

Transportation Engineering – II
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Lecture – 40
Visual Aids – Lighting & Signage

Dear students, I welcome you to this final lecture of the lecture series on the course material of Transportation Engineering II. From the previous lecture, we have started with the visual aids and we have already discussed regarding different types of marking in that lecture. In today's lecture, we will be concentrating on lighting and signages.

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On that aspect this lecture is being outlined with the following - the airport lighting and the signages.

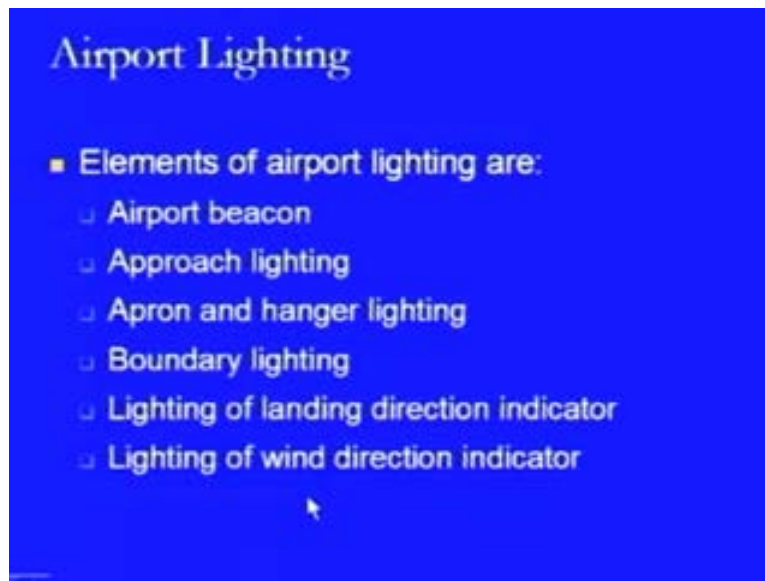
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Starting with the airport lighting, there are different factors which affect the type of the lighting needs to be provided and the intensity of the airport lighting. We look at those factors. It is on the basis of airport classification whether the airport is a smaller airport or a bigger airport, depending on that the type of the lights needs to be provided or the intensity of those lights which are provided at any specific location changes. What is the total amount of traffic which is coming on that airport which needs to be handled is another aspect which defines the type of lightings. The type of availability of the traffic which is there for that airport, the nature of aircraft which will be using the airport is another factor which may define that how or at what particular position the lighting needs to be provided.

Then, the type of night operations being planned, whether under the visual conditions or under the instrumental conditions depending on that one, again there may be a difference or a change. Then, the type of landing surfaces which are provided that will also create its effect and the weather conditions.

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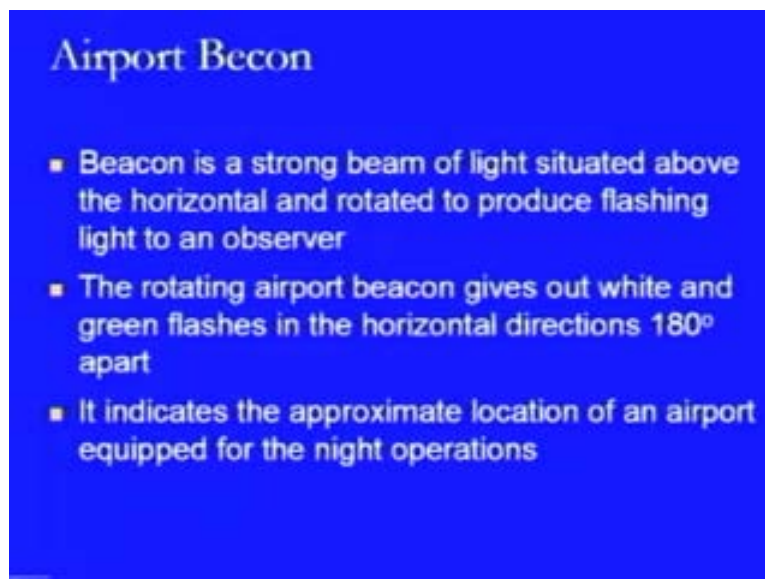
So, once we have looked at the various factors which can control the type of the airport lightings which can be provided, we look at the various elements of airport lighting or the types of the airport lightings which needs to be provided. They are airport beacons, the approach lightings for the aircrafts landing on the airport, the apron and hanger lightings for the aircrafts which are standing near the terminal buildings or in the hangers, the boundary lightings, the lighting of landing direction indicators, as we have seen in the case of markings and similarly, the lighting of the wind direction indicators.

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So, further there are runway lightings also. Then, there are taxiway lightings, the threshold lightings for the threshold markings being provided.

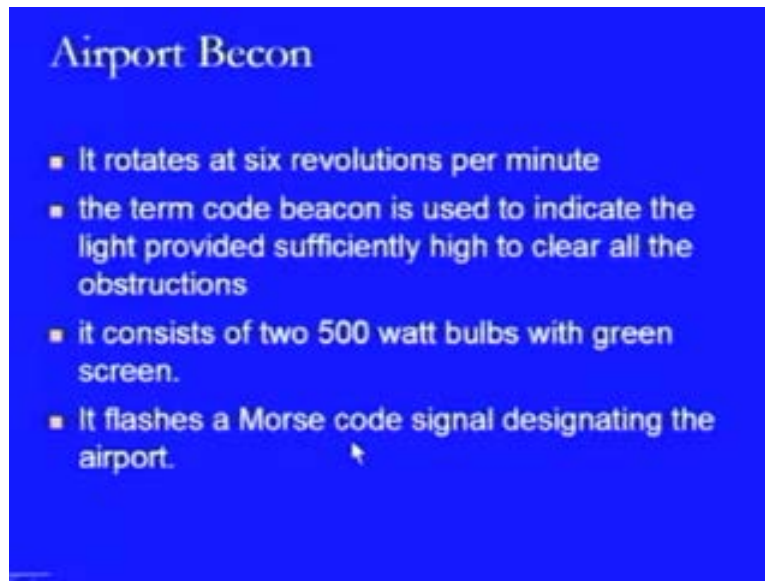
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So, looking at these one, we are starting with the first one that is the airport beacon. This beacon is a strong beam of light which is situated above the horizontal and it is rotated to produce flashing light to an observer. So, this flashing light which is being rotated defines

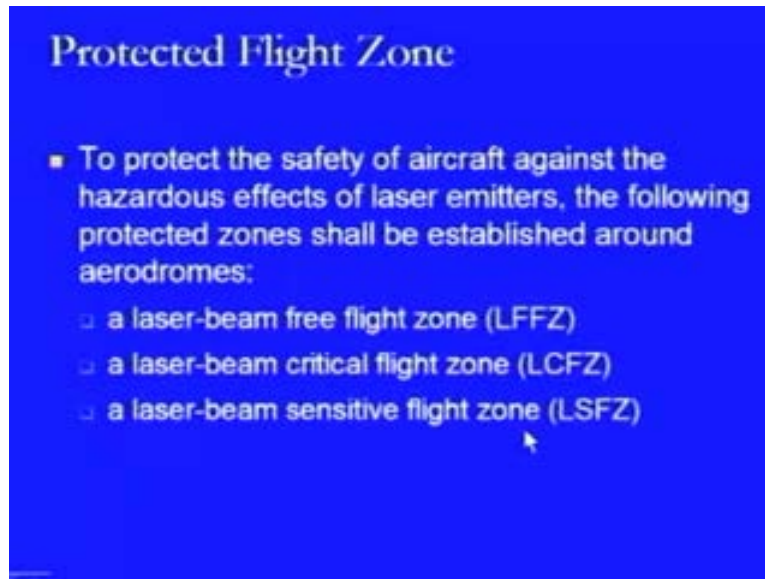
that there is a location of the airport and this is how the pilot from quite a big distance can understand and can start orienting themselves. The rotating airport beacon gives out white and green flashes in the horizontal directions, 180 degrees apart. These are the two colour lights which will be coming at an angle of 180 degrees. It indicates the approximate location of an airport which is equipped for night operations.

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It rotates at 6 revolutions per minute and the term code beacon is used to indicate the light which is provided sufficiently high to clear all the obstructions. It consists of two 500 watt bulbs with green screens and it flashes a Morse code signal designating the type of the airport. So, the way the flashing is being done, this is based on the Morse code and this defines what is the classification of this airport.

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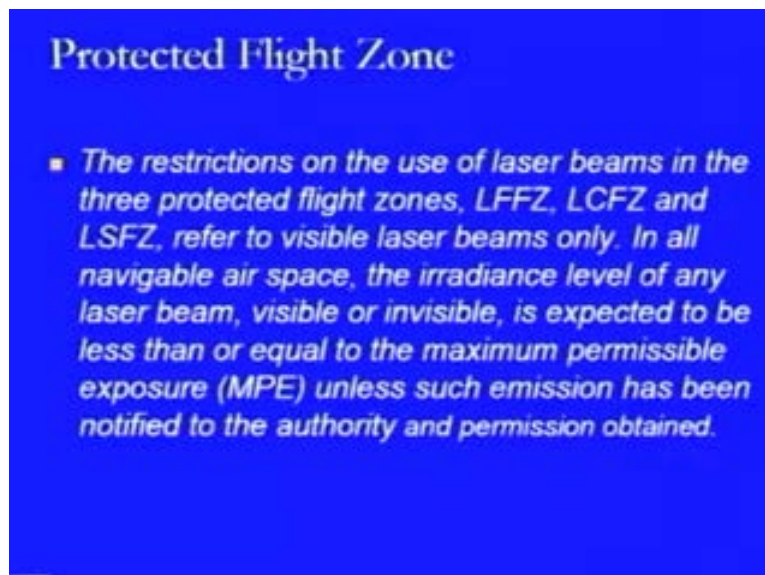


Protected Flight Zone

- To protect the safety of aircraft against the hazardous effects of laser emitters, the following protected zones shall be established around aerodromes:
 - a laser-beam free flight zone (LFFZ)
 - a laser-beam critical flight zone (LCFZ)
 - a laser-beam sensitive flight zone (LSFZ)

Then, there is another type of lighting which defines the protected flight zone lighting. This is used to protect the safety of aircrafts against the hazardous effects of laser emitters and these protected zones they shall be established around all the aerodromes, so that this can be done and this is done in the form of, like for laser beam free flight zone that is LFFZ, a laser beam critical flight zone which is termed as LCFZ, a laser beam sensitive flight zone that is LSFZ.

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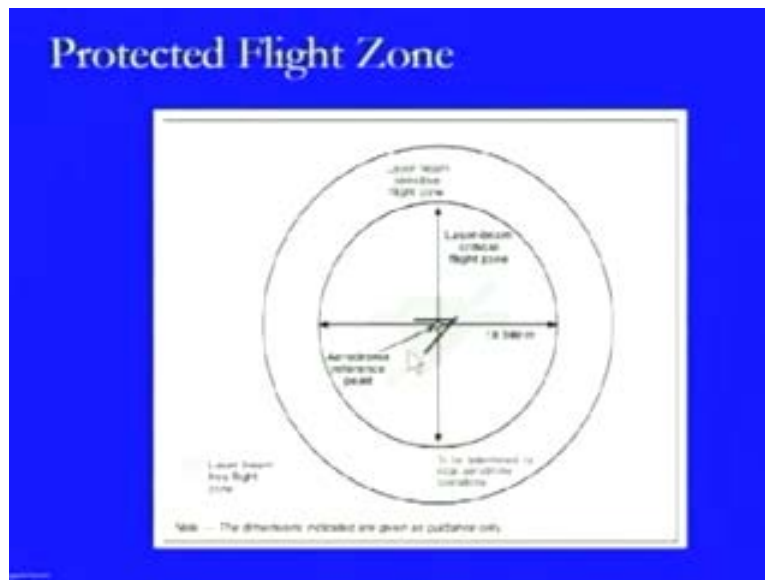


Protected Flight Zone

- *The restrictions on the use of laser beams in the three protected flight zones, LFFZ, LCFZ and LSFZ, refer to visible laser beams only. In all navigable air space, the irradiance level of any laser beam, visible or invisible, is expected to be less than or equal to the maximum permissible exposure (MPE) unless such emission has been notified to the authority and permission obtained.*

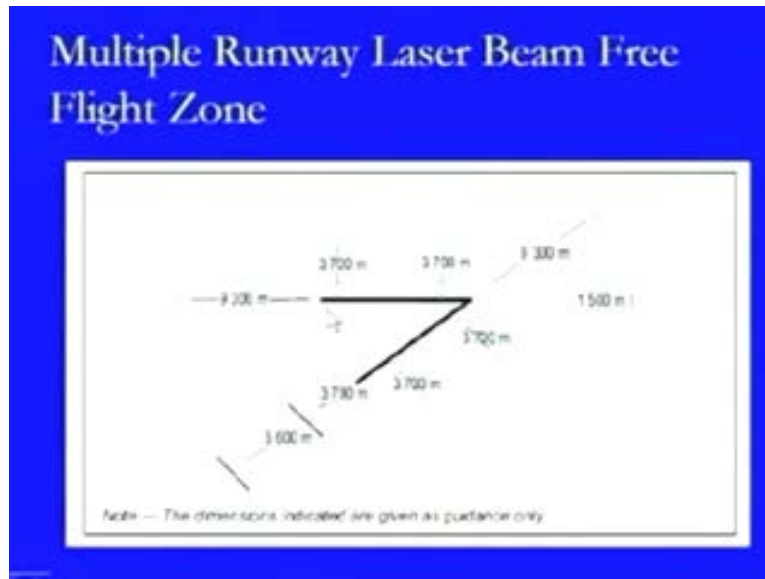
The restrictions on the use of laser beams in these protected flight zones that is as we have seen LFFZ, LCFZ and LSFZ refer to visible laser beams only. In all navigable air space, the irradiance level of any laser beam which is visible or which is not visible is expected to be less than or equal to the maximum permissible exposure which is defined for all such zones, unless such emission has been notified to the authority and permission is being obtained, so as to have higher level emission. This is the way it is being defined.

