KINGDOM OF BAHRAIN
Ministry of Transportation
and Telecommunications

مملكة البحرين
وزارة المواصلات والاتصالات

CIVIL AVIATION PUBLICATION

CAP-110

Dated: 18 July 2024

Standards for Marking and Lighting of Obstacles Outside Aerodrome / Heliport

This Page Intentionally Left Blank

RECORD OF AMENDMENTS

Amendments				
Serial No.	Issue No.	Revision No.	Date	Description
01	01	0	31 Oct 2019	Initial Issue
02	01	1	01 Sept 2020	Section 4.1.3 added
03	01	02	18 July 2024	Logo update on cover page

Table of Contents

Page

1. Intent

This Civil Aviation Publication (CAP) is to provide supplementary guidance to Aerodrome operators / Developers / Contractors / Crane operators etc. on marking to be painted and lighting to be installed on high structures (Building / Construction crane etc.) in the vicinity of airports or on navigational routes of aircrafts /helicopter in the Kingdom of Bahrain.

2. Introduction

Obstacles can be created in both the aerodrome and en-route environments by a range of structures; some of the most common are multistory buildings power transmission masts, pylons, bridges, cooling towers, communication masts and cables**.**

Where it is impractical to eliminate an obstacle, it should be appropriately marked and/or lighted so as to be clearly visible to pilots in all weather and visibility conditions. ICAO Annex 14 Chapter 6 contains detailed requirements concerning marking and /or lighting of obstacles. It should be noted that the marking and lighting of obstacles is intended to reduce hazard to aircraft by indicating the presence of obstacles.

Annex 14 specifies that obstacles shall be marked and lighted, except that:

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

b) the marking may be omitted when the obstacle is appropriately lighted and its height above the level of the surrounding ground does not exceed 150mtr.

3. Applicability

If a difference between a standard prescribed in ICAO Annex 14 and the Civil Aviation Publication - CAP 110 exists, the CAP 110 standard shall prevail.

4. Marking and Lighting of Obstacles

The safety of flying at low levels under visual flight rules (VFR) depends significantly on the pilot being able to see any obstruction that constitutes an obstacle to flight in sufficient time to carry out an evasive manoeuvre in an unhurried and controlled manner. The most demanding circumstances occur when flights take place in a visibility close to the limiting value for that class of operation. Obstacles cannot be seen at ranges in excess of the prevailing visibility and will often be seen at lesser ranges. The shortfall in obstacle range performance is what constitutes the flight hazard. In practical terms, flight safety considerations require the conspicuity of obstacles to be enhanced so that their visual range is at least the same as the prevailing visibility in marginal weather conditions. At night, similar considerations arise. Pilots have the same need to see obstacles in sufficient time to carry out any necessary evasive manoeuvre.

4.1 Structures to be marked/ lighted

4.1.1 Article 27 of Civil aviation law no.14 stipulates requirements of placement of markings on any obstacles that represent threat to air navigation safety by the person responsible for the presence of such obstacles; Accordingly, any structure exceeding 30mtr. above ground level, or structures where the top of the structure exceeds 45mtr above the Mean Sea level shall be marked in red/orange and white or lit with aviation warning lights.

4.1.2 Overhead wires, cables, etc., crossing a river, valley or major roads shall be marked and in addition, their supporting towers marked and lighted if an aeronautical study indicates that it could constitute a hazard to aircraft.

4.1.3 Civil Aviation inspectors will conduct frequent site inspections to ensure the compliance of aviation warning light requirements

4.2 Painted Markings (Day Markings)

4.2.1 Paint Colors

Alternate sections of international orange or signal red and white paint shall be used as they provide maximum visibility of an obstruction by contrast in colors.

The colors shall comply with the British standards or equivalent as indicated –

(a) International Orange
Color range: BS 381 C
Color reference: BS381C 592

(b) Signal Red
Color range: BS 381C
Color reference: BS 381 C 537

(c) White
Color range: BS 4800/5252

Color reference: 00 E 55

4.2.2 Paint Standards

Quality paints shall be used and applied in accordance to Bahrain ministry of works standards for the relevant surfaces.

