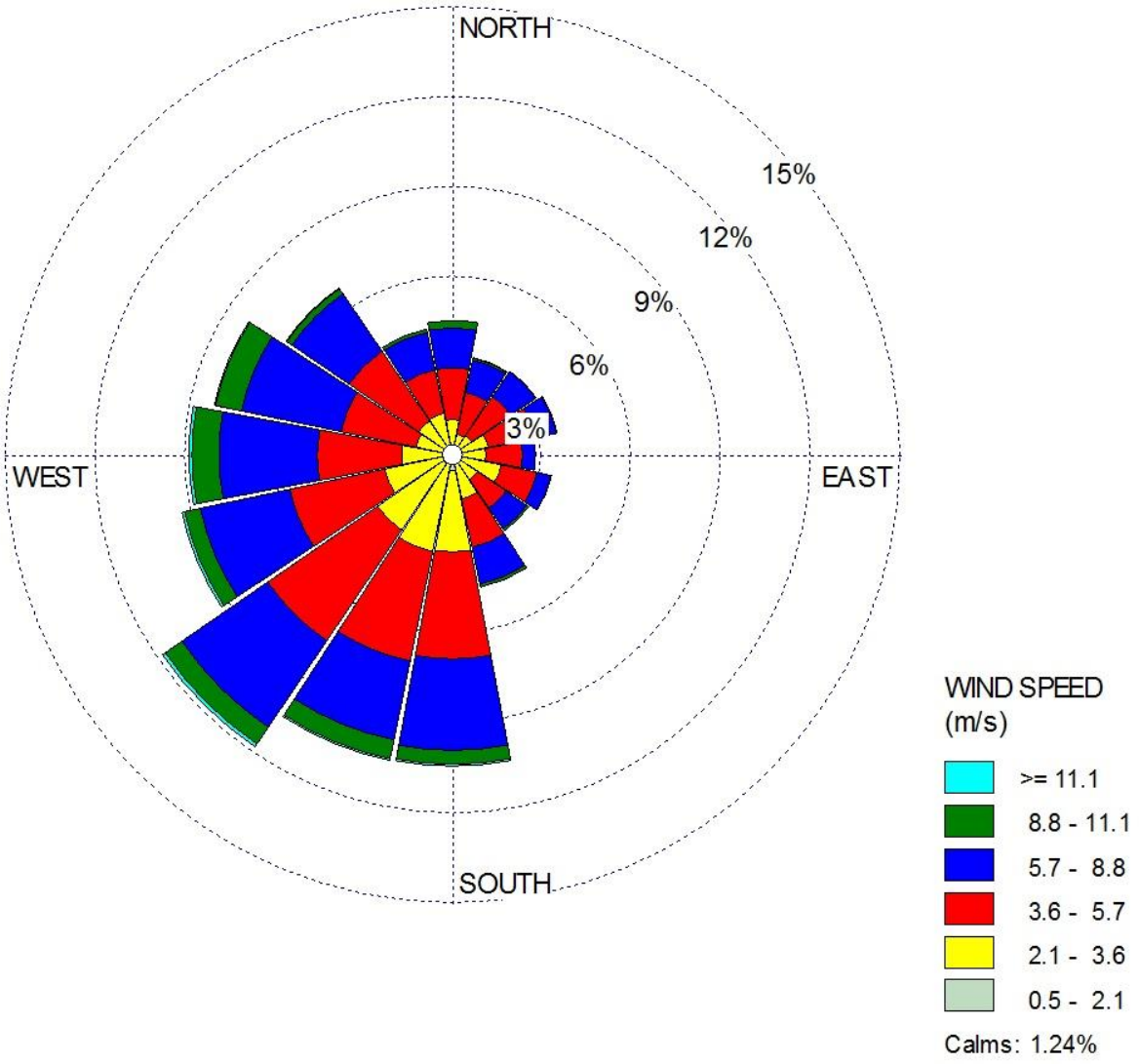
Factors Influencing Airport Size

- Performance characteristics and size of aircraft expected to use the airport.
- Anticipated volume of traffic.
- Meteorological conditions.
- Elevation of site.

Wind Rose Diagram



Wind Rose Diagram

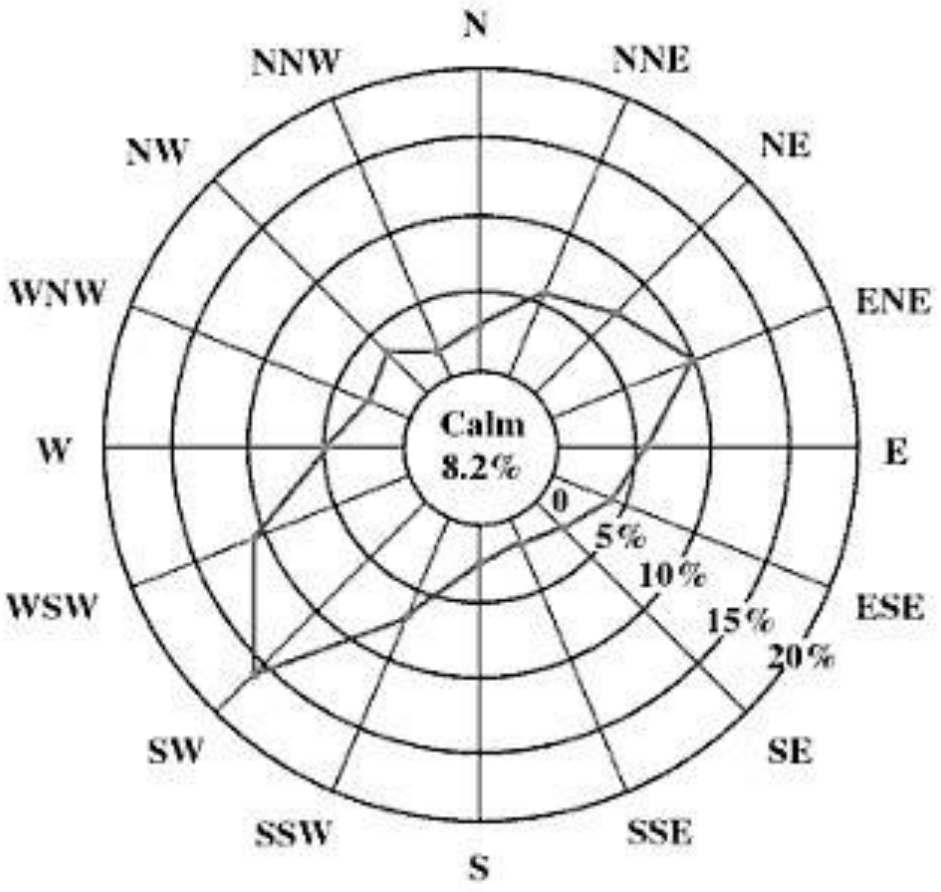


Plotting Wind Rose Diagram

The plotting of the wind rose diagrams can be done in the following two ways:

- Type I: showing direction & duration of wind
- Type II: showing direction, duration and intensity of wind

Type I: Wind Rose Diagram



Type I: Wind Rose Diagram

- The radial lines indicate the wind direction and each circle represents the duration of wind to a certain scale.
- From the wind rose diagram, the total percentage of wind blowing in SW is 15.5% and, accordingly, this point is marked along SW direction.
- Similarly, all other values are plotted and then joined by the straight lines.
- The best direction of runway is indicated along the direction of the longest line on the wind rose diagram.

Type I: Wind Rose Diagram

- From wind rose diagram, SW – NE is the best orientation for the runway.
- This type of wind rose does not consider the effect of the cross wind component.