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Here, we have the runway strips like being located in this form and in this form and then with respect to the airport reference point, for certain distance we are defining that this is the laser beam critical flight zone. Then, there is a laser beam sensitive flight zone. So, these needs to be determined for the local aerodrome operations and this particular area which is shown by this gray colour in this side, this one, this is a laser beam free flight zone. So, this is free, this is critical and this is sensitive.

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Here, we are looking at another one. This is a multiple runway laser beam free flight zone and the various dimensions has been shown for that one, as we have seen in the previous diagram, where in the central area with respect to the runway strips that was defined. So, this is how it is being defined. This is a V shaped runway strip being located.

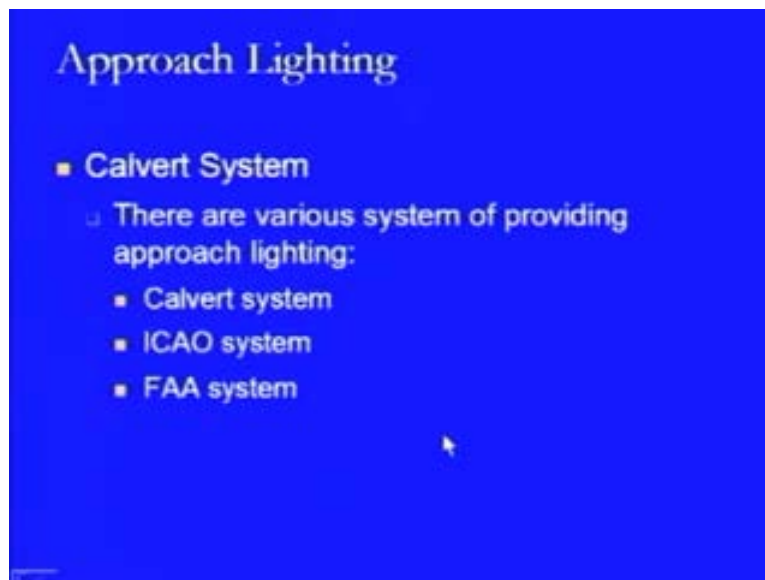
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Approach Lighting

- Calvert System
 - These are provided before the start of the runway as a sequence of high-intensity lighting arrangement for a length of 900 m.
 - These are mounted on pedestals of varying heights, maintaining the lights at the same level

Now, we look at the approach lightings. In the case of approach lightings, we have different systems of providing the approach lightings. One such system is Calvert system. In the case of Calvert system, the lightings are provided before the start of the runway as a sequence of high intensity lighting arrangement for a length of 900 meters. So, this is the way the lights are provided. Just before the end of the runway strip for a length of 900 meters, there will be large number of high intensity lights being provided. These are mounted on pedestals of varying heights maintaining the lights at the same level. So, it depends like, this is, if you are at the furthest point, then it will be the highest level and as we are coming towards the runway strips, it keeps on going towards the downward side. But then, whatever lights are provided at one particular location, they are having the same level.

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We start discussing another system will be ICAO system and FAA system.

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Approach Lighting

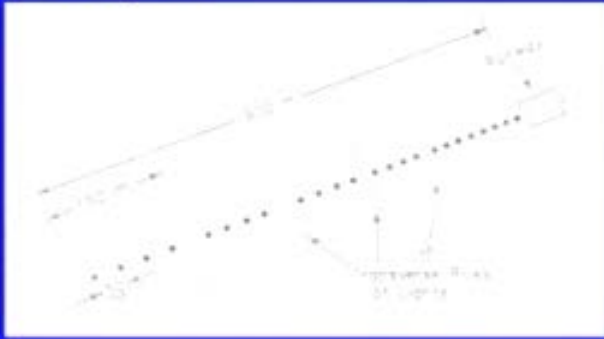
- **Calvert System**
 - Developed by E.S. Calvert of Great Britain
 - Widely in use in Europe
 - There are six transverse rows of lights of variable length placed at a centre to centre distance of 150 m.
 - The roll guidance is primarily by the transverse rows of lights

This was developed by E.S. Calvert of Great Britain and it is widely in use in Europe. There are 6 transverse rows of lights of variable length being placed at a centre to centre distance of 150 meters. The roll guidance is primarily by the transverse rows of lights. So, whatever transverse rows of lights are provided, by the height of those transverse rows of lights, we understand or the pilot understands that which is the direction in which the aircraft is to be rolled down and that is how they attain the different heights.

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Approach Lighting

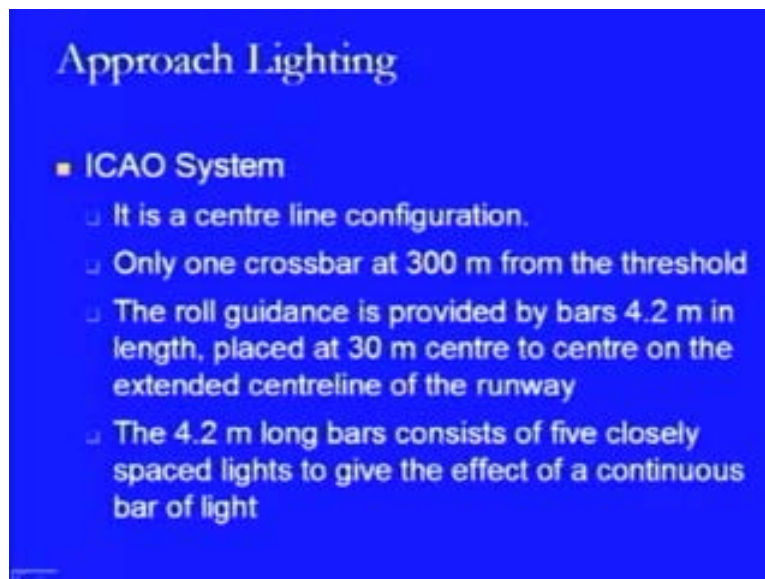
- **Calvert System**



The diagram illustrates the Calvert System approach lighting layout. It shows a series of transverse rows of lights, with the length of each row increasing as the aircraft approaches the runway. The lights are arranged in a way that provides roll guidance. Labels in the diagram include 'Runway', 'Approach Lights', and 'Transverse Rows of Lights'.

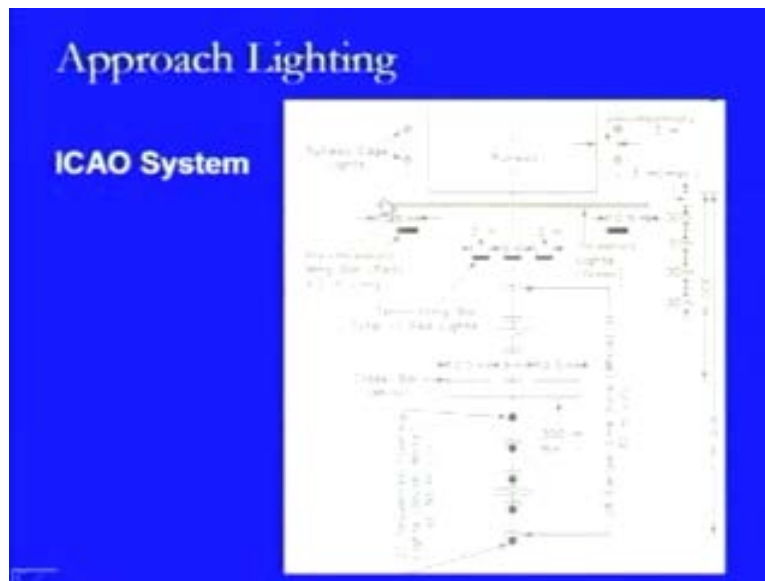
This is the way this is provided, like we can see there are, this is the one series of light which indicates the centre line of this runway strip. These are at 30 meters intervals and then there are transverse strips being provided like this. They are the transverse rows of lights, high intensity lights; number of lights which are provided very close to each other and that is how it looks like one strip. So, this is one strip, then there is a gap, then there is a strip of lights, then there is a gap and this is how it looks like during night and as we see that they are going in the direction where this is the highest width being provided and then, as we are coming towards the runway strip, it keeps on reducing. So, it defines that the aircraft has to go in this particular direction towards the runway strip.

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Now, we look at another system. This is ICAO system. It is also termed as the centre line configuration system, where only one crossbar at 300 meter from the threshold is provided and the roll guidance is provided by bars which are 4.2 meters in length which are placed at 30 meters centre to centre on the extended centreline of the runway strip. The 4.2 meter long bars consists of 5 closely spaced lights to give the effect of a continuous bar of light. That is what I was also discussing for the other system.

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Here, this is one diagram which is trying to depict the ICAO system, where this is one continuous bar of the lights being provided and this defines the end of the runway strip and after that the runway strip is being provided that is the way. Then with respect to this centreline of this runway strip number of lights are provided. We can see these lights which are 28 centreline bars, which are white in colour and they are spaced at 30 meters centre to centre.

Between this bar and this bar, centreline bars which are provided, there are terminating bars. This is the terminating bar and this is known as the pre threshold wing bar. This pre threshold wing bar is red in colour which is 4.2 meters long and this end of this bar is at a distance of 10.5 meters from the end of this bigger bar and here this threshold line bar, these are provided in a continuous form. They are green in colour. So, this shows that after this you can use the runway strip. Here, these lights which are terminating bars they are also red in colour and then, these are the bars which are the crossbars and these crossbars are white in colour.

Here, for some distance we are providing these bars along with the flashing lights and these are again the 21 flashing lights which are placed at 30 meters centre to centre

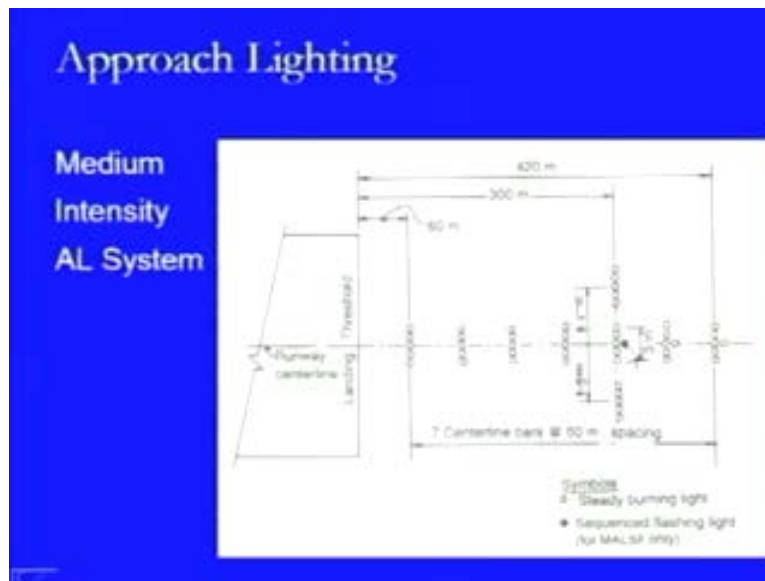
distance with respect to each other and they are bluish white in colour. So, that is the combination which is provided and still in this case also it is provided for a distance of 900 meters that is with respect to the end of the runway strip.

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Then, we look at another system which is FAA system, the federal aviation agency system. Here the groups it groups the lights in the eight standard approach lighting systems that is ALS and these are then further categorized as 3 categories. One is the medium intensity system which uses 150 watt lamps and this is termed as medium intensity ALS. This MALSR is provided with the sequenced flasher. So, that is termed as MALSF and it uses 3 flashing lights. This MALSR with runway alignment indicator lights, in this case it is termed as MALSR and this is similar to the ICAO system and it uses 8 flashing lights. So, there are different number of lights which are provided at one place depending on for what particular way the system or for what particular purpose they have been provided.