4.2.3 Surfaces Not Requiring Paint

Ladders, decks, and walkways of steel towers and similar structures need not be painted if a smooth surface presents a potential hazard to maintenance personnel. Paint may also be omitted from precision or critical surfaces if it would have an adverse effect on the transmission or radiation characteristics of a signal. This should not reduce the overall marking effect of the structure.

4.2.4 Solid Pattern

Obstacles should be colored in orange (or red) if the structure has a horizontal dimension of less than 1,5 m and vertical dimensions not exceeding 4,5 m.

4.2.5 Checkerboard Pattern

Alternating rectangles of orange (or red) and white are normally displayed on the following structures:

(a) Water reservoirs, fuel storage tanks, and grain storage silos when required.

(b) Buildings, as required.

(c) Large structures where its projection on any vertical plane equals or exceeds 4.5 m in both dimensions. The pattern should consist of rectangles of not less than 1.5 m and not more than 3 m on a side, the corners being of the darker color. The colors of the pattern should contrast each with the other and with the background against which they will be seen. Orange (or red) and white should be used. However, if it is impractical because of the size or shape of a structure, the patterns may have sides less than 1,5 m. When possible, corner surfaces should be colored orange.

4.2.6 Alternate Bands

Alternate bands of orange (or red) and white are normally displayed on structures when –

(a) it has essentially unbroken surfaces and has one dimension, horizontal or vertical, greater than 1,5 m and the other dimension, horizontal or vertical, less than 4,5 m, or

(b) it is of skeletal type with either a vertical or a horizontal dimension greater than 1.5 m, and Includes the following structures –

(i) Communication towers and catenary support structures.

(ii) Poles.

(iii) Smokestacks.

(iv) Skeletal framework of storage tanks and similar structures.

(v) Coaxial cable, conduits, and other cables attached to the face of a tower.

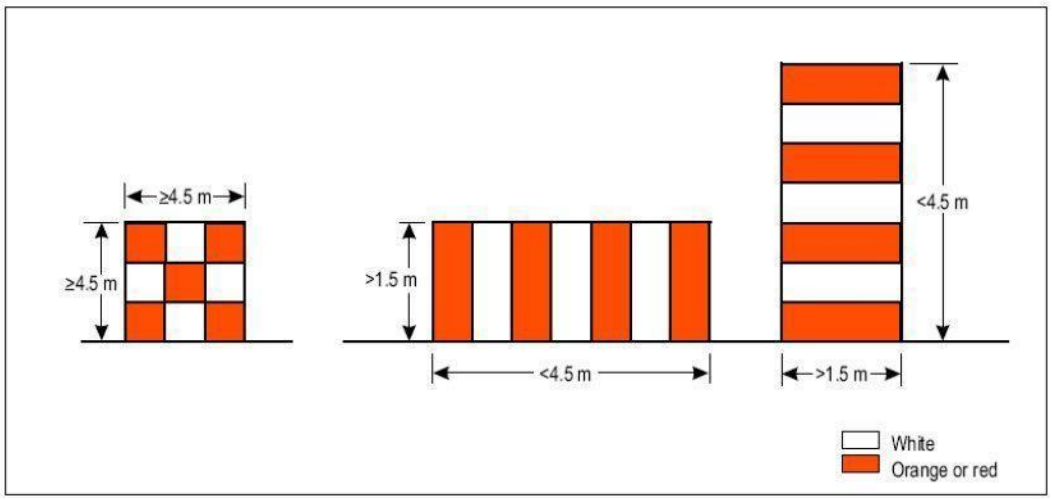


Figure 1

4.2.7 Color Band Characteristics

The bands should be perpendicular to the longest dimension and have a width approximately 1/7 of the longest dimension or 30 m, whichever is less, and not less than 0,65 m. The colors of the bands should contrast with the background against which they will be seen. Orange (or red) and white should be used, except where such colors are not conspicuous when viewed against the background. The bands on the extremities of the object should be of the darker color.