Type II: Wind Rose Diagram

Typical Wind Data

Wind direction	*Percentage of Time*			*Total % in each direction*
	6-25 Kmph	*25-50 Kmph*	*50-80 Kmph*	
N	4.60	1.40	0.10	**6.10**
NNE	3.40	0.75	0.00	**4.15**
NE	1.80	0.03	0.10	**1.93**
ENE	2.80	0.02	0.03	**2.85**
E	2.10	2.20	0.00	**4.30**
ESE	5.40	4.75	0.00	**10.15**
SE	6.40	1.40	0.00	**7.80**
SSE	7.50	0.02	0.00	**7.52**
S	4.60	1.40	0.10	**6.10**
SSW	2.40	0.75	0.00	**3.15**
SW	1.20	0.03	0.10	**1.33**
WSW	3.60	0.02	0.03	**3.65**
W	1.80	2.20	0.00	**4.00**
WNW	6.00	4.75	0.00	**10.75**
NW	5.90	1.40	0.00	**7.30**
NNW	6.90	0.02	0.00	**6.92**
Total	66.40	21.14	0.46	**88.00**

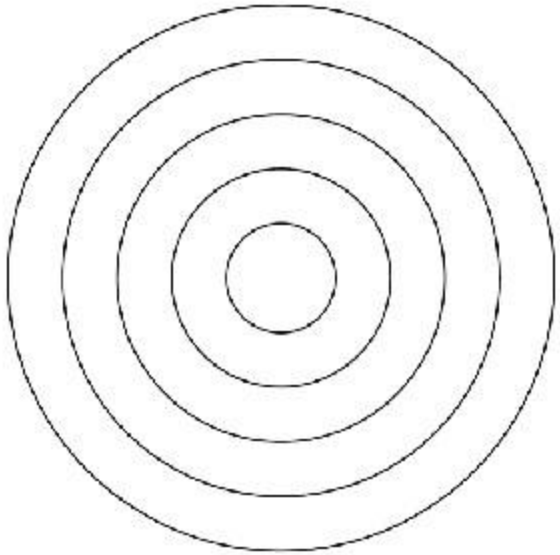
Type II: Wind Rose Diagram

- From the wind data, it is observed that the percentage of time during which the wind velocity is less than 6 Kmph works out to (100 – 88) = 12.
- This period is called the calm period and it does not influence the operations of landing and take off because of low wind velocity.
- Thus, the wind velocities below 6 Kmph have no effect on the fixing of orientation of a runway.

Construction Procedure

- The concentric circles with radii corresponding to 6, 25, 50, and 80 kmph to some scale are drawn. Thus, each circle represents the wind velocity to some scle.

Concentric Circles →



Construction Procedure

- Starting with centre of the concentric circles, the 16 radial directions are shown on the outer circle. The mid points of 16 arcs on the outermost concentric circle are marked and they are given the cardinal directions of compass like N, NNE, NE, ENE, E, etc.

Construction Procedure

- The recorded duration of winds and expressed as percentage are shown for each cardinal direction. It may be noted that the cardinal direction is central to sector.
- A transparent rectangular template or paper strip is taken. Its length should be slightly greater than the diameter of the wind rose diagram and its width should be greater than twice the allowable cross wind component i.e. (2 × 25 =) 25 kmph.

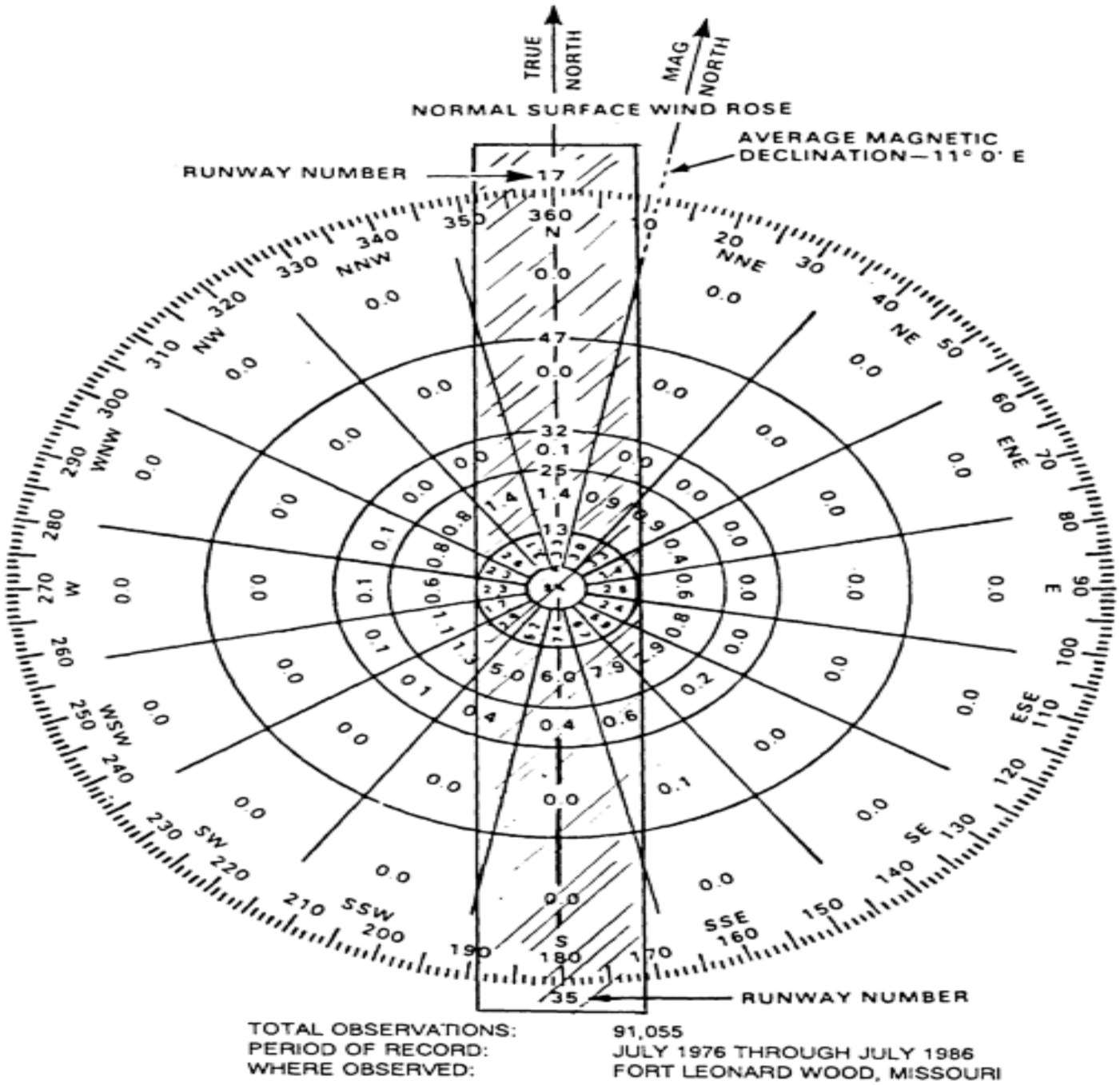


Figure 11-10. Determination of runway alignment by wind-rose analysis

Construction Procedure

- The scale for cross wind component should be the same as that of the concentric circles of the wind rose diagram.
- Along the centre of the length of this template, a line is marked corresponding to the direction of runway.
- The two parallel lines, one on either side of the centre-line, is drawn at a distance equal to the allowable cross wind component i.e. 25 Kmph from the centre line. In other words, the two parallel lines are 50 Kmph away from each other.

Construction Procedure

- The wind rose diagram is fixed in position on a drawing board.
- A hole is drilled in the centre of the template and it is placed on the wind rose diagram such that its centre lies over the centre of the wind rose diagram.
- In this position, the template is fixed by a pin passing through its centre so that the template can rotate about this pin as axis.

Construction Procedure

- The template is rotated and is placed along a particular direction.
- In this position of the template, the duration of 6-25, 25-50 and 50-80 Kmph winds are read for the cardinal directions (N, NNE, NE etc.) lying between the two extreme parallel line marked on the template.
- The sum of all these durations is expressed as the percentage and it gives the total wind coverage for that direction.