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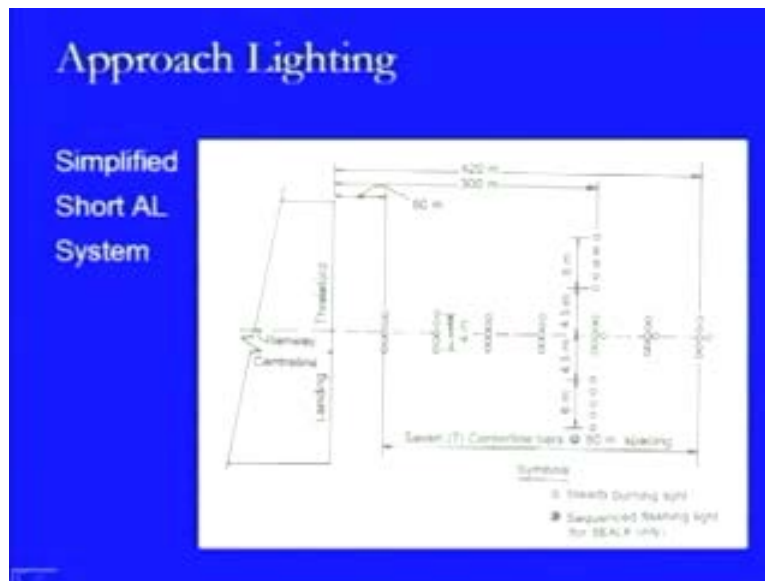
Then, here we are looking at the medium intensity AL system that is in this system we have the runway strip being provided here. So, this is the landing threshold, this is the centreline, then with respect to this centreline the lights are being provided. Here we see the number of lights being located in this form. These are 7 centreline bars at a spacing of 60 meters spacing. Then, here there is a crossbar condition which is provided, say at a distance of 300 meters from the end of the runway, **centre** runway strip and again in this case, we are locating, we are providing the sequenced flashing lights. In this case if they are provided that is for MALS condition sequenced flashing light condition, whereas if it is white one, then it is **.....** Light, so this is white being provided in the normal basic condition.

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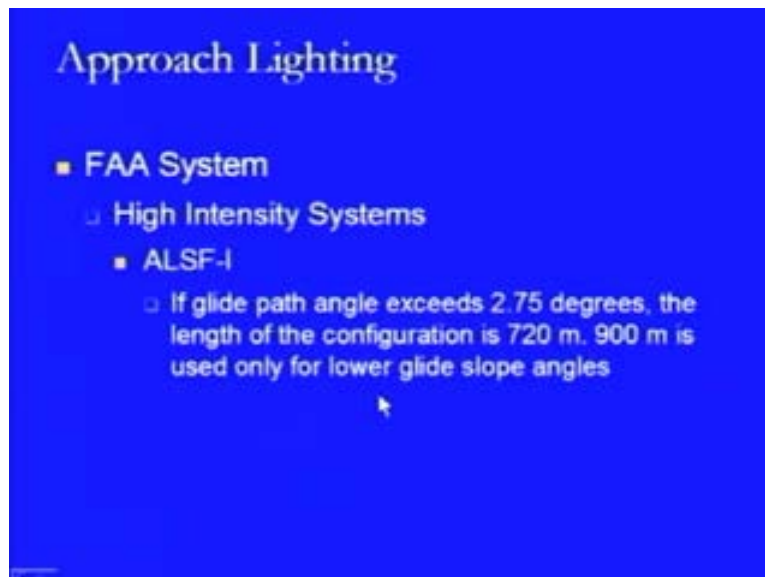
Then there is, in the FAA system there is a simplified short system where again within that simplified short system we have the system with respect to ALS like the simplified short approach lighting system termed as SSALS. Then, SSAL system with sequenced flashers that is SSALF sequenced flashers for SSAL and then, SSAL system with runway indicator lights which is termed as SSALR runway indicators. This is economy type system with 8 flashing lights. Here in the case of sequenced flasher, there are 3 sequenced flashers as being taken in the previous system also.

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Here we are going to look at this simplified short AL system and with respect to this end of the runway strip, these are located in this form and here they are the 7 centreline bars again at 60 meters interval and we are providing the steady burning lights here.

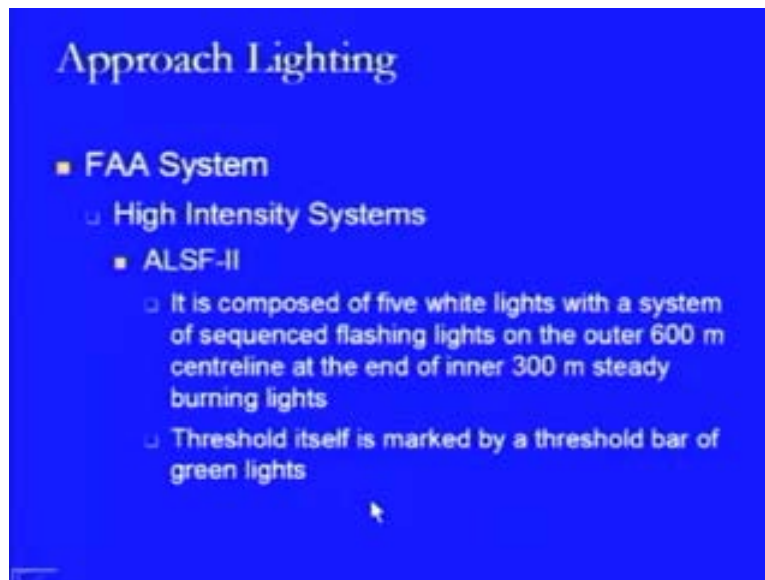
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Then, there is a high intensity system which is, within the high intensity system again we have different systems like ALSF – I. In this case, if the glide path angle exceeds 2.75

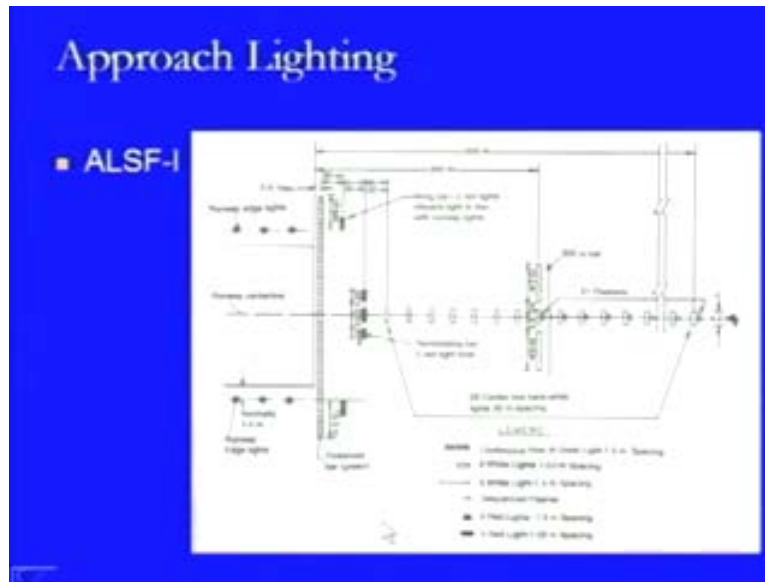
degrees, the length of the configuration is 720 meters. 900 meters is used only for lower glide slope angles. The slide path means the angle with which the aircraft is coming to the runway strip. So, if this angle exceeds 2.75 degrees, then it is 720 meters, but if it is lower, then it is 900 meters.

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Then, there is ALSF - II system which is high intensity system. In this case, this is composed of 5 white lights with a system of sequenced flashing lights on the outer 600 meters centreline, at the end of inner 300 meter steady burning lights and here, the threshold itself is marked by a threshold bar of green lights as we have seen previously in ICAO condition.

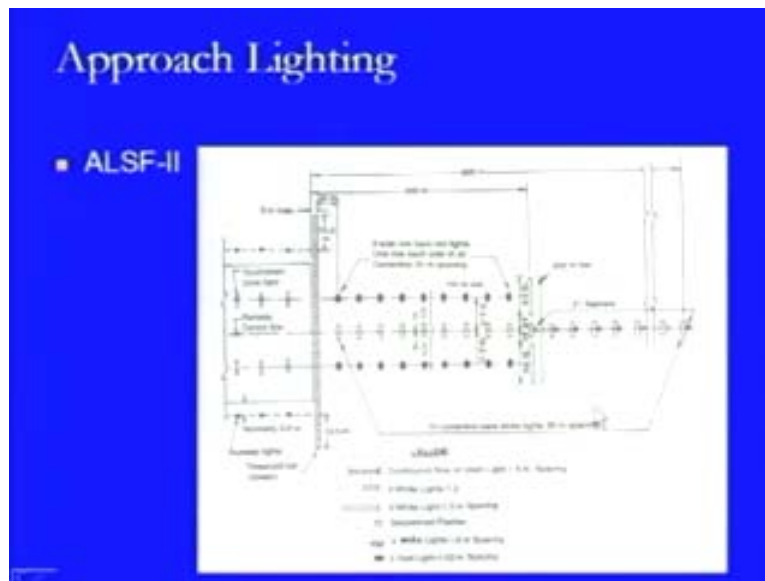
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Now, here in this diagram, this is diagram for ALSF - I condition, where this is runway strip, this is the threshold bar of green light provided with the, this is pre threshold bar and the terminating bars which are red in colour and this is the centreline profile with respect to this. Then, we have the crossbars where this is a sequence of **cross** lights being provided, so that this looks like a bigger bar in this form. So, in this case, where this bigger bar is provided there are 8 white lights provided in this case, whereas if this smaller bar is provided, then there are 5 white lights being provided for this one.

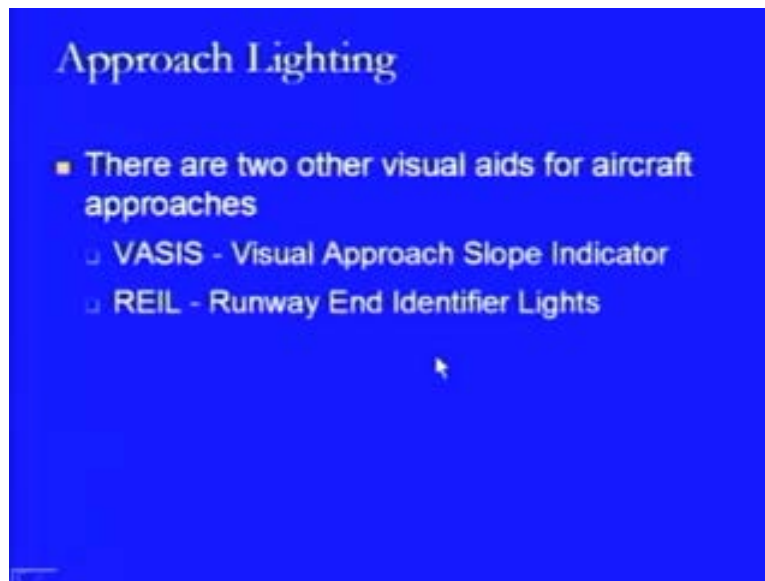
Further in this case, where we are using these terminating bars, again there are, here there are 5 lights and in this case, there are 3 lights. So, it depends on the location and the purpose with which these are being provided. These smaller bars which are being provided with some medium sized bar as we have seen with respect to the centreline, then they are the sequenced flashers being located in this form.

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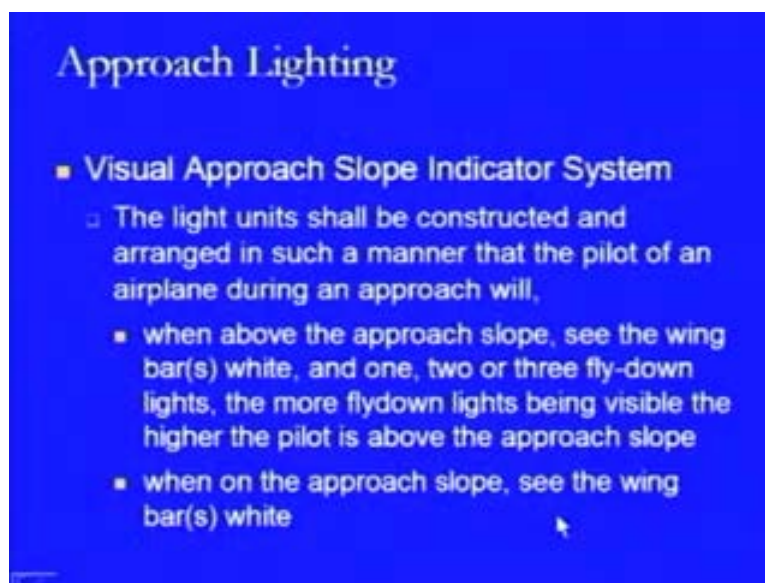
Then if you look at this ALSF - II condition, in the case of ALSF - II condition we are increasing this location as well as there is one row on this side, another row on this side being provided of red lights and here these are provided at the 30 meter spacing. So, that is the difference between this system and the other system. That is for the high intensity conditions. Here some lightings are also being shown in this diagram, where runway centreline lightings are being shown like this and then these are the touch down zone lightings. So, these are three series being shown here. These three row series being shown here instead of the markings as we have shown in the case of one type of touch down condition. So, this is the similar condition being given here by the lights.