Marking Band Widths		
Longest Dimension		Band width
Greater than (m)	Not exceeding (m)	
4,5	210	1/7 of longest dimension
210	270	1/9 „ „
270	330	1/11 „ „
330	390	1/13 „
390	450	1/15 „
450	510	1/17 „
510	570	1/19 „
Table 1		

Note: Table 1 shows a formula for determining bandwidths and for having an odd number of bands, thus permitting both the top and bottom bands to be of the darker color.

4.2.8 Skeletal Structures on Top of Buildings

If a flagpole, skeletal structure, or similar object is erected on top of a building, the combined height of the object and building will determine whether marking is required; however, only the height of the object under study determines the width of the color bands.

4.2.9 Partial Marking

If marking is recommended for only a portion of a structure because of shielding by other objects or terrain, or it is not practicable to mark the full structure, the width of the bands should be determined by the overall height of the structure. A minimum of three bands shall be displayed on the upper third of the structure.

4.2.10 Extensive Structures

Paint markings may be omitted when an aeronautical study indicates that a structure is extensive to the extent that additional marking will not improve the visual impact of the structure.

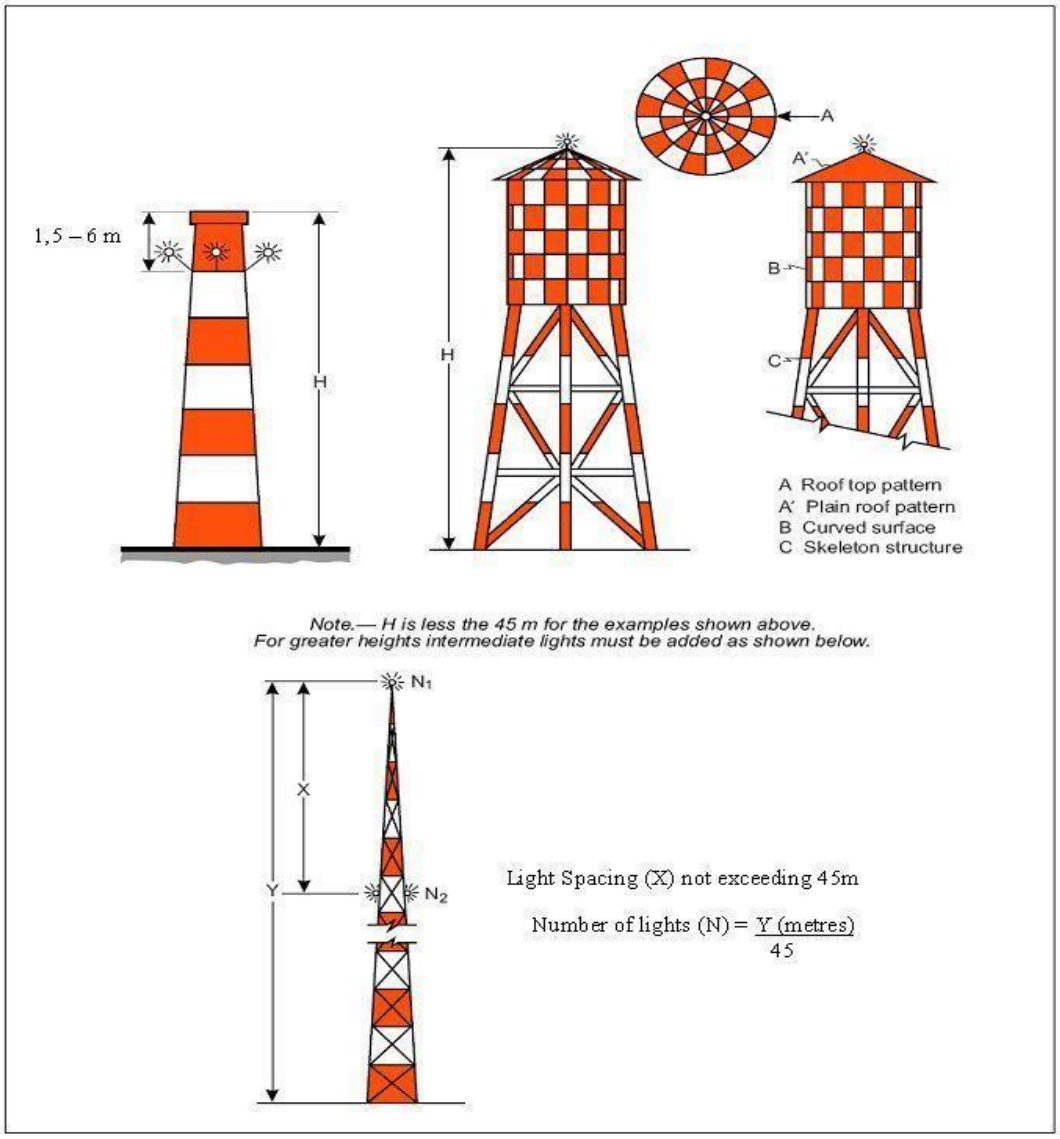


Figure 2

5. Markers

Markers are used to highlight structures when it is impractical to make them conspicuous by painting. Markers may also be used in addition to orange (or red) and white paint when additional conspicuousness is necessary for aviation safety.

They should be displayed in conspicuous positions on or adjacent to the structures so as to retain the general definition of structure. They should be recognizable in clear air from a distance of at least 1 000 m and in all directions from which aircraft are likely to approach. Markers should be distinctively shaped, i.e., spherical or cylindrical, so they are not mistaken for items that are used to convey other information. They should be replaced when faded or otherwise deteriorated.

5.1 Spherical Markers

Spherical markers are used to identify overhead wires. (Figure 3) Markers may be of another shape, i.e., cylindrical, provided the projected area of such markers will not be less than that presented by a spherical marker.

Figure 3