Construction Procedure

- The template is then rotated and placed in the next direction.
- The total wind coverage is calculated and the process is repeated for all the directions.
- **The direction which gives the maximum wind coverage is the suitable direction for the orientation of the runway.**

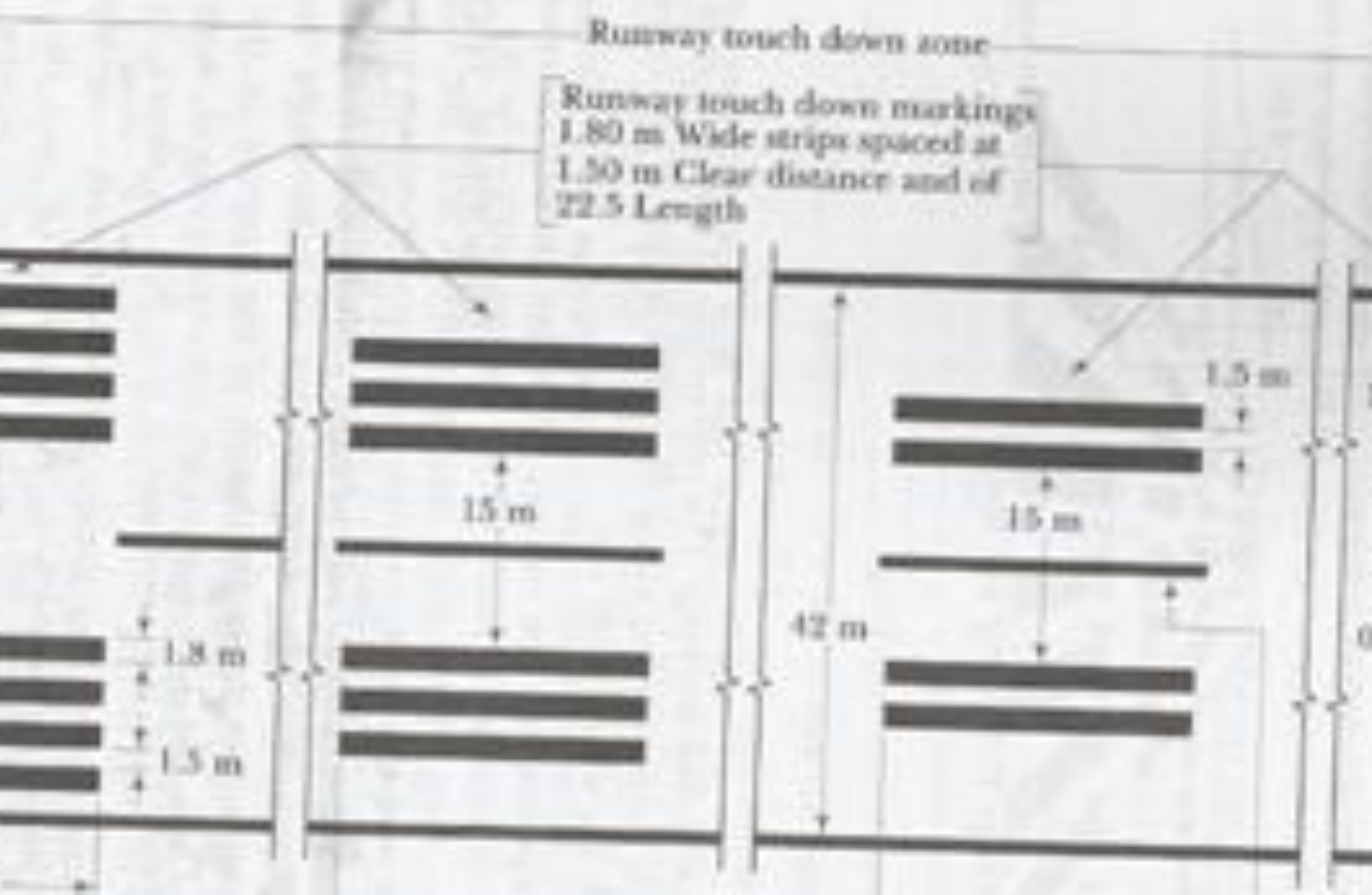
Runway Markings

- Following markings are made on the runways

1. Runway centre-line marking
2. Runway edge stripes
3. Touch down zone marking
4. Threshold marking
5. Displaced threshold marking
6. Runway numbering
7. Two or more parallel runways

Runway centre-line marking

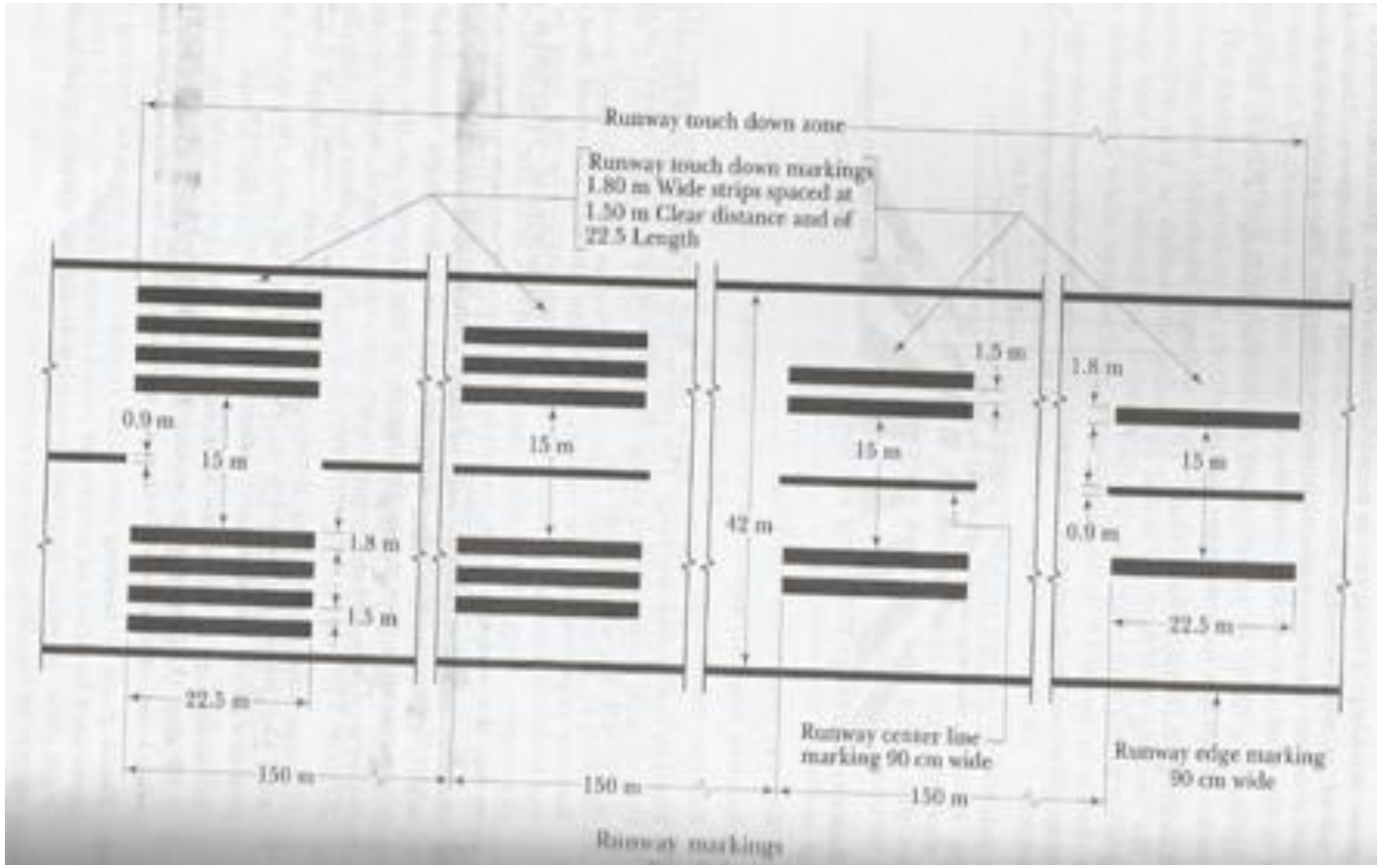
- It is represented by a broken line along the entire length as shown in figure.
- Its width is 90 cm.