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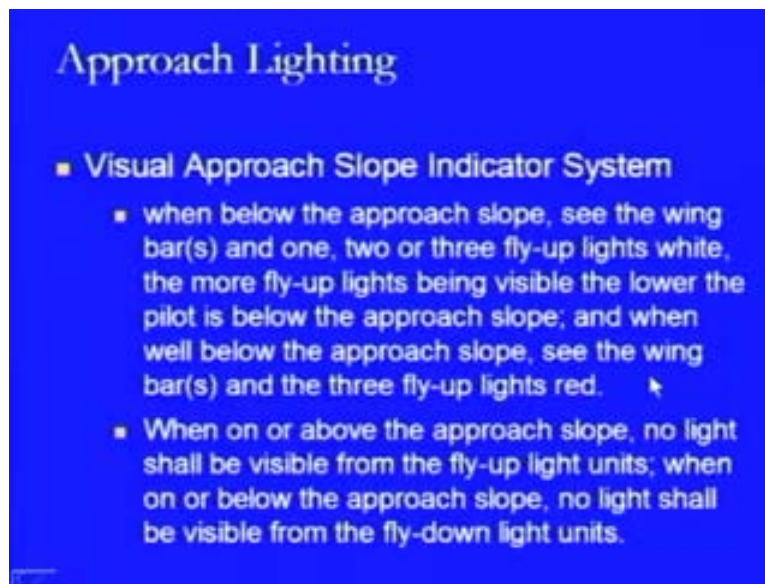
Then, there are approach lights where there are two other visual aids for aircrafts approaches like VASIS, which is termed as visual approach slope indicator and there is REIL, which is termed as runway end identifier lights. So, we will just look at on this visual approach slope indicator and REIL in the just coming discussion.

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So, the visual approach slope indicator system is basically, this is the light units which are constructed and arranged in such a manner that the pilot of an airplane during an approach will perform certain things like, when above the approach slope that pilot can see the wing bars white and one, two or three fly down lights and the more fly down lights being visible, the higher the pilot is above the approach surface. So, it means if the pilot can see more of the lights it means, here he is not going with respect to the approach slope and is much higher with respect to that approach slope or when on the approach slope he can see the wing bars white, that is the another condition.

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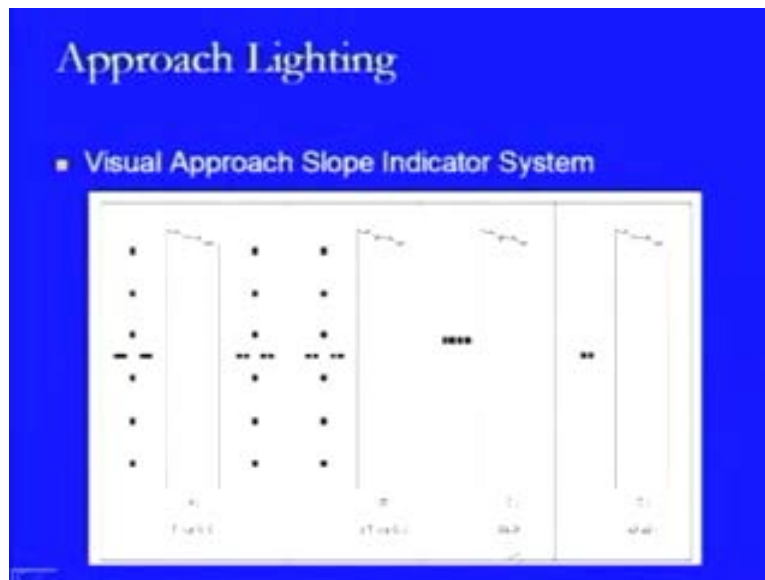
Approach Lighting

- **Visual Approach Slope Indicator System**
 - when below the approach slope, see the wing bar(s) and one, two or three fly-up lights white, the more fly-up lights being visible the lower the pilot is below the approach slope; and when well below the approach slope, see the wing bar(s) and the three fly-up lights red. ➤
 - When on or above the approach slope, no light shall be visible from the fly-up light units; when on or below the approach slope, no light shall be visible from the fly-down light units.

Similarly, there is condition when below the approach slope he can see the wing bars and one, two or three fly up lights white and the more fly up lights being visible, the lower the pilot is below the approach slope. In case the pilot is going above the approach slope or in case he is going below the approach slope, he will be able to see more of the fly up lights and that defines that he is not following the approach and when well below the approach slope, he sees the wing bar and the three fly up lights red. So, this defines that they are going down and therefore it is a hazardous condition, should go up.

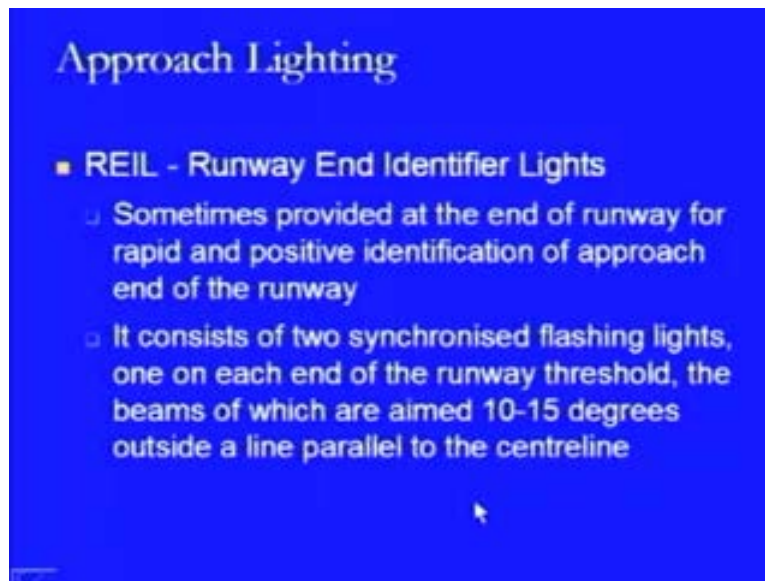
When on or above the approach slope, then no lights shall be visible from the fly up light units; this is important. If the pilot is coming with respect to the approach slope only, then he will not be able to see any of the lights which otherwise are visible to him when they are going above or below the approach slope. That is the importance of provision of this type of lighting system and when on or below the approach slope no lights shall be visible from the fly down light units. So, this is the thing which needs to be maintained.

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Here, different types of system have been shown. This is the T VASI, this is T VASI, this is PAPI, this is a PAPI system and this is how the lights are being shown with respect to the approach. This is at the crossbars and this is the runway strip. So, this way we can see.

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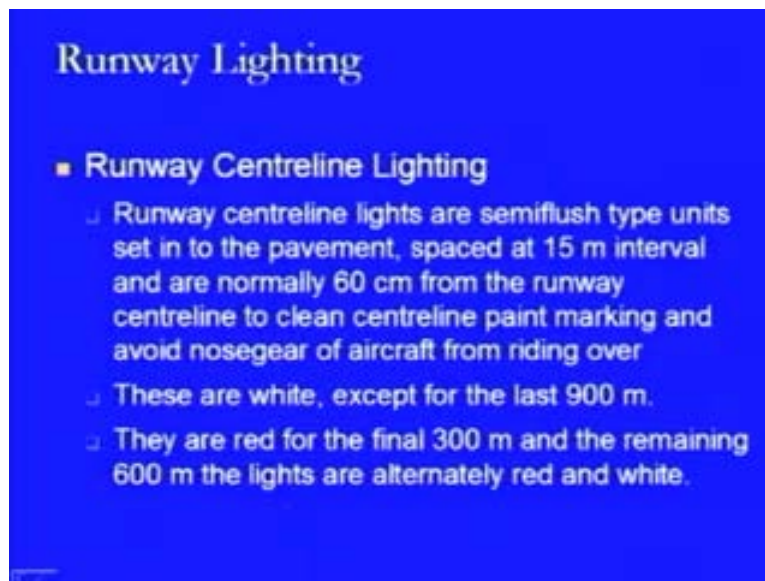
Then, another system as we have seen is the runway end identifier light system that is also termed as REIL. Here, sometimes they are provided at the end of the runway for rapid and positive identification of approach end of the runway strip. So, that is the reason they are generally provided and it consists of two synchronized flashing lights one on each end of the runway threshold and the beams of which are aimed at 10 to 15 degrees outside a line parallel to the centreline.

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Now, we look at the other runway lightings, like here we are starting with the runway lightings. Runway lightings are again in the same form as we have seen the markings. We have the runway centreline lighting, we have the touch down zone lighting, then runway edge lighting, runway threshold lighting.

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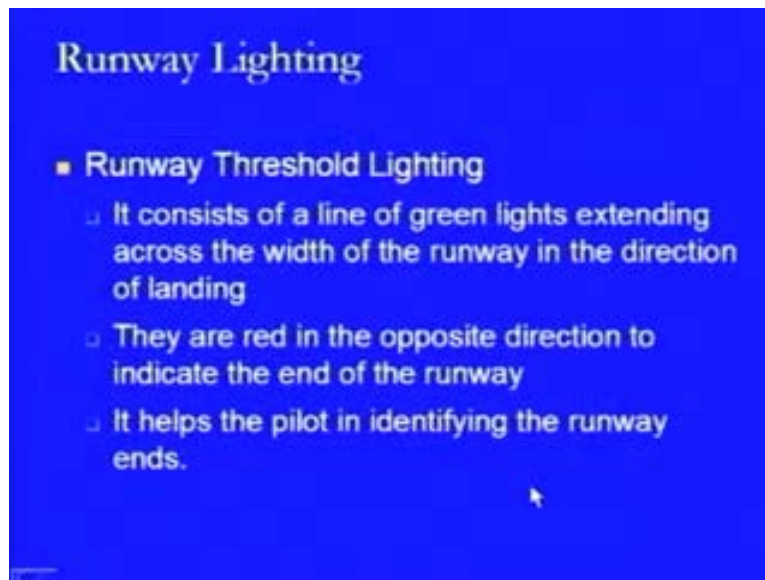


We will be starting with the runway centreline lighting. In the case of this runway centreline lighting, these are semiflush type means with the pavement surface they are flushing with the pavement surface and they are spaced at 15 meter interval and are normally 60 centimeters from the runway centreline, so as to clean the centreline paint marking and avoid nose gear of aircraft from riding over. That is the way they are provided. With respect to the centreline, they are provided at a distance of 60 centimeters.

The reason is that it makes it clear that where the centreline is and whatever the paint markings are provided they are not getting distorted. Second thing is the pilot tries to move along the centreline and therefore, the nose gear will be on the centreline and if these lights are provided along the centreline because they are semi flush condition, then the nose gear will ride over these lights and the lights will get damaged. At the same time,

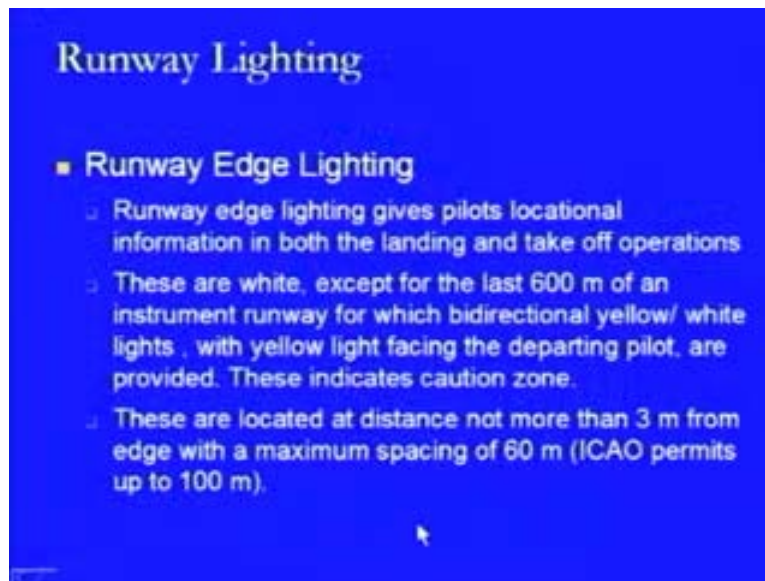
there may be some damage to the nose gear. These are white except for the last 900 meters. They are red for the final 300 meters and the remaining 600 meters, the lights are alternatively red and white. So, this is how the various distances will be understandable to the pilot based on the various colours along the runway centreline.

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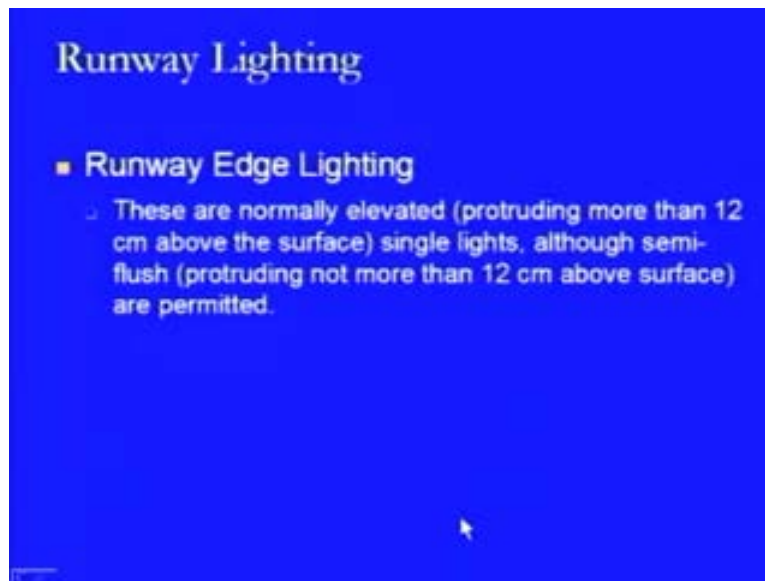
Then, in the case of runway threshold lighting, it consists of a line of green lights which extends across the width of the runway in the direction of landing and they are red in opposite direction to indicate the end of the runway. So, that is where the lights are provided. When you are looking towards from the landing direction then it is green, but if you are looking from the take-off direction, then it is red in colour. It helps the pilot in identifying the runway ends.