Air craft warning spheres are used as a visual marking of overhead power lines crossing deserts, valleys and rivers or generally where there is a need to make power line visible to aircraft and helicopters. The warning spheres are attached to the shield wires or to the phase conductors .

5.2 Size and Color

The diameter of the markers used on extensive catenary wires across canyons, lakes, rivers, etc., shall be not less than 60 cm.

Smaller 30 cm spheres are permitted on less extensive power lines or on power lines below 15 m above the ground and within 500 m of an aerodrome runway end. Each marker should be a solid color such as orange or white.

5.3 Installations

(a) Spacing

Markers should be spaced equally along the wire at intervals of approximately 30m where the marker diameter is 60 cm progressively increasing to 35m where the marker diameter is 80 cm and further progressively increasing to a maximum of 40 m where the marker diameter is at least 130 cm.

Where multiple wires, cables, etc. are involved, a marker should be located not lower than the level of the highest wire at the point marked. They should be displayed on the highest wire or by another means at the same height as the highest wire. Where there is more than one wire at the highest point, the markers may be installed alternately along each wire if the distance between adjacent markers meets the spacing standard. This method allows the weight and wind loading factors to be distributed. Where 30 cm spheres are used, intervals between markers should be 10 m to 15 m.

(b) Pattern

An alternating color scheme provides the most conspicuousness against all backgrounds. Overhead wires shall be marked by alternating solid colored markers of international orange and white. An orange sphere is placed at each end of a line and the spacing is adjusted not to exceed the maximum spacing for the applicable size of spheres used to accommodate the rest of the markers. When less than four markers are used, they should all be international orange.

6. Flags

(a) Flags used to mark objects shall be displayed around, on top of, or around the highest edge of, the object. When flags are used to mark extensive objects or groups of closely spaced objects, they shall be displayed at least every 15m. Flags shall not increase the hazard presented by the object they mark.