Runway touch down zone
Runway touch down markings
1.80 m Wide strips spaced at
1.50 m Clear distance and of
22.5 Length
15 m
15 m
1.5 m
42 m
1.8 m
1.5 m

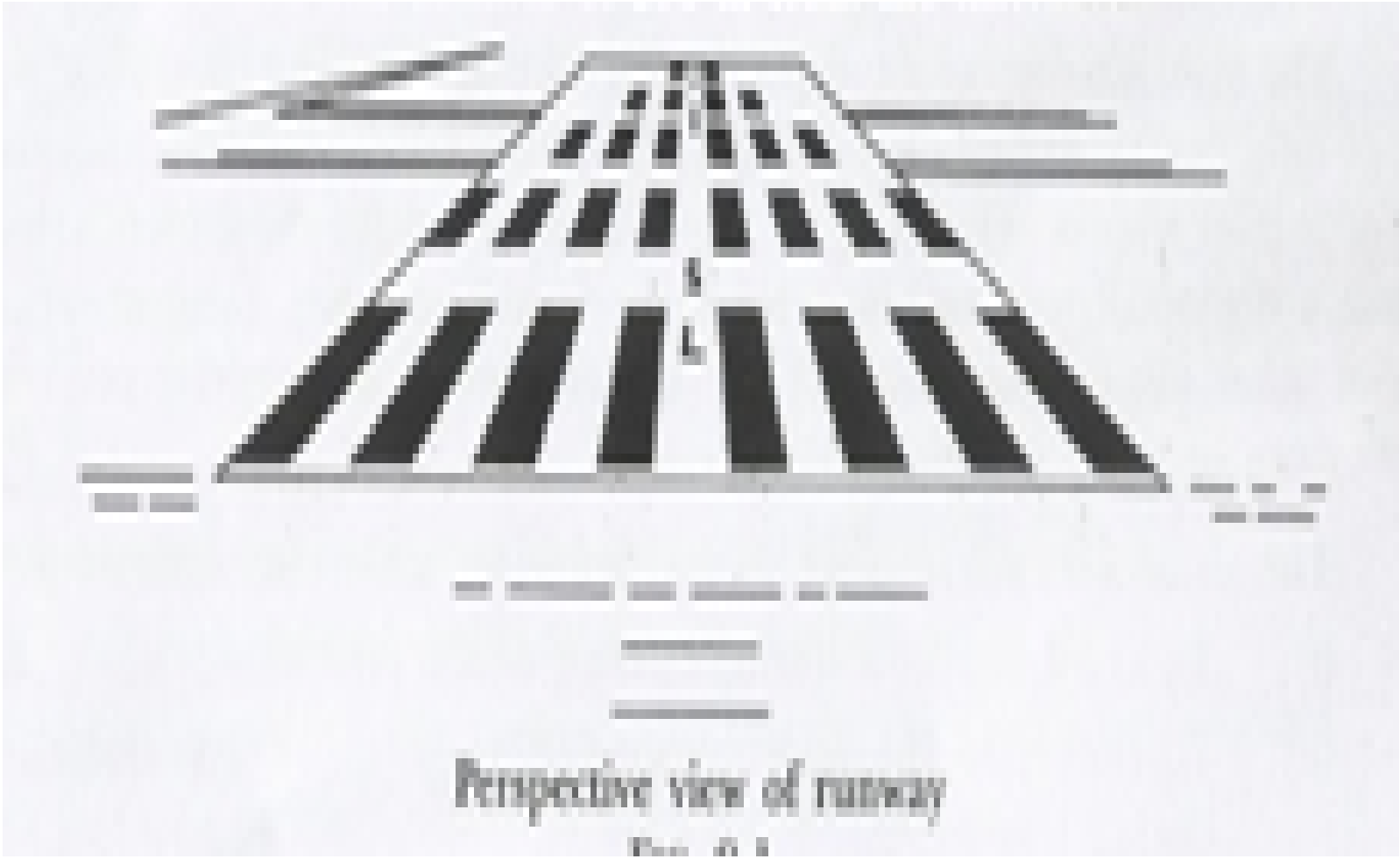
Runway edge stripes

- The runway edge stripes are normally marked.
- But when the runway width exceeds 45 m, the side stripes in the form of long continuous lines 90 cm wide may be marked near the edges as shown in figure.

Runway Markings



Perspective view of a Runway



Touch Down Zone Marking

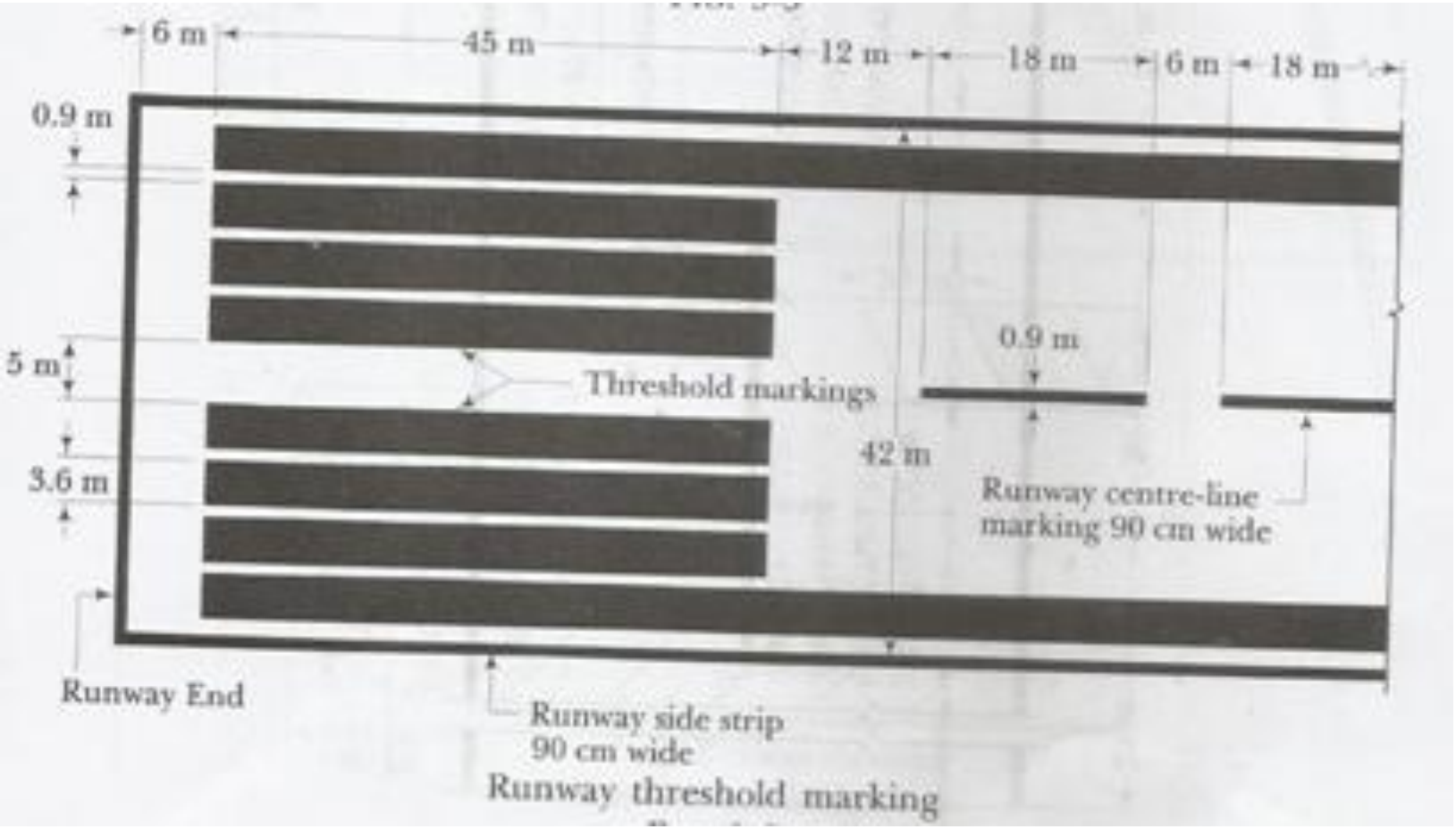
- The runway touch down zone or landing zone is indicated by a series of stripes arranged symmetrically about the centre-line with their number decreasing gradually in the direction of landing as shown in figure.

Threshold Marking

- The runway threshold is indicated by a series of parallel lines starting from a distance of 6 m from the runway end.

- The threshold markings are in the form of stripes 3.6 m wide spaced at 0.9 m clear and placed symmetrically on either side of the runway centre-line.