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Then, we have another lighting for edges and in this case, the runway edge lighting, it provides the locational information at both the operations that is the landing operation as well as during the take-off operation. These are white in colour except again for the last 600 meters of an instrument runway for which the bidirectional yellow or white lights are provided with yellow light facing the departing pilot are provided. So, again here in this case, if you are looking on these lights at the edge, then the white lights will be seen from the outer side towards the, whereas if we are talking about the departing pilot, then he will see the yellow lights which are facing to him and these indicates the caution zone that is for the safety reasons. These are located at distance not more than 3 meters from the edge with a maximum spacing of 60 meters, whereas in the case of ICAO, it permits up to 100 meters.

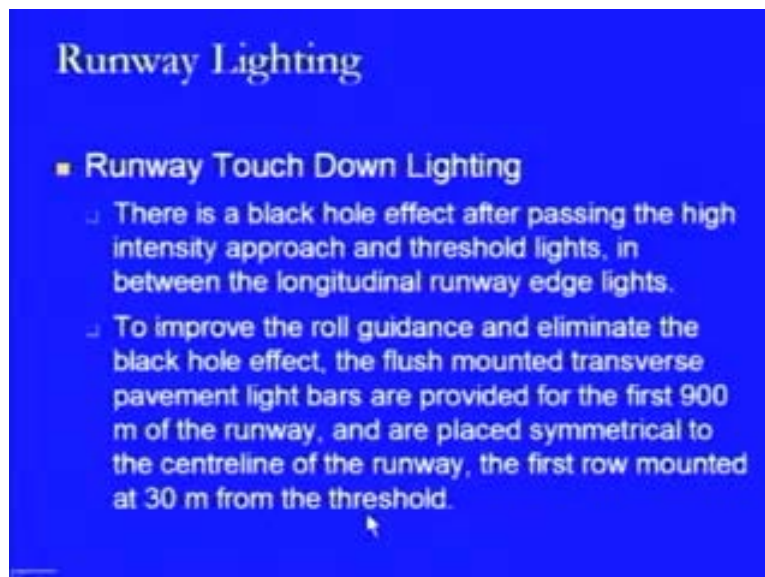
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These are normally elevated. They are protruding more than 12 centimeters above the surface, not semiflush type. They are just above surface and they are single lights. All those semiflush type lights are also permitted which protrude not more than 12 centimeter above the surface.

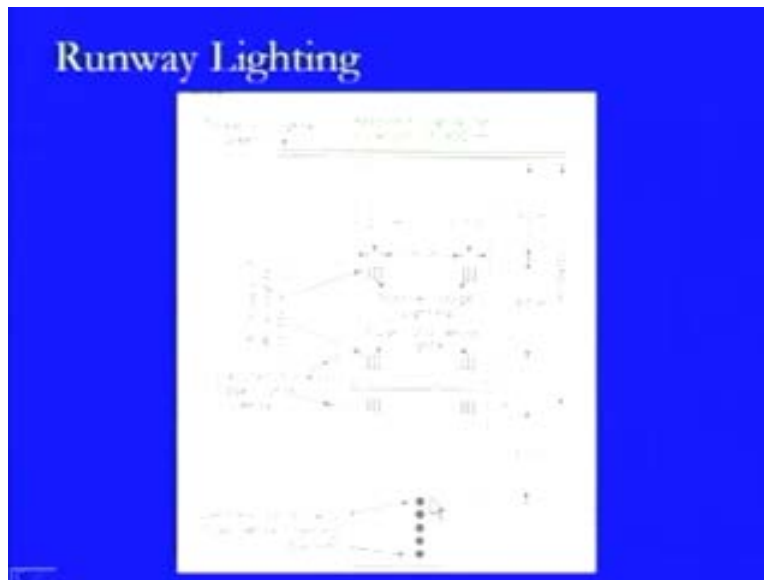
Then, there is another category that is touch down lighting.

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In this case, there is a black hole effect after passing the high intensity approach and threshold lights and in between the longitudinal runway edge lights. So, as soon as we are crossing the threshold and threshold is a green colour, then there will be a black hole condition which will be getting created, because of the high intensity and just to improve the role guidance, so that the pilot is understanding what way they are going down and to eliminate this black hole effect which gets created after the high intensity lights, the flush mounted transverse pavement light bars are provided for the first 900 meters on the runway and these are placed symmetrical to the centreline of the runway as we have discussed about the threshold markings and the first row mounted at 30 meter from the threshold.

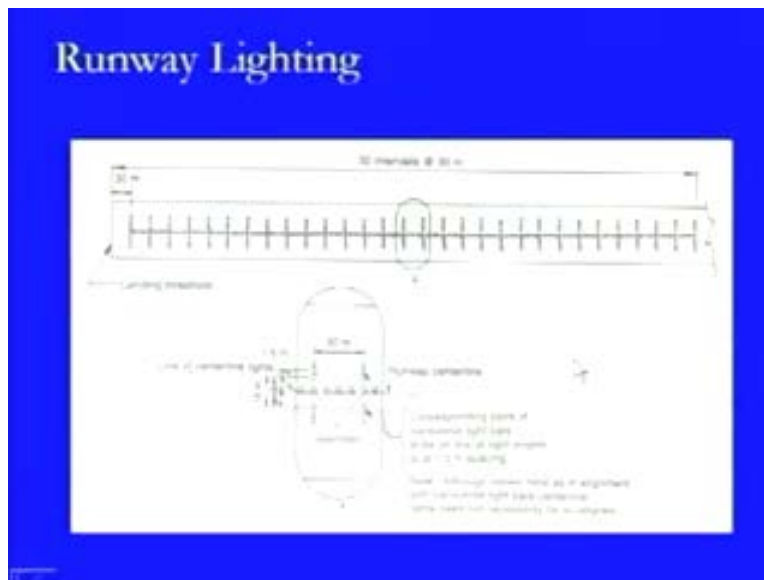
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This is the threshold light which is green in colour and these are the approach lights which are provided on this side, which are high intensity lights and you are coming for a length of 900 meters all these lights are provided. So, when you are coming on this runway strip, then we have these narrow, here this is the narrow gauge lighting system being provided, where in each of this system there are 18 groups of white lights which are located at 60 meter centre to centre distance and these are provided symmetrical in both

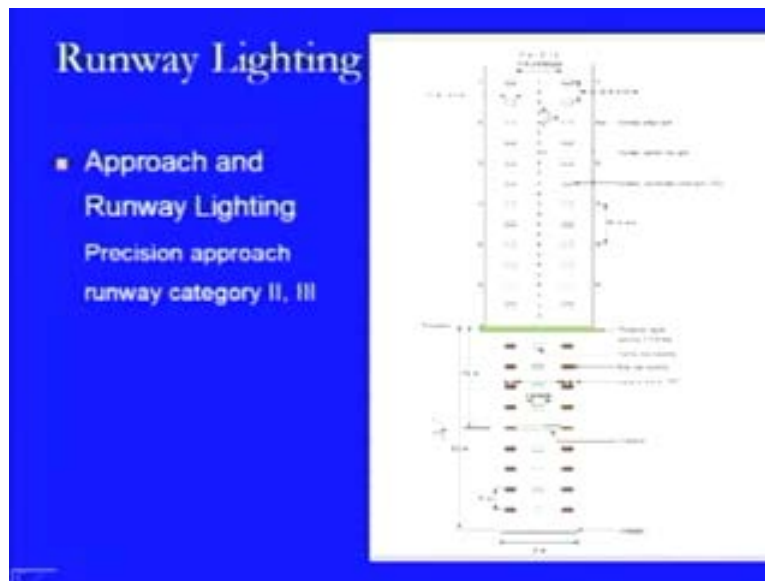
the sides with respect to the centreline. Here, we can see the centreline runway flush white lighting system which looks like this way and here we are also having the edge light systems which are elevated lights, which define the end of the runway in the transverse direction and these lights are provided, here this type of elevated lights which are white in colour they are provided for a distance of 1080 meters from the end of the runway.

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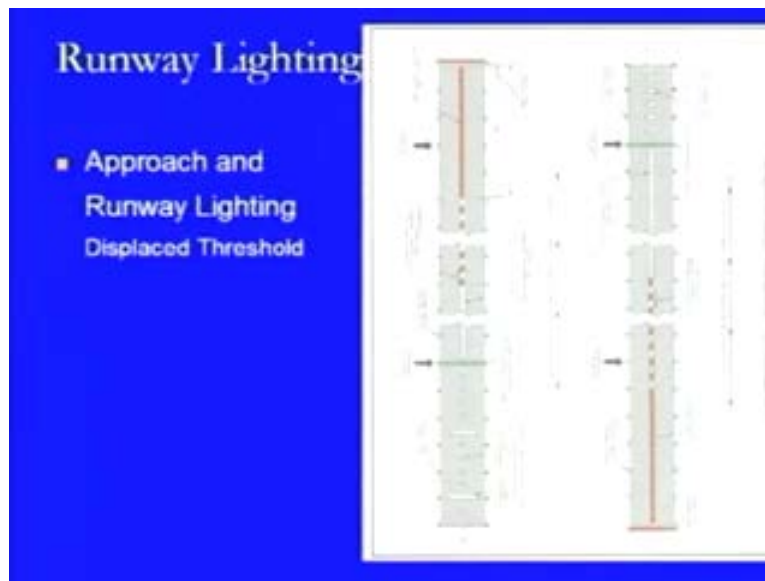
This is another runway lighting system being shown here. We can see that this is a landing threshold point and then, this is going in this form. These are the centreline lights and then, these are the transverse lights being shown here and they are trying to define the way we are moving on this runway strip, so as to have a touch down condition and for this one, this is a **broad** view of how it looks like. Here, we have three lights being provided on this side and this side with a spacing of 1.5 meter. These are the centreline runway lightings and then, these lights are provided at a distance of 18 meters from centre to centre.

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Then, we look at the approach and runway lighting for the precision approach runway category, which category II and category III. Here, this is a green colour lighting system. Then, we have the **red** high intensity lighting system with the central white lighting system. Then, there is a crossbar light being provided here. Then, after this, there is a centreline lighting system being provided at 15 meters centre to centre distance and then, these are the runway touch down zone lighting system. So, this is for two types of the categories, has been listed here.

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We look at now another approach and runway lighting system, especially for displaced threshold condition. Here, we can see that this is the threshold being displaced here in this form. This is another diagram which is trying to depict the same thing or different ways by which it can be done, the type of the lighting systems being used here on this side.

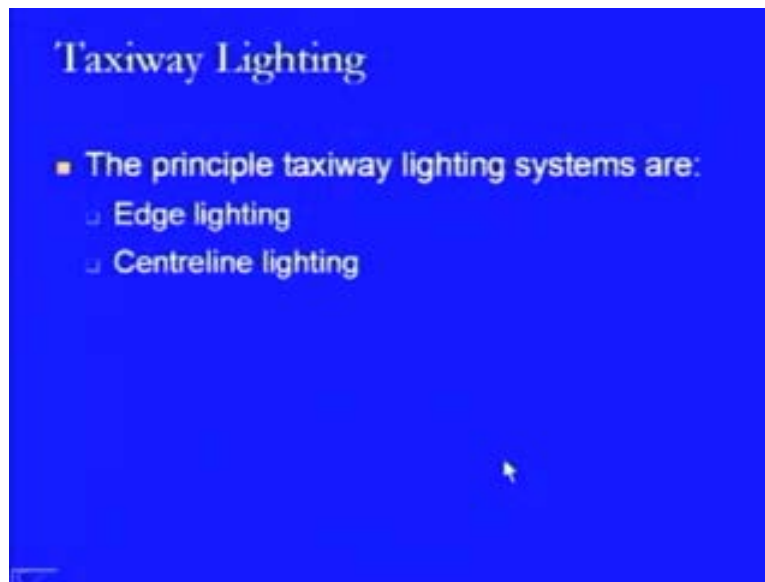
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Taxiway Lighting

- Taxiway Lighting
 - The following design criteria apply to taxiway lighting:
 - Elimination of all possibilities of confusion
 - Identification and location of exit taxiway, well ahead of point of turnoff
 - Adequate guidance along the taxiway

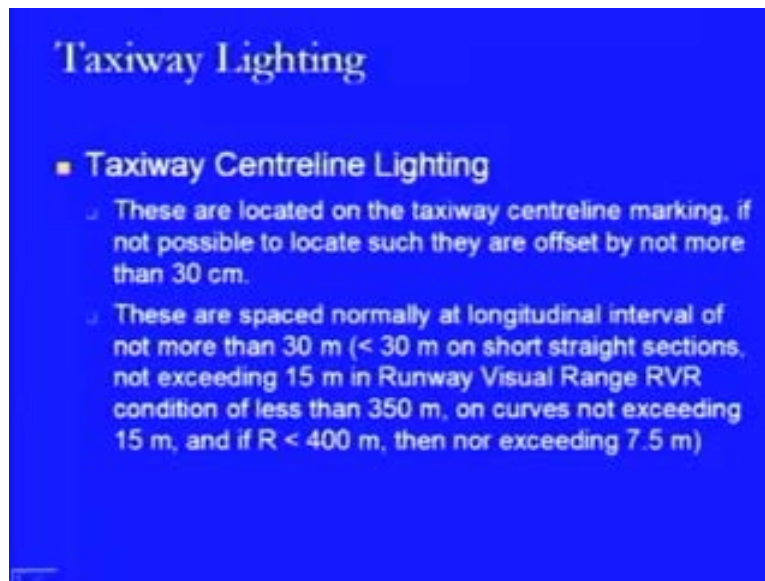
Now, we look at the taxiway lighting systems. In this case we have various types of lighting systems and we will be looking at again on those types, but the design criteria which is applied to the taxiway lighting is that there should be an elimination of all possibilities of confusions and then, identification and location of exit taxiway well ahead of point of turnoff should be possible. That is another important thing that is important for the landing aircrafts. Adequate guidance along the taxiway should be provided, so that the aircraft can be moved in the direction towards the terminal apron.