(b) Flags used to mark fixed objects shall not be less than 0.6 m square and flags used to mark mobile objects, not less than 0.9 m square.

(c) Flags used to mark fixed objects should be orange in color or a combination of two triangular sections, one orange and the other white, or one red and the other white, except that where such colors merge with the background, other conspicuous colors should be used.

(d) Flags used to mark mobile objects shall consist of a chequered pattern, each square having sides of not less than 0.3 m. The colors of the pattern shall contrast each with the other and with the background against which they will be seen. Orange and white or alternatively red and white shall be used, except where such colors merge with the background.

7. Aviation warning lights

7.1. Aviation warning lights brands and technical specifications:

Objects shall be installed with Bahrain Civil Aviation approved aviation warning light products only. Details of approved products and name of supplier is published in BCAA web site.

7.2. Aviation warning light categories:

ICAO divides Aviation warning lights into three main groups:

a) **Low intensity obstruction lights**: these lights should be used where the object height above the surrounding ground is lower than 45 m.

b) **Medium intensity obstruction lights:** should be used where the object height above the level of the surrounding ground is higher than 45 m.

c) **High intensity obstruction lights**: these lights should be used to indicate the presence of an object if its height above the level of the surrounding ground exceeds 150 m.

In detail, the ICAO regulation describes different lamp types within the above three groups.

a. Low intensity obstacle lights, on fixed objects, are fixed-red lights divided in two types:

- Type A: with minimum intensity of 10 candelas. (red fixed)
- Type B: with minimum intensity of 32 candelas. (red fixed)
- Type E: with minimum intensity of 32 candelas. (red flashing)

There are two other types of low intensity obstacle lights, Type C and D used on security vehicles and other vehicles.

b. Medium intensity obstacle lights are divided into three types:

- Type A: white color flashing lights with intensity of 20000 candelas during daytime, 2000 during nighttime.

- Type B: red color flashing lights with minimum intensity of 2000 candelas.

- Type C: red color fixed lights with intensity of 2000 candelas.

d) **High intensity lights are divide in two types:**

- Type A: white color flashing lights, with minimum intensity of 200000 candelas during daytime, 20000 candelas during twilight and 2000 candelas during nighttime.

- Type B: white color flashing lights, with minimum intensity of 100000 candelas during daytime, 20000 candelas during twilight and 2000 candelas during nighttime.

7.3 Lighting of objects with a height less than 45m above ground level

Low-intensity obstacle lights, Type B, red color shall be used on the top of the object where the object is a less extensive one and its height above the surrounding ground is less than 45 m.