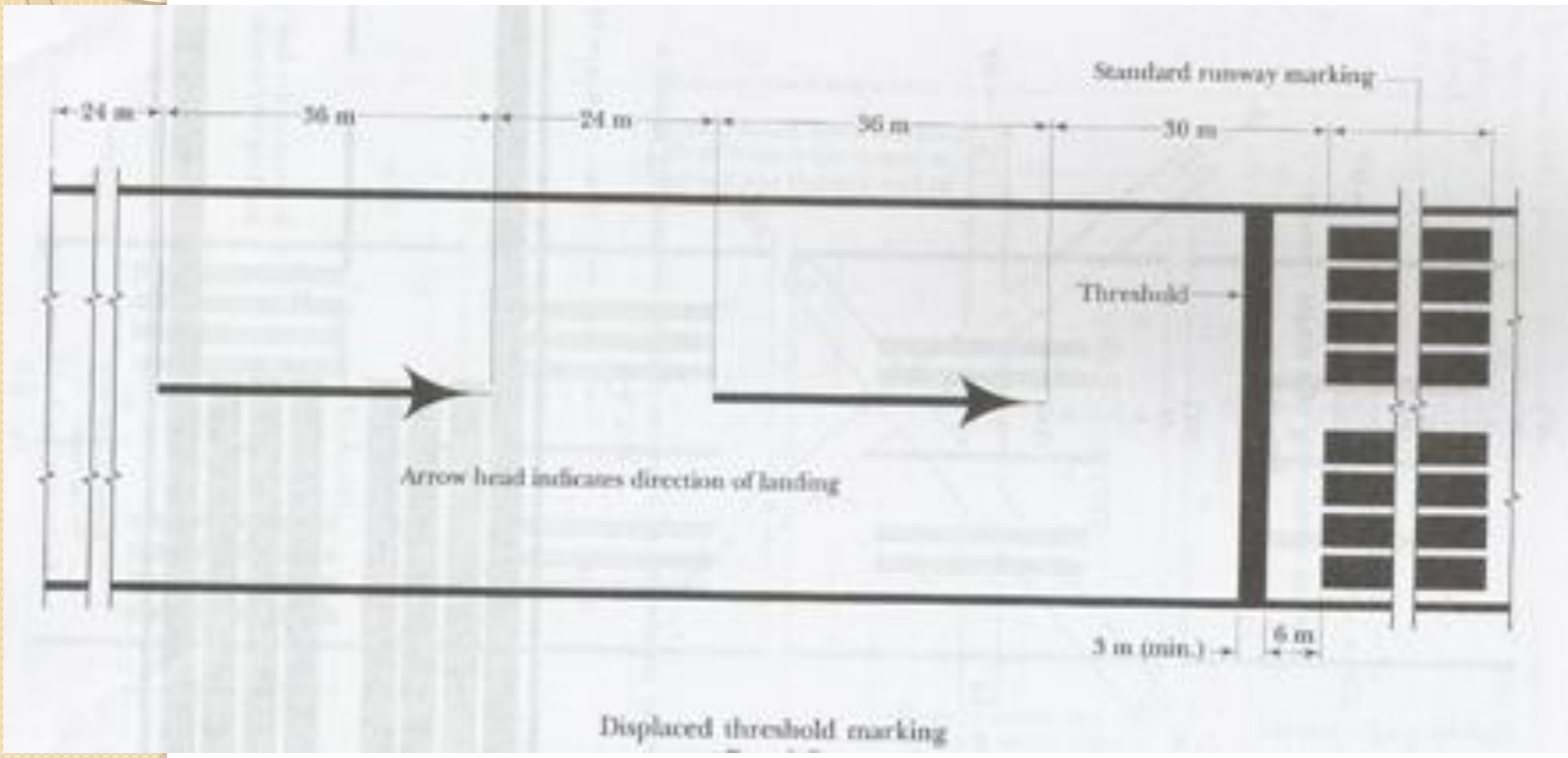
Runway Threshold Marking



Displaced Threshold Marking

- At some airports, it is desirable to displace the runway threshold on a permanent basis.
- A displaced threshold is one which has been moved a certain distance from the end of the runway.

Displaced Threshold Marking



Displaced threshold marking

Airport Lighting

- It is essential to provide adequate lighting in the airport during night for clear visibility of centre lines, edges and thresholds of runways, taxiways, aprons and hangars etc.

- In order to achieve uniformity and to guide the pilots for using the airport for which he may not be familiar, the colors and general arrangement of the airport lights for all civil airports have been standardized.
- Some of the major airports may contain nearly 30000 lights.
- The bulbs should be checked regularly and the faulty bulbs are to be replaced immediately.

Factors Affecting Airport Lighting

The various factors affecting airport lighting are given below.

1. Airport Classification
2. Amount of Traffic
3. Availability of Power
4. Nature of aircraft using the airport
5. Type of Night Operations Planned
6. Type of Landing Surfaces Provided
7. Weather Conditions etc.

Airport Lighting

There are 9 elements of Airport Lighting.

1. Airport Beacon
2. Boundary Lighting
3. Approach Lighting
4. Threshold Lighting
5. Runway Lighting
6. Taxiway Lighting
7. Apron and Hangar Lighting
8. Lighting of Landing Direction Indicator
9. Lighting of Wind Direction Indicator

Airport Beacon

- A Beacon is a strong beam of light which is used to indicate any geographical location.
- The rotating airport beacon gives out white and green flashes in the horizontal direction 180^{o} apart.
- It rotates at 6 revolutions per minute and is usually mounted over the top of terminal building or hangar.

Boundary Lighting

- The entire boundary of the airfield is provided with lights at a centre to centre distance of about 90 m with a height of about 75 cm form the ground.
- When fence is provided, they can be placed at 3 m distance.
- To indicate hazardous approach, they are normally in red color.

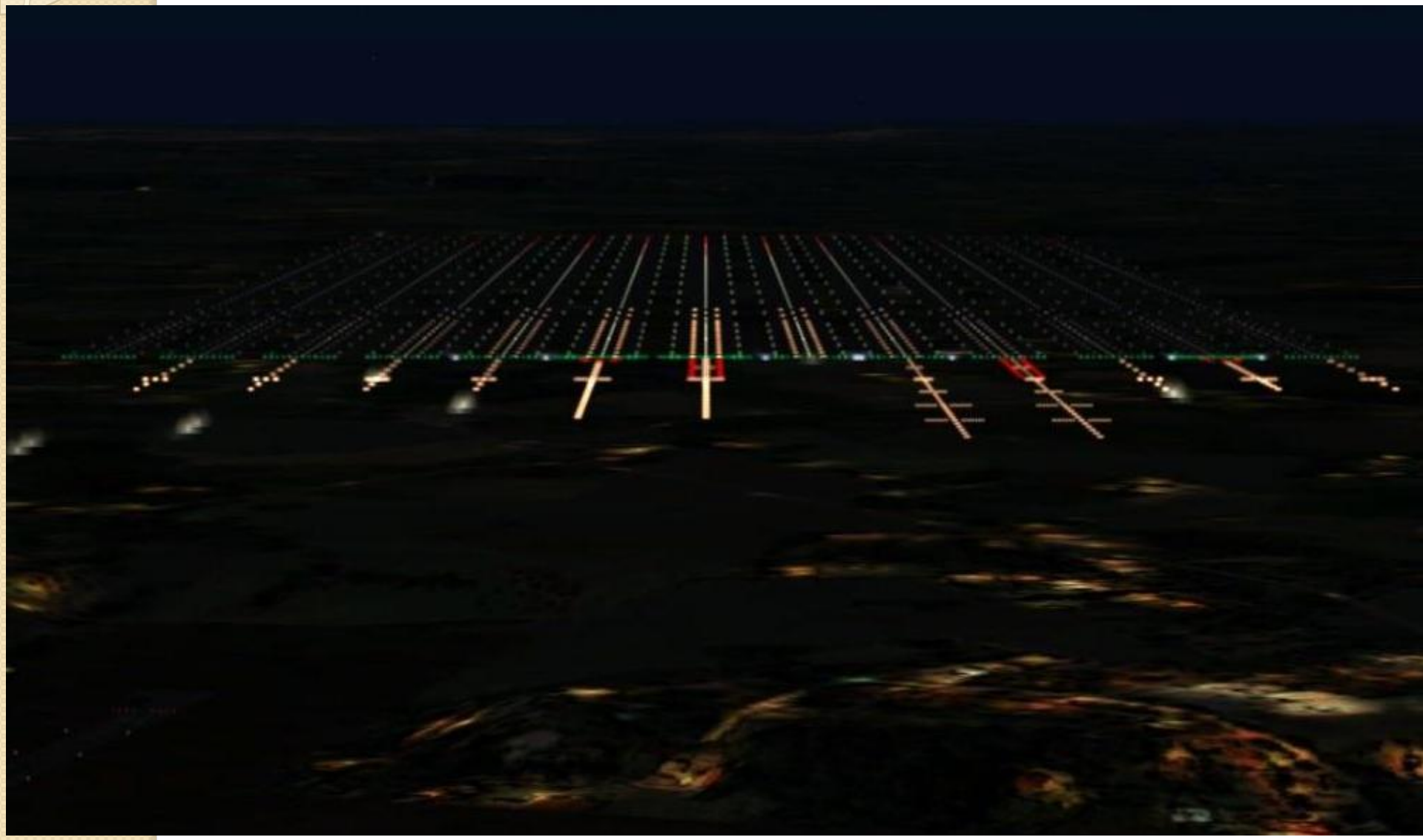

White Runway lights
Threshold Green Lights
Sterile Area
Red Obstruction Lights

Approach Lighting

- Before the runway actually begins, there is a sequence of high-intensity lighting arrangement for a length of 900 m.
- These lights then give way to touch down zone lights from the threshold lighting.