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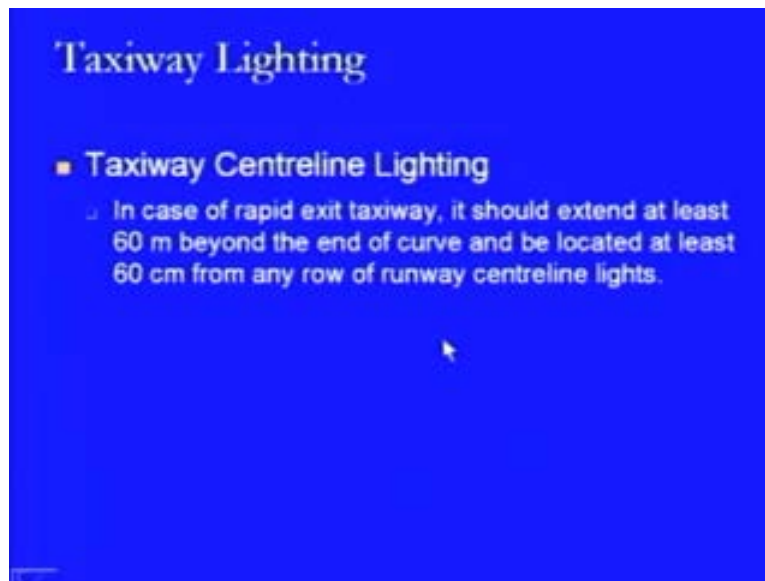
Then, the principle taxiway lighting systems are the edge lightings, the centreline lighting.

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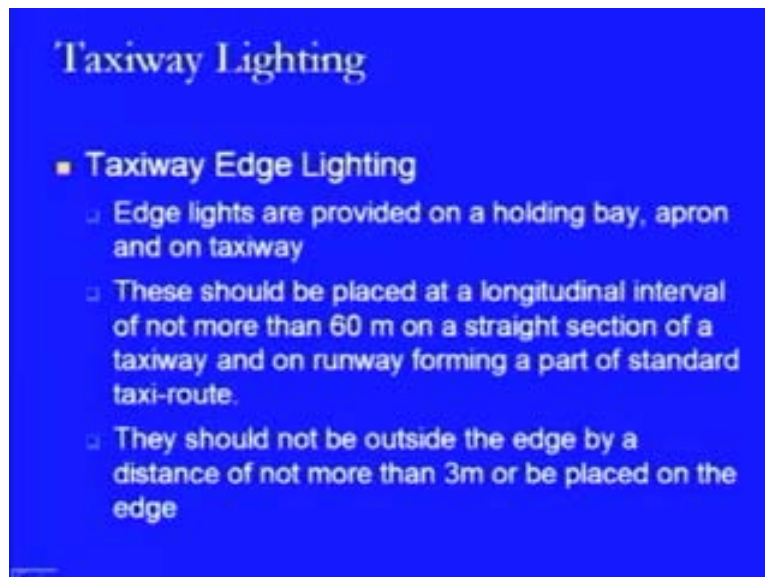
We look at the taxiway centreline lighting first and these lightings are located on the taxiway centreline marking and if not possible to locate such, then they are offset by not more than 30 centimeters. That is the way they are located with respect to this centreline of the taxiway. These are spaced normally at longitudinal interval of not more than 30 meters and it is less than 30 meters on short straight sections not exceeding 15 meters in runway visual range that is RVR condition of less than 350 meters on curves not exceeding 15 meters and if the radius is less than 400 meters, then not exceeding 7.5 meters.

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The taxiway centreline lighting in case of rapid and exit taxiway should extend at least 60 meters beyond the end of curve and be located at least 60 centimeter from any row of runway centreline lights.

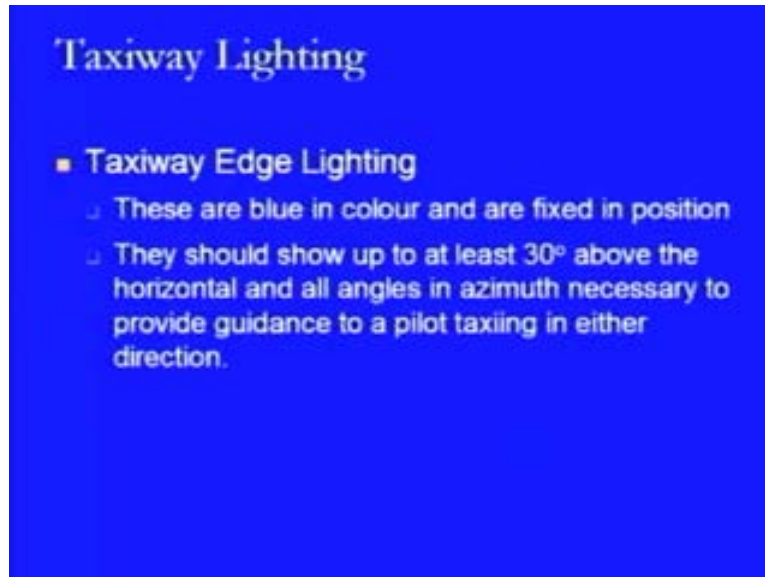
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Then, we have the taxiway edge lighting. In this case, these are provided on a holding bay, apron and on the taxiway, these should be placed at a longitudinal interval of not

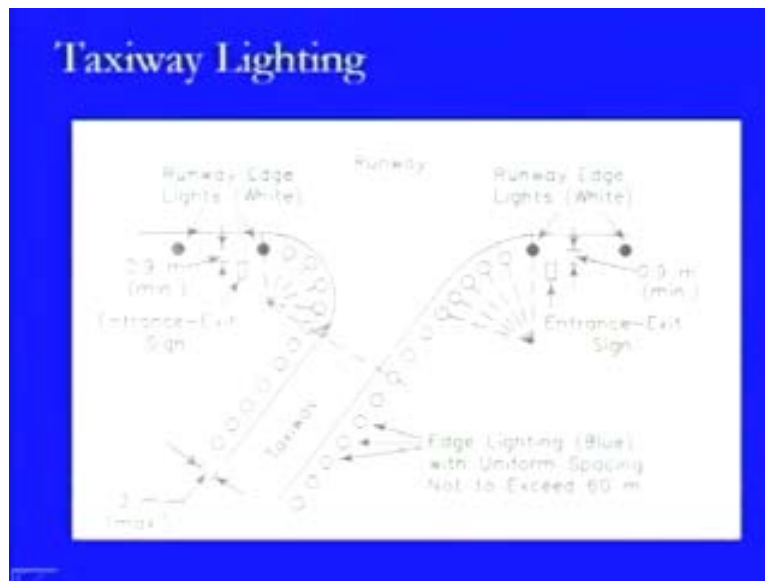
more than 60 meters on a straight section of a taxiway and on the runway forming a part of the standard taxi-route. They should not be outside the edge by a distance of not more than 3 meters or be placed on the edge.

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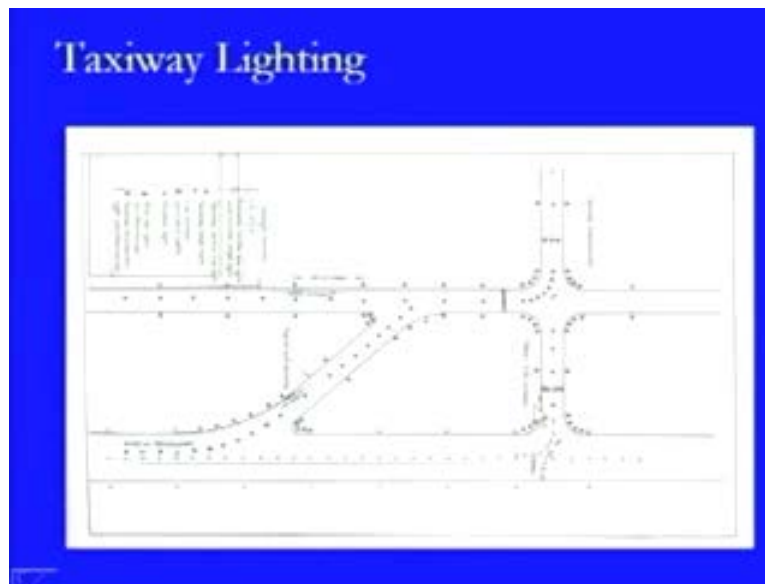
These are blue in colour and they are fixed in position. They should show up to at least 30 degrees above the horizontal and at angles in azimuth necessary to provide guidance to the pilot taxiing in either direction. So, whatever way the pilot is moving, whether it is coming from the runway to the apron or from apron to the runway, in both the direction it should be visible and it should be visible up to a height of 30 degrees angle, atleast to that particular value.

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This is one figure, which tries to show the various lightings on the edges of the taxiway. This is the taxiway, this is the runway strip. So, this taxiway is provided with the edge strip. These are edge lightings which are blue in colour and they are provided at a uniform spacing which should not exceed 60 meters and then, as these reaches the connectivity with the runway strip, then they are provided at closer spacing and then, it transforms into the runway edge light which is white in colour. So, that is how a pilot can distinguish from the edge lighting conditions that they are ending towards the taxi, from the taxiway towards the runway strip and there is another set up of lights which is provided, which defines the entrance or the exit signage, which is located at this particular location.

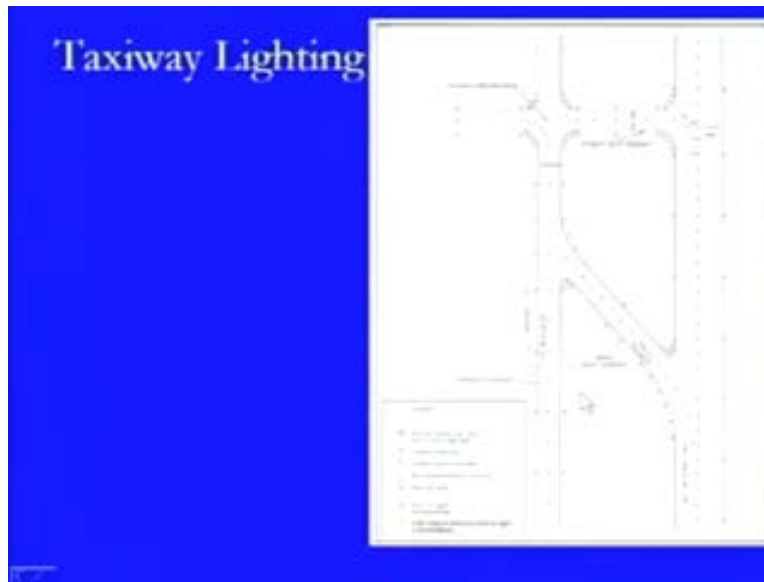
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This is another diagram, which shows the various lightings being provided. Here we are providing, this is a runway strip, this is a parallel taxiway, this is the rapid exit taxiway and this is the perpendicular taxiway line being provided. So, in this case, what we can see is that as we have discussed with respect to the marking that the markings of the rapid taxiway or the perpendicular exit taxiway, they move along the centreline of the runway strip. Then, it moves for certain distance that is 60 meters. So, that is the same thing being shown here that these markings of the centreline of this exit taxiway, it is going for a distance of 60 meters.