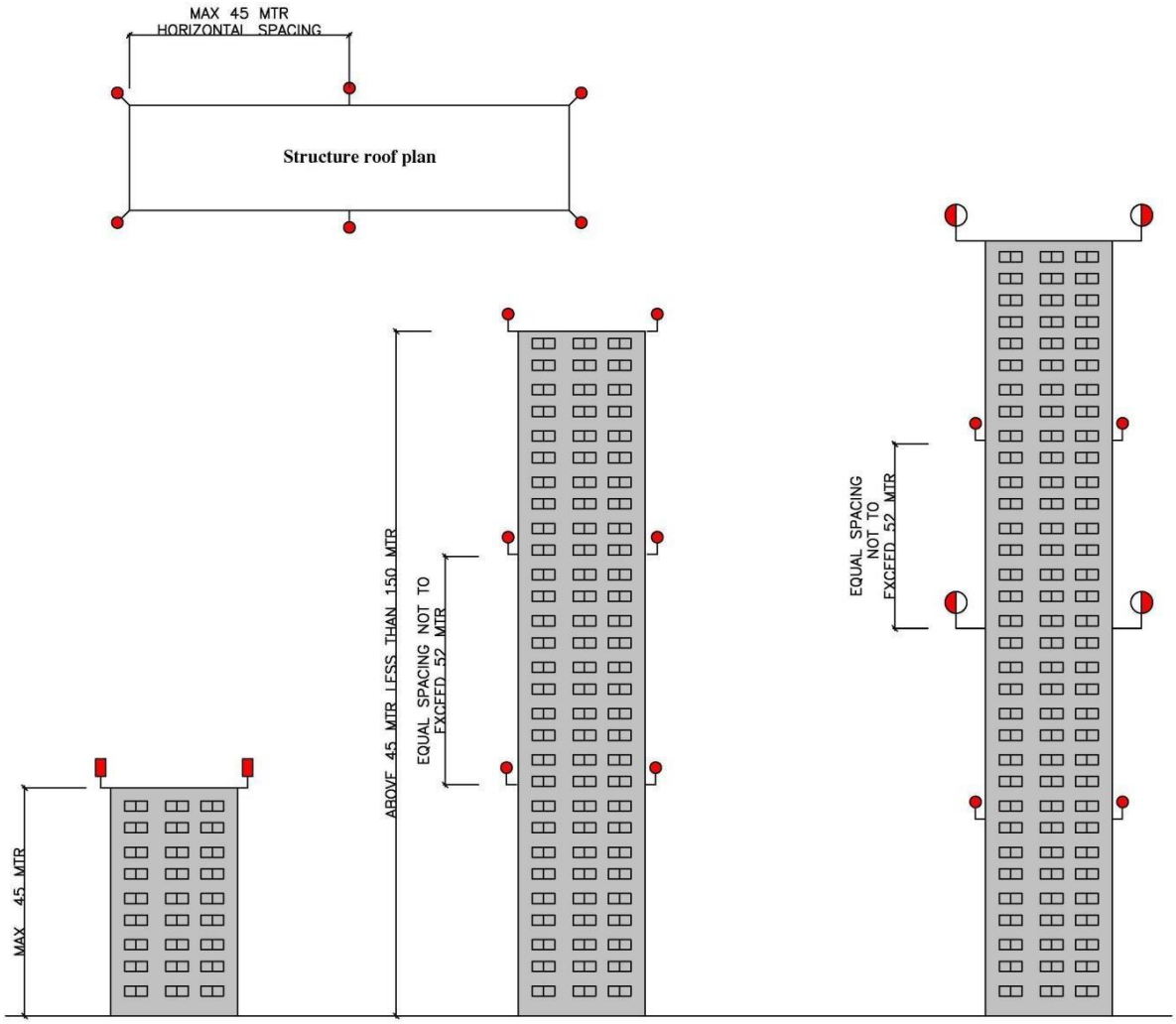
They shall be spaced at longitudinal intervals not exceeding 45 m (see figure 4 below).

7.4 Lighting of objects with a height 45m to a height less than 150m above ground level

Objects shall be installed with medium-intensity obstacle lights, Type C, and the top of the object is more than 45 m above the level of the surrounding ground or the elevation of tops of nearby buildings (when the object to be marked is surrounded by buildings), additional lights shall be provided at intermediate levels. These additional intermediate lights shall be spaced as equally as practicable, between the top lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 52 m vertically. They shall be spaced at longitudinal intervals not exceeding 45 m (see figure 4 below).

7.5. Lighting of objects with a height 150m or more above ground level

Objects shall be installed with High-/Medium intensity dual obstacle lighting system, Type A/ Type / C, and the top of the object is more than 45 m above the level of the surrounding ground or the elevation of tops of nearby buildings (when the object to be marked is surrounded by buildings), additional lights shall be provided at intermediate levels. These additional intermediate lights shall be spaced as equally as practicable, between the top lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 52 m vertically . They shall be spaced at longitudinal intervals not exceeding 45 m (see figure 4 & 5 below).