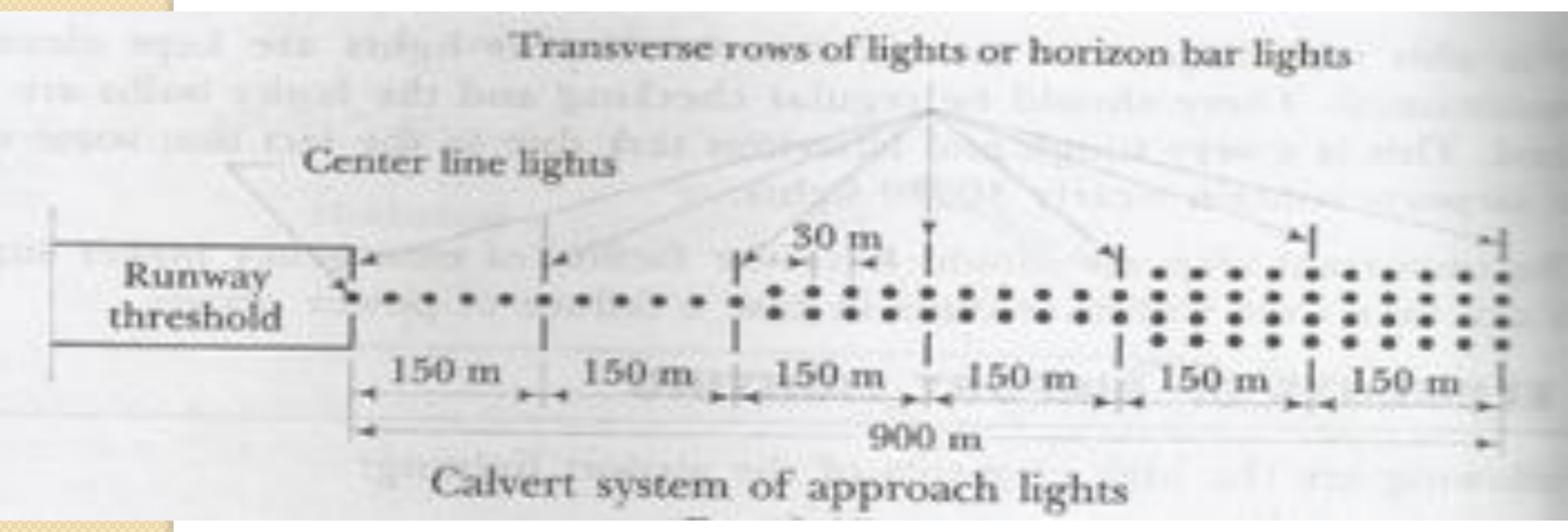
- There are two types of arrangements for approach lighting

1. Culvert system - widely used in Europe
2. ICAO system - widely used in US



Calvert System of Runway Approach Lighting

- In calvert system, the approach lights are provided along the centre line for a length of 900 m from the threshold.
- The number of rows of lights will be decreasing in the direction of landing as shown in figure.
- **Number of transverse bars:** There are 6 transverse rows of lights of variable length placed at a centre to centre distance of 150 m.
- **Roll guidance:** The roll guidance is principally provided by the transverse rows of lights.



Calvert system of approach lights

ICAO System of Runway Approach Lighting

1. Number of transverse crossbars:

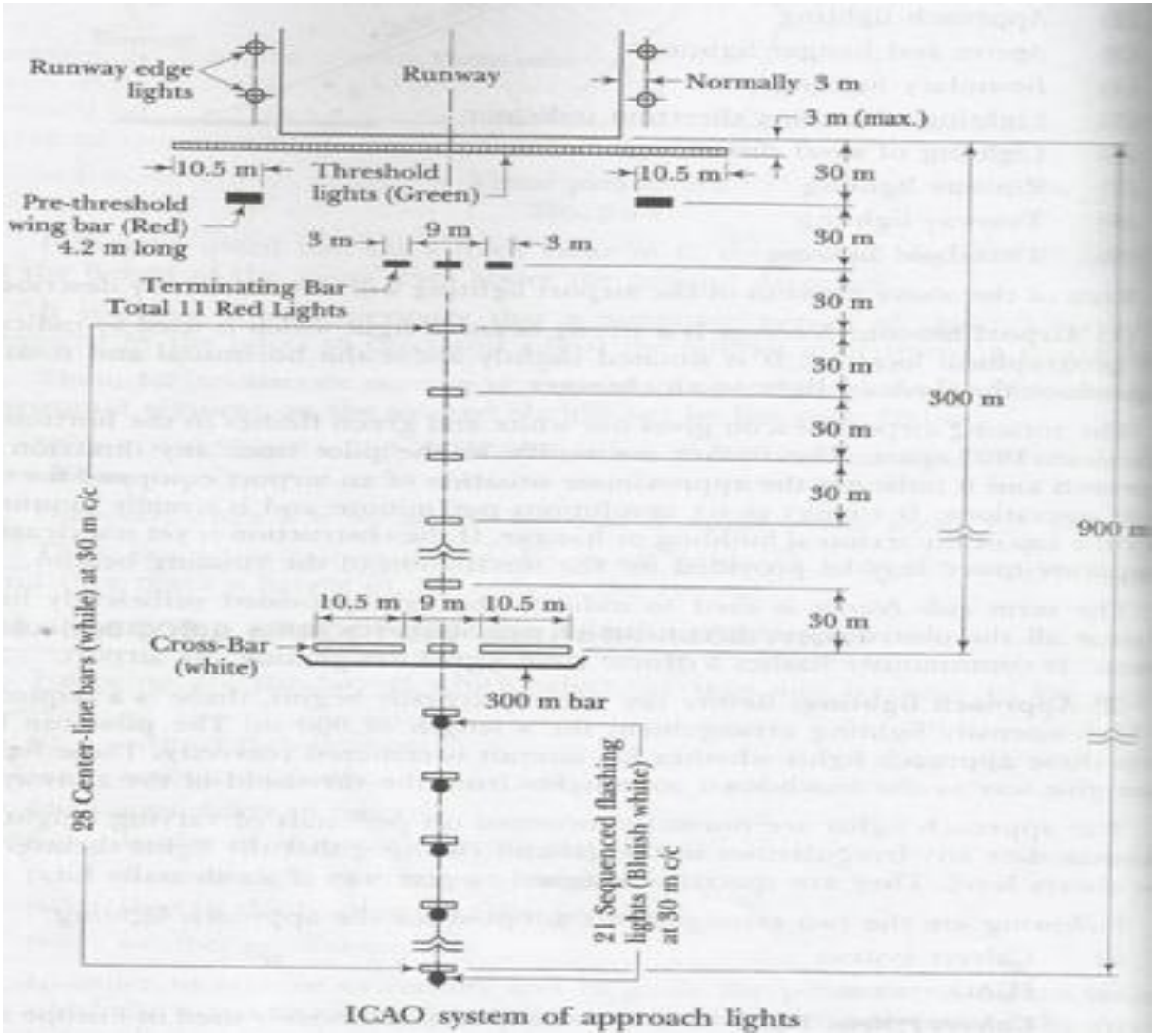
In ICAO system, there is only one crossbar 300 m from the threshold.

2. Roll Guidance:

In ICAO system, the roll guidance is provided by bars 4.2 m in length, placed at 30 m centre to centre on the extended centre-line of the runway and a single crossbar 300 m from the threshold.

The 4.2 m long bars consist of five closely spaced lights to give the effect of a continuous bar of light.

ICAO System of Runway Approach Lighting



ICAO system of approach lights

Threshold Lighting

- The identification of runway threshold is a major factor for the decision of the pilot to land or not to land.
- For this reason, the region near the threshold is given special lighting treatment.
- At large airports, the threshold is identified by a complete line of green lights extending across the entire width of the runway.
- The threshold lights in the direction of landing are green and in the opposite direction, they are red to indicate the end of runway.
- They must be of semi-flash type i.e. protruding not more than 12 cm above the surface.