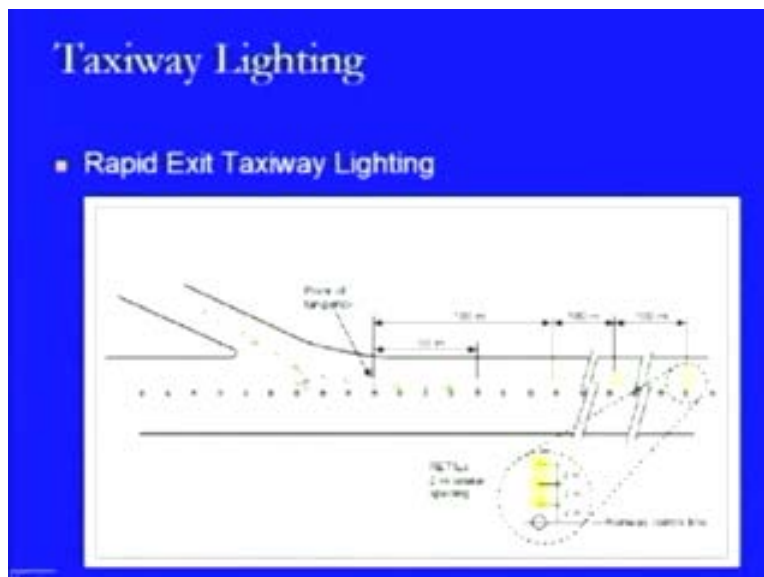
So, this is the rapid exit taxiway and here at this location as well as at this location, so as to define the turning condition, these lights are being provided. Similar is the condition here; we have the lights being provided at this location too. So, we have the edge lights being provided in this form or we have the centreline lights which are bigger than these edge lights has been provided and then, there will be stopping lights being located, like here we have this condition being provided with the interchange, where there is cross over from one taxiway to another taxiway. So, we have these holding lights being located at this location, so that when we are reaching to this direction we have these lights conditions. So, likewise there are different types of lights needs to be provided.

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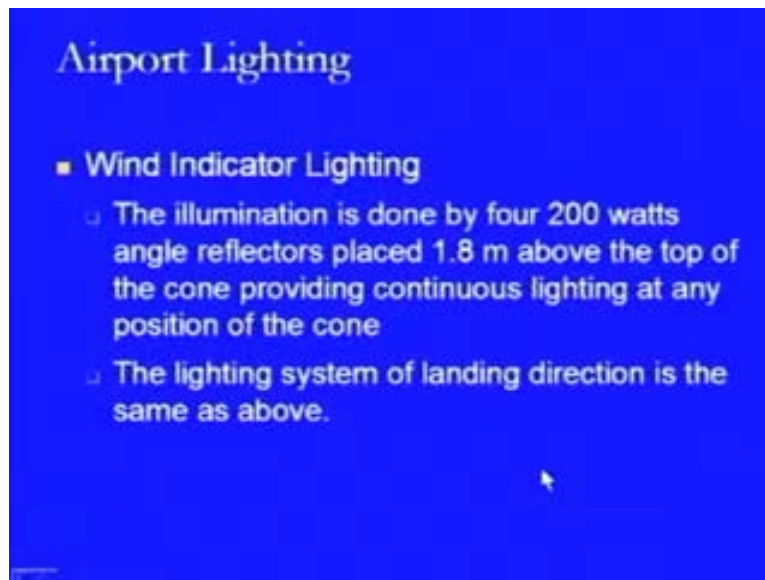
Then, this is another set, where the colours have been shown. These are the blue colour being shown like this. This is again blue colour, these are white in colour. So, they show that they are on the runway and here this is for holding lines, so they are red in colour. So, we have another, then these are green in colour on the intersection of one taxiway with another taxiway and these are green in colour, so as to show the centreline of the taxiway. So, these are different type of the lights which are provided.

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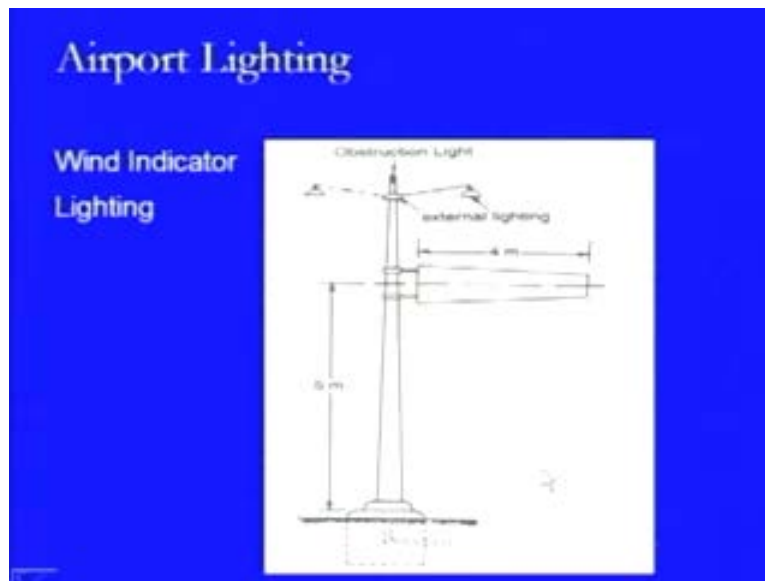
This is a bigger diagram of rapid exit taxiway lighting system, where we can see the way the lights are being provided. They are green from this direction and they are yellow from this direction. That is how they look like and they are coming for up to a certain distance of 60 meters from the point of tangency.

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Then, on the airport there is another lighting system, which is wind indicator lighting system. This is in the form of an illumination which is done by four 200 watts angle reflectors, which are placed 1.8 meter above the top of the wind indicator cone, providing continuous lighting at any position of the cone. Whatever is the direction in which that cone moves because of the direction of the wind, this lighting will remain available for all those directions. The lighting system of landing direction is the same as we have discussed previously.

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Here, we are going to look at the wind direction indicator. This is the pole on which the wind direction indicator has been provided. This is the cone of the wind direction indicator and this is provided at a height of 5 meter above the ground and then, above that we are providing the lights and these are the external lights which illuminate this indicator.

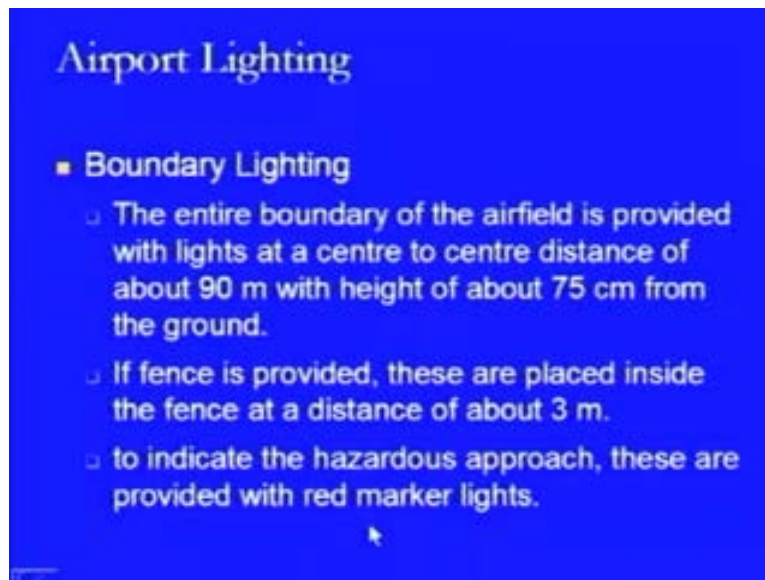
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Airport Lighting

- **Apron and hanger Lighting**
 - These are flood lit for the convenience in servicing and loading.
 - These are placed such that they do not cause glare in the eyes of the pilots, passengers and service personnel.
 - The flood lights should be placed at a height not less than 12 m above the pavement.

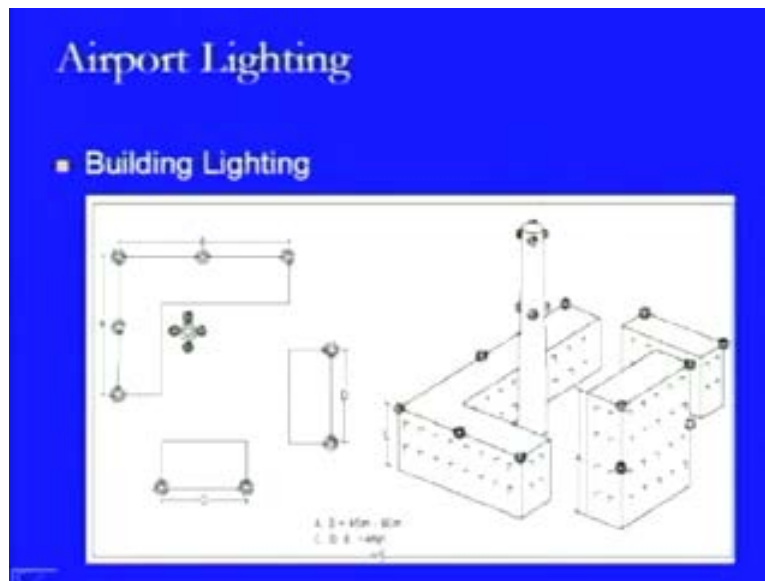
Then, there is another light, which is apron and hanger lighting system. In this case, these are flood lit for the convenience in servicing and loading being done either on the apron or in the hanger area. These are placed such that they do not cause any glare in the eyes of the pilots or in the eyes of the passengers who are moving on the apron or in the eyes of the servicing personnel who may be working on the apron or in the hanger. The flood lights should be placed at a height not less than 12 meter above the pavement.

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Then, another type of lighting is for boundary and this boundary lighting is provided for the entire boundary of the airfield using the lights at a centre to centre distance of about 90 meters with the height of about 75 centimeters from the ground. If fencing is provided for the airport, then these are placed inside the fence at a distance of about 3 meters and this indicates the hazardous approach and these are provided with red marker lights.

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This is one typical figure, which tries to define how the lights are located in the case of a building. What we can see is this is the plan of that building. So, here say this is for this one and then, **this depends this particular**, so the plan of this one and the plan of the other one is defined here. So, in this case, here if this is A is or this B is 45 meters to 90 meters, then we are having 3 lights being located this way, whereas if it is less than 45 meters, then we can have 2 lights at the ends of that, those edges. So, that is the way the lights are provided. Similarly, in the case of spherical towers being located like the control towers or the other towers, then in that case the lights needs to be located at different heights and as well as in all the directions.

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This is one typical big view of an airport lighting system, where we can see that there is an airport beacon provided near the terminal building. Then, we have the **ramps** or the taxiways being provided. When we are coming from this side, the taxiways are provided with bluish lights and the centre with the green lights and these are the white lights being provided and during the night time, this runway strip other apart from these lights will look like black in colour and we have these runway numbers which have some colour and they may be visible. Here, we can see the green threshold lights being located and then, we have other systems being provided like this is VASI, visual approach slope indicator.

This is how, this is a combination of red or white colour and this goes, this tells that this is way the landing is to be done. So, this is provided on both the sides. At the same time, here this is another location for wind direction indicator being provided. So, we have at the top the lights located like this.

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This is another photograph, where we can see the different lighting systems and this defines the lights which will be visible, at a time when there is landing going on. We can see that there are lights which are at some height from the ground level, as we can see this way and as we are going towards this side they become more of a flush type and then, towards the edge again there are some lights which are at a higher level and then, these are all flush lights. So, these are the centreline lights. Then, these are the edge lights on this side and on this side and this then we have the series of lights which defines the landing, the direction.

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Whereas, if we look at the same one from the take-off side, then it will look like this way and from this side, this is the end of the runway strip which is looking like green in colour, but from the aircraft side it will be red in colour. So, this difference between the two lighting systems we can easily see that this difference can define that which one is the landing side and which one is the take-off side.

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Now, we come to the signages. In the case of airport signages, they are the mandatory instruction signs, like these type of the signs we can see on any of the airport. If they are being shown in this form, that it defines this is the particular location which is being defined in the form of A or B likewise, whereas when it is being given in this way, then it defines that on the left hand side there is something. So, this is the location as well as the runway designation. So, location for B and the runway designation means which runway is being provided on this side. This is for right hand side and condition, runway designation and then location on the right hand side.

When there is only runway holding position then this is defined by some numbers like this particular type of signage, whereas if we are looking for this runway designation, then this is defined by this 25 and there is a category II holding position. So, category II will be written in that space. This sign shows no entry condition.

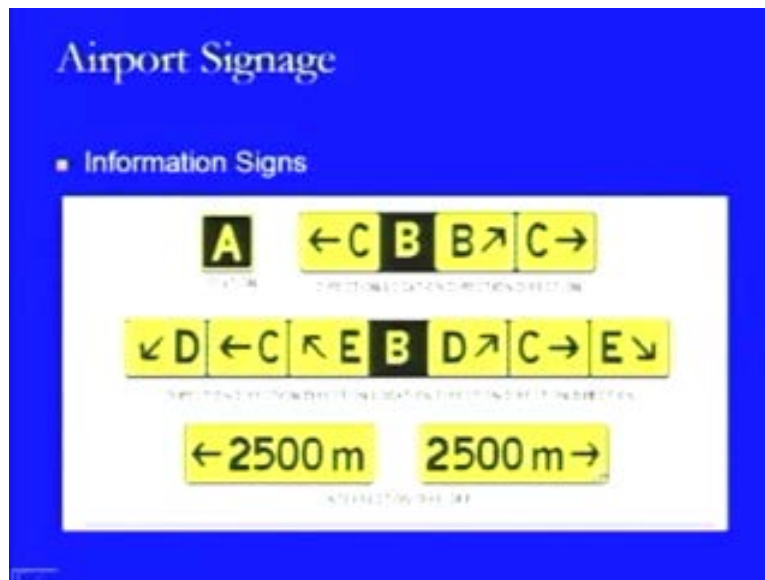
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Then, there are certain information signs which are used on the airport, like if this is the type of the sign, it says is that at the centre being shown with the black background this is the location at this point, whereas on the left hand side this is C or the right hand side this is another direction like for location C. Here, it is a combination of only one location and

one direction. Then, this is for the destination that the apron is towards this side. Here, it is showing the location. This remains the location and it shows that there is a vacated runway or similarly this maybe the other way round. The runway exits they are being defined in this form that there is a runway exit on this side or there is going to the runway exit at an angle, rapid runway exit or the perpendicular runway exit; similarly for the right hand side.