Threshold lighting at Small Airports

- At small airports, the threshold is identified by 4 lights on each side of the threshold.
- They can be of elevated type i.e. protruding more than 12 cm above the surface

Runway Lighting

- After crossing the threshold, the pilot must complete a touch down and roll out on the runway.
- The planning of the runway lighting is carried out in such a way that the pilot gets enough information on alignment, lateral displacement, roll and distance.
- Earlier, night landings were made by flood-lighting the entire runway area.
- The more precise runway lighting arrangement which is now commonly used on all the major airports is known as the narrow gauge pattern.
- It makes use of the centre-line and touch down zone lights for operations in very poor visibility.

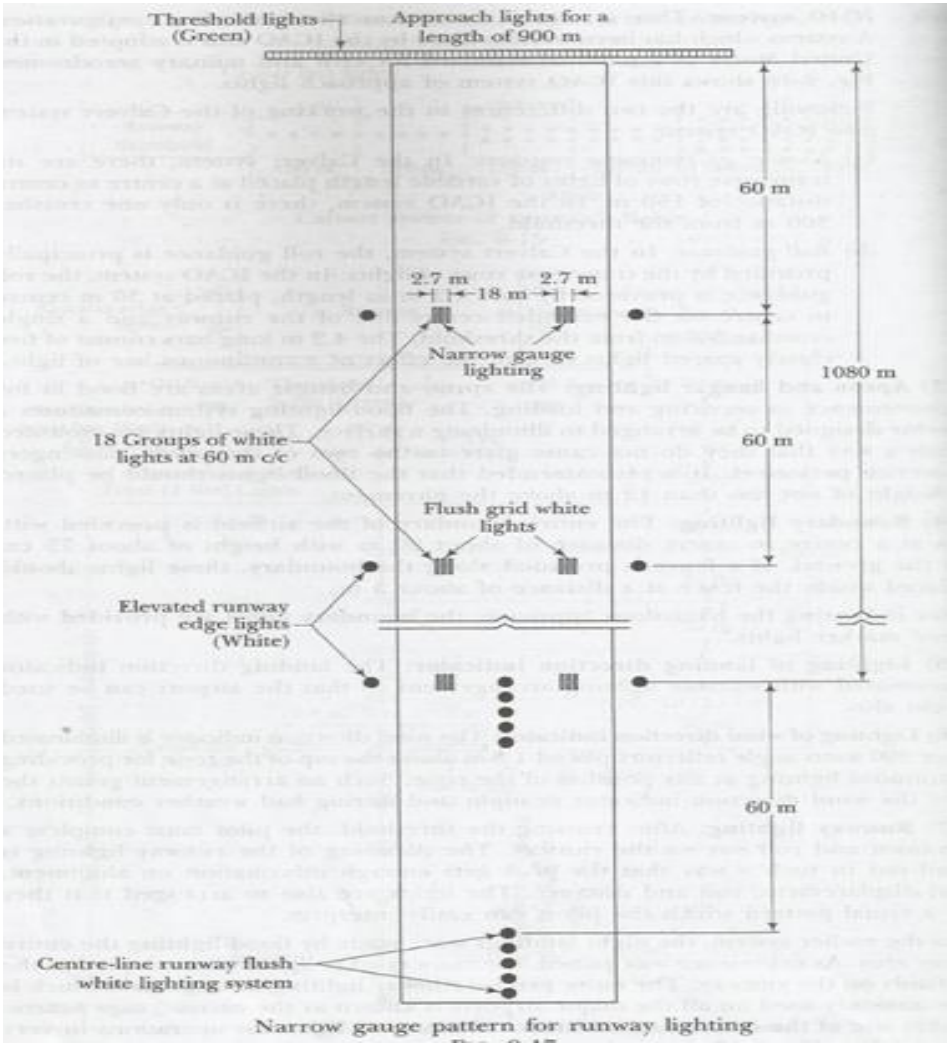
Black Hole Effect

- As the pilot crosses the threshold and continues to look along the centre-line, the principal source of guidance, namely, the edge lights have moved far to each side in their peripheral vision.
- As a result, the central area appears excessively black and the pilot is virtually flying blind except for the peripheral reference information.
- This is known as "black hole effect".

Narrow gauge pattern for runway lighting

- To eliminate the black hole effect by increasing the intensity of edge lights was proved ineffective.
- Therefore, the narrow gauge pattern of runway lighting is introduced in which the central portion gets illuminated and the black hole effect is partly illuminated.
- The narrow gauge pattern forms a channel of light 18 m width up to 1140 m 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 1 cm above the surface of the pavement)
- The runway edge lights are of elevated type and they are white in color except for the last 600 m of an instrument runway facing the pilot which are of yellow color to indicate a caution zone.

Narrow gauge pattern for Runway Lighting

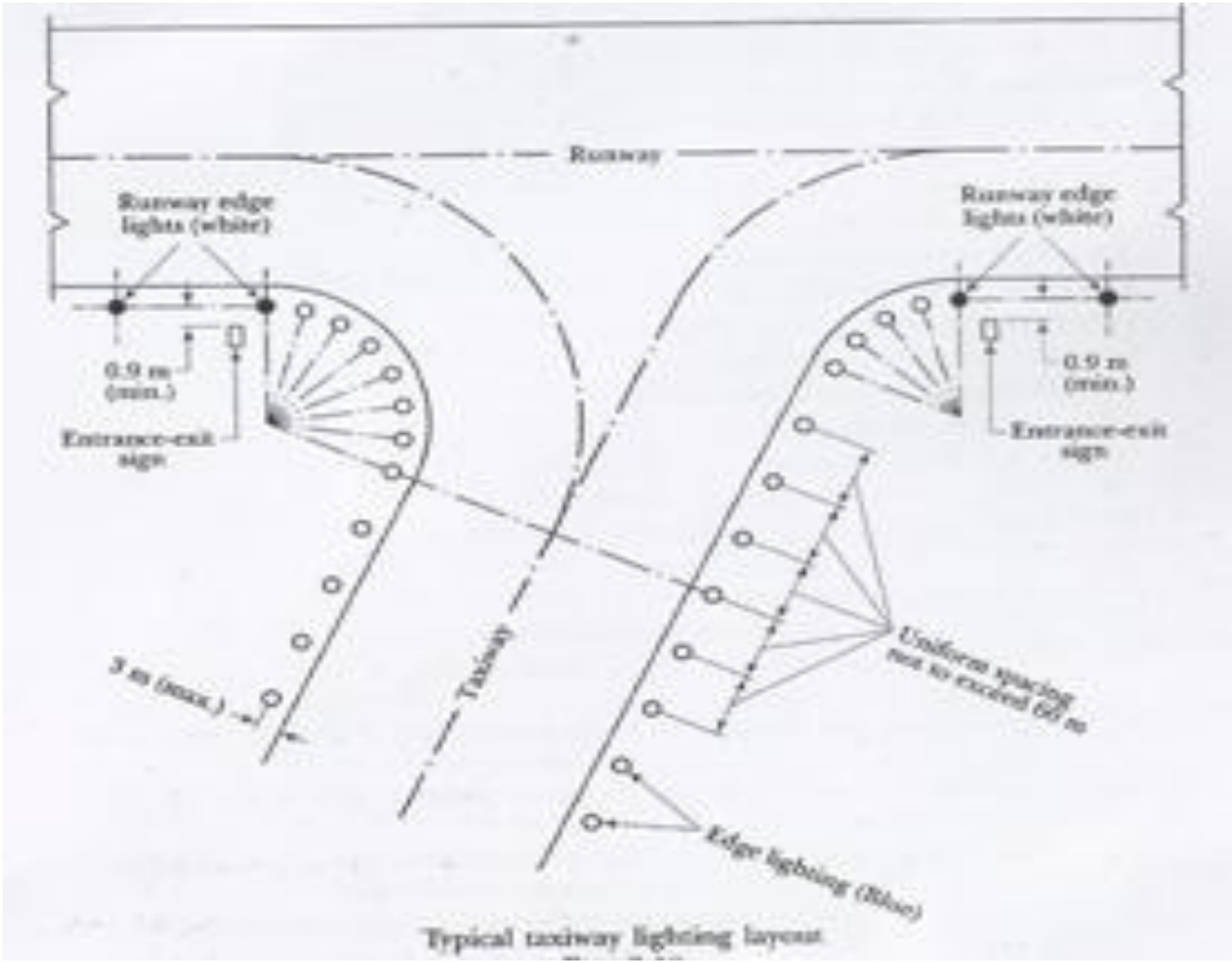


Narrow gauge pattern for runway lighting

Taxiway Lighting

1. For normal exits, the centre line lights are terminated at the edge of the runway.
2. At taxiway configurations, the lights continue across the intersections.
3. They are placed at a distance of 6 m to 7.5 m along the straight length and 3 m to 3.6 m along the curves.
4. The edge lights should not extend more than 75 cm above the pavement surface.
5. The exits from the runways should be so lighted that the pilots are able to locate the exits 360 m to 400 m ahead of the point of turn.
6. The taxiway edge lights are blue and the taxiway centre-line lights are green.

Taxiway Lighting



Typical taxiway lighting layout

Apron and Hangar Lighting

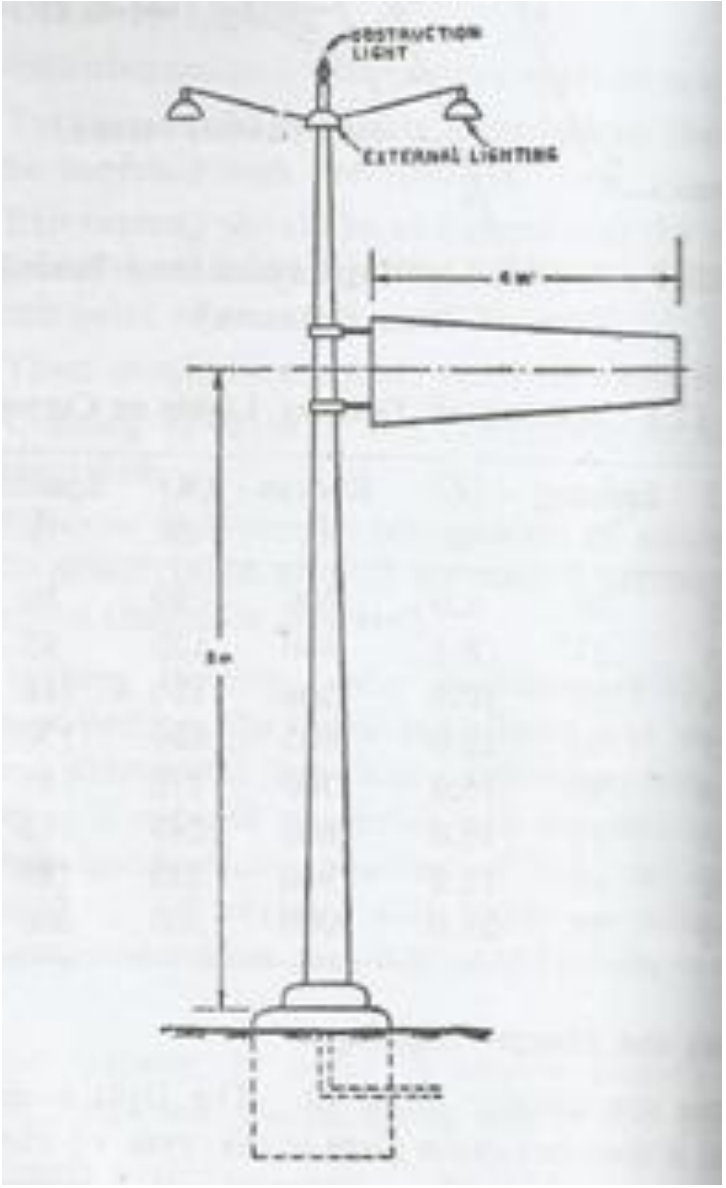
- Apron and Hangars are provided with flood lighting system in order to facilitate servicing loading and unloading.
- The light source is so mounted that it does not cause glare in the eyes of the pilots, the service personnel or the passengers.
- It is recommended that flood lights should be mounted at least 12 m (40 ft) above the pavement.

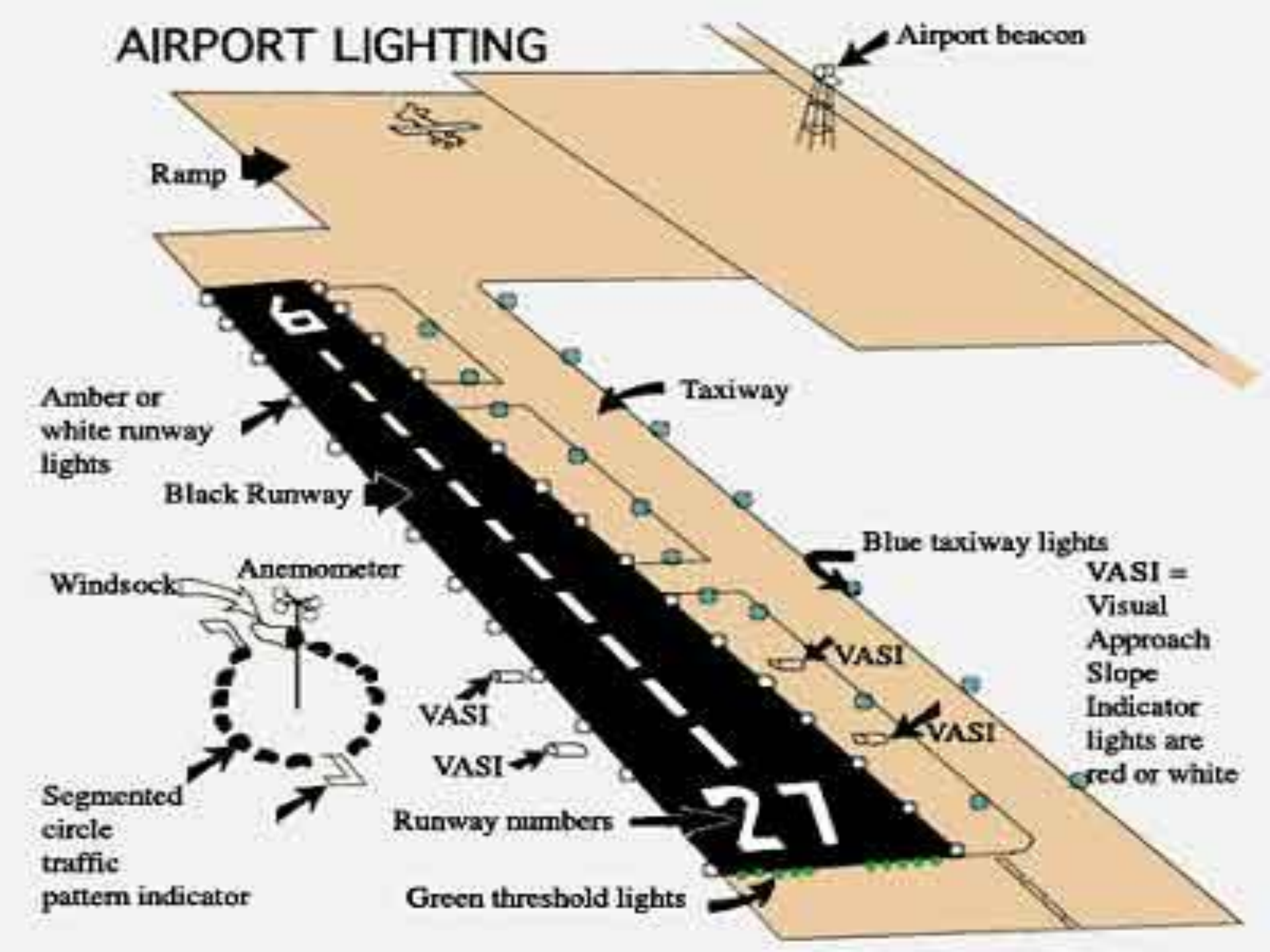
Lighting of Landing Direction Indicator

- The landing direction indicator usually a tee or arrow is illuminated with suitable lighting arrangement so that it is visible to the pilot during night also.

Lighting of Wind Direction Indicator

- The wind direction indicator is illuminated by 4 x 200 watts angle reflectors placed 1.8 m above the top of the cone for providing a continuous lighting at any position of the cone, so that it can be used during night or bad weather condition.




AIRPORT LIGHTING
Airport beacon
Ramp
Taxiway
Amber or white runway lights
Black Runway
Blue taxiway lights
Windsock
Anemometer
VASI = Visual Approach Slope Indicator lights are red or white
VASI
VASI
VASI
VASI
Segmented circle traffic pattern indicator
Runway numbers
Green threshold lights
27