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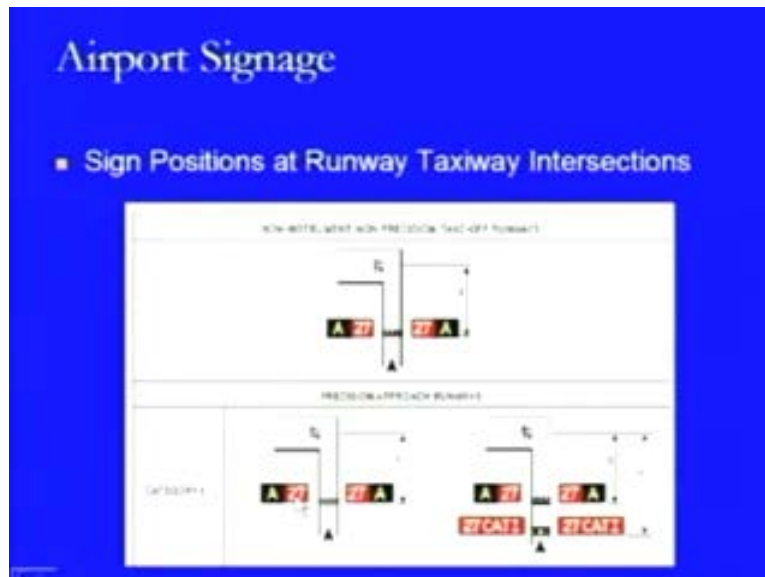
Then, we have other type of signs. They are again for information signs, like if you are simply only talking about a single one location, then that single one location will be defined by this type of sign, where this is, as we have seen previously too, it is the black background with the white writing condition. We can have different combinations of the signs also, different combinations of the things like the directions or the locations.

Here, what we are looking is that this is again a location. Then, there are different types of directions. There are directions towards the left or direction towards the right or there are directions which are going at an angled location, at angled position with respect to the location at which this information sign is being provided. In case there are different large number of connectivities which are going away from that particular location, then what

we can find out is that there may be a combination of a direction sign coming towards the backward side or the direction sign going towards the left hand side or the direction sign which is going in the front side, but an angled condition. Then, the location at which this is being placed and the location of that place and then, further again the same sort of a condition on the right hand side.

Here, these informations, they are being provided to the pilot and they define the intersection take-off condition. So, this is intersection of the take-off condition at 2500 meters on this side or 2500 meters on the other side.

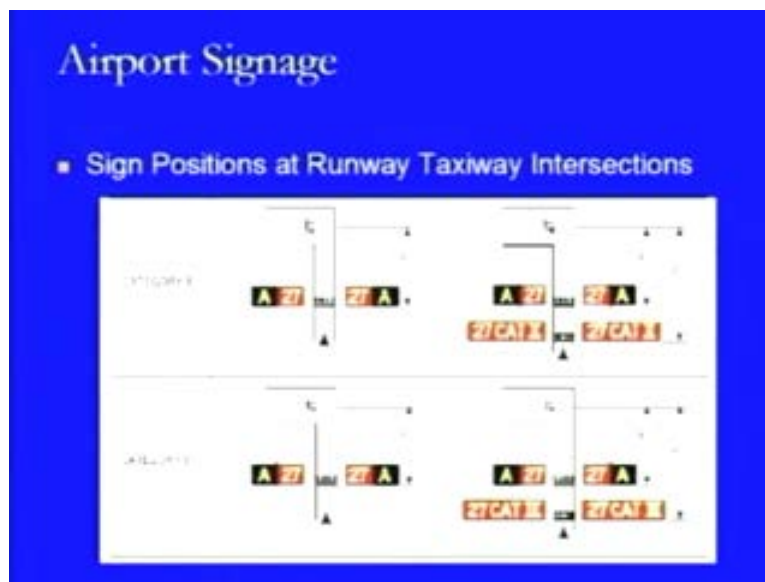
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Then, here we are looking at sign positions at the runway or the taxiway intersections. This is for non-instrument, non-precision take-off runway condition. In this case, this is a runway and this is a taxiway. The signs will be shown, will be given in this form at a distance of X. Here, these are the holding line. So, this is A with 27, which defines that we are reaching a runway strip which is defined by the number 27 and 27 number as we have discussed previously, defines the direction in which this movement will be going that is at an angle of 270 degree with respect to North Azimuth or one may be provided on this side, like this way, which says that you coming from 27 and moving towards A.

This is a category I condition for precision approach runway, where this is a similar condition, has been defined here, but the distance changes in this case. There can be another way of defining the same thing. In this case, the category is also being defined that this 27 runway strip, number runway strip is being controlled by category I precision approach and in this case, we will be having two distances with respect to the centreline of the runway strip. One distance will be for the location and the position of the runway number and another will be for the category of that one that is X and Y.

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So, in this diagram, the category II precision approach and the category III precision approach has been shown. The main difference remains in the distances being defined by X and Y in all the three cases.

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Airport Signage	
Inscription/symbol	Use
Runway designation of holding a runway extremity extremity	To indicate a runway-position at a runway OR
Runway designation of holding both extremities of a runway intersections	To indicate a runway-position located at other taxiway/runway or runway/ runway intersections
25 CAT I (Example) of runway 25	To indicate a category I runway- holding position at

Here we have the various symbols and their uses like in the case of runway designation of holding a runway extremity. Then in this case, to indicate the runway position or a runway extremity or there is a runway designation of holding both extremities of a runway intersections, then it is done to use, to indicate a runway position which is located at other taxiway or runway or runway or runway intersections, means it may be either runway taxiway intersection or a runway-runway intersection, then we use this type of designation of holding.

One example of this one is like 25 category I, which says that we are talking about the runway strip which is defined by the number 25 and it is controlled by category I approach and it indicates that category I runway holding position, category I of runway 25, runway holding position at the threshold.

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Airport Signage	
Inscription/symbol	Use
25 CAT II (Example) of runway 25	To indicate a category II runway- holding position at the threshold
25 CAT III (Example) of runway 25	To indicate a category III runway-holding position at the threshold
25 CAT II/III (Example) position 25	To indicate a joint category II/III runway-holding at the threshold of runway

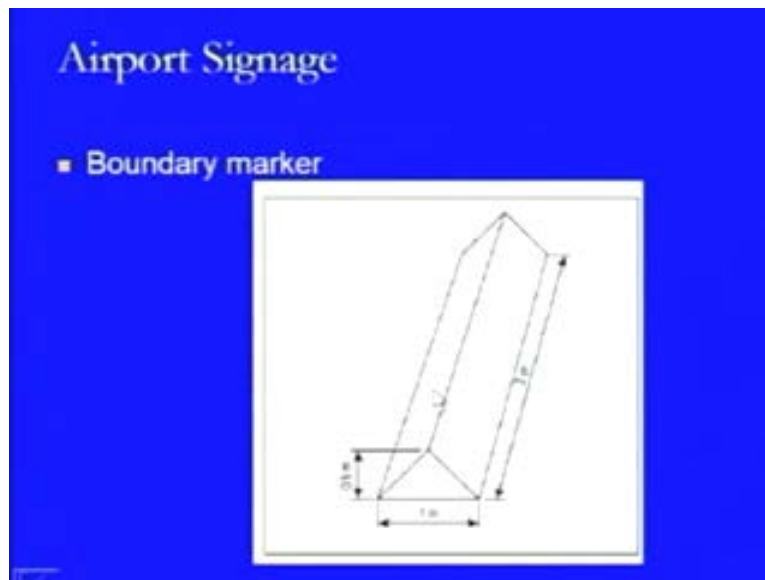
Further, we have another example like this is 25 category II. So, this indicates a category II of runway 25, runway holding a position at the threshold. Then, 25 category III similarly defines another way and there is another 25 category II oblique III position, which defines to indicate the joint category of II or III runway holding position at the threshold of the runway.

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Airport Signage	
Inscription/symbol	Use
NO ENTRY symbol	To indicate that entry to an area is prohibited
B2 (Example) holding	To indicate a runway-position established in accordance

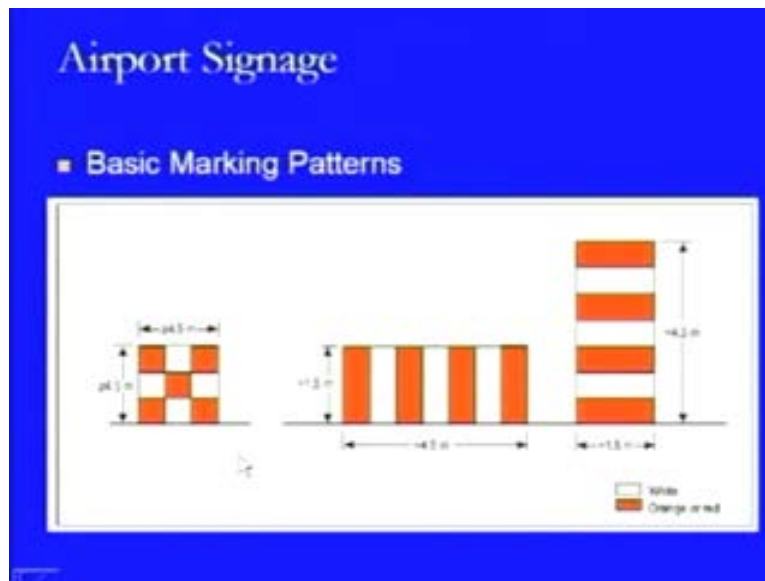
Then, there is a no entry symbol as we have seen that this indicates that the entry to the area is prohibited. There is another example of like B2 holding condition which indicates that the runway position established in accordance.

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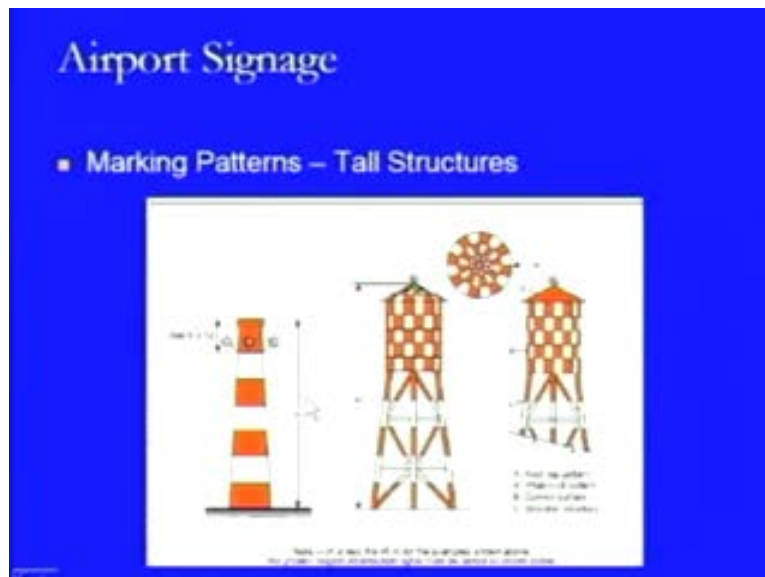
Then, there is another sign which is related to the boundary and this sign is in the form of this way and it is a sort of a condition and where it has a base of 1 meter by 3 meter and the height is around 0.5 meters.

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Then, these are the basic marking patterns which are used at the fences or at the walls. They are the alternate white or orange patterns generally being used or it may be used in the form of the squared checkered condition.

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Then, in the case of tall structures we have the marking patterns as being shown here. This is a tall chimney sort of a structure, where again there will be alternate band of the

two colours that is orange and the white with the lights being provided at the top, as we can see here. Similarly, if there are other types of structure in the vicinity of this airport, then they also need to be provided with the similar colours being at an alternate form and the checkered form. From the top it will look like this. So, this is the top of this particular building or it may be completely orange in colour. So, these are the different types of signages which can be used at any of the airport, so as to provide information to the pilots for their movements as well as to provide the specific information regarding the type of the development taking place on the sites.

So, in this today's lecture we have discussed about the various type of lighting systems which are provided on any of the airport and the different type of the signs which are used for safe movement, efficient movement of the aircrafts. I hope that with this as we are completing our all of the lecture series on Transportation Engineering – II, you have been able to understand and get certain specific information in the area of railway engineering and airport engineering and that is a gain for you and I also understand you have enjoyed the lectures which have been delivered in this course series. With that we are stopping at this point and convey my thanks to you for your patient listening to me. Thank you.