Structure Height less than 45 mtr

Structure Height between >45 m - <150 m

Structure Height above 150 mtr refer Figure .5

Legend

Symbol	Description	Colour	Signal type/ flash rate	Peak intensity (cd)
	Low intensity, Type -B	Red	Fixed	32 at Night
	Medium intensity, Type - C	Red	Fixed	2000 at Night
	Dual L ighting High intensity, Type - A in day time and Medium intensity, Type - C	White Red	Flashing (20-60 fpm) Fixed	20,000 at Day 2000 at Night

Figure -4

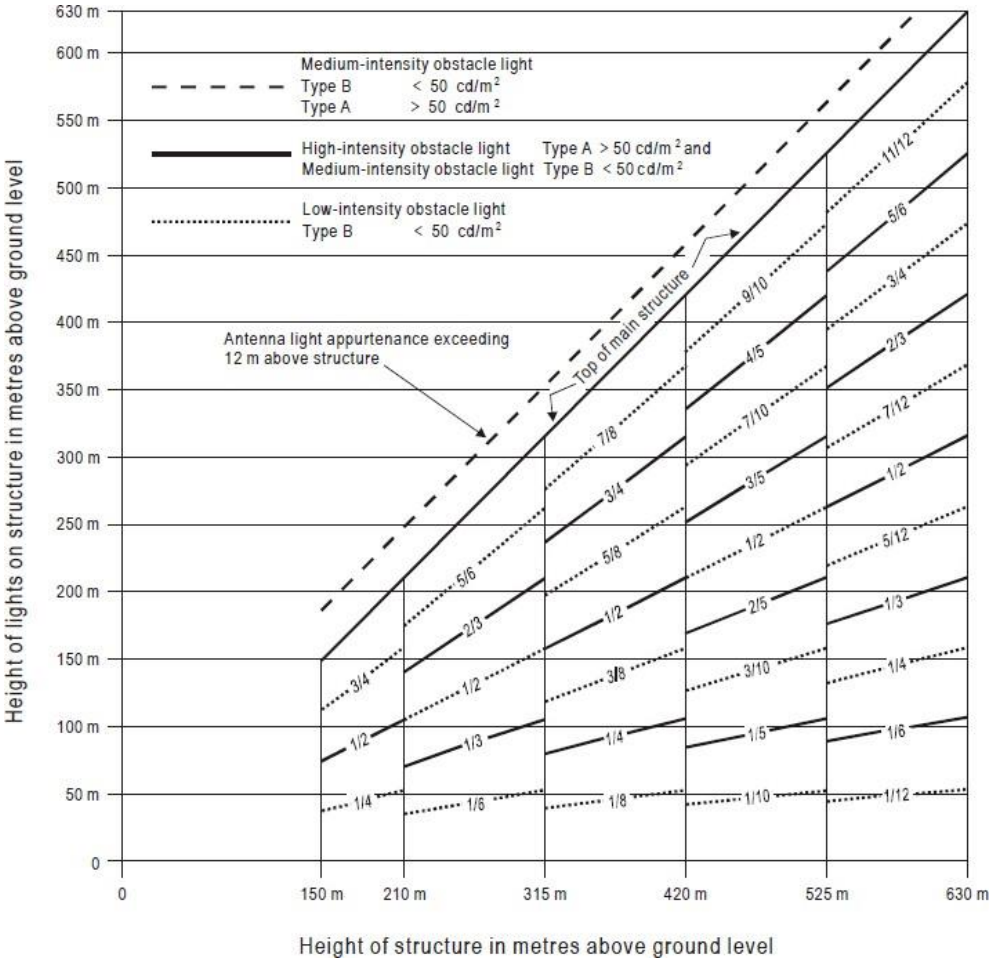


Figure 5

Figure 4 & 5 are graphical interpretation of configuration indicated in clauses 7.1, 7.2 & 7.3 to give an easy understanding of light configuration to builders and standardize installation of aviation warning light in a consistent manner.

7.6 Aviation warning lights on tall construction crane / equipment.

Figure 6, 7, 8 & 9 below are the standards for aviation warning lights for tall construction crane to be followed.

i. For Crane less than 45 mtr above ground level (fig. 6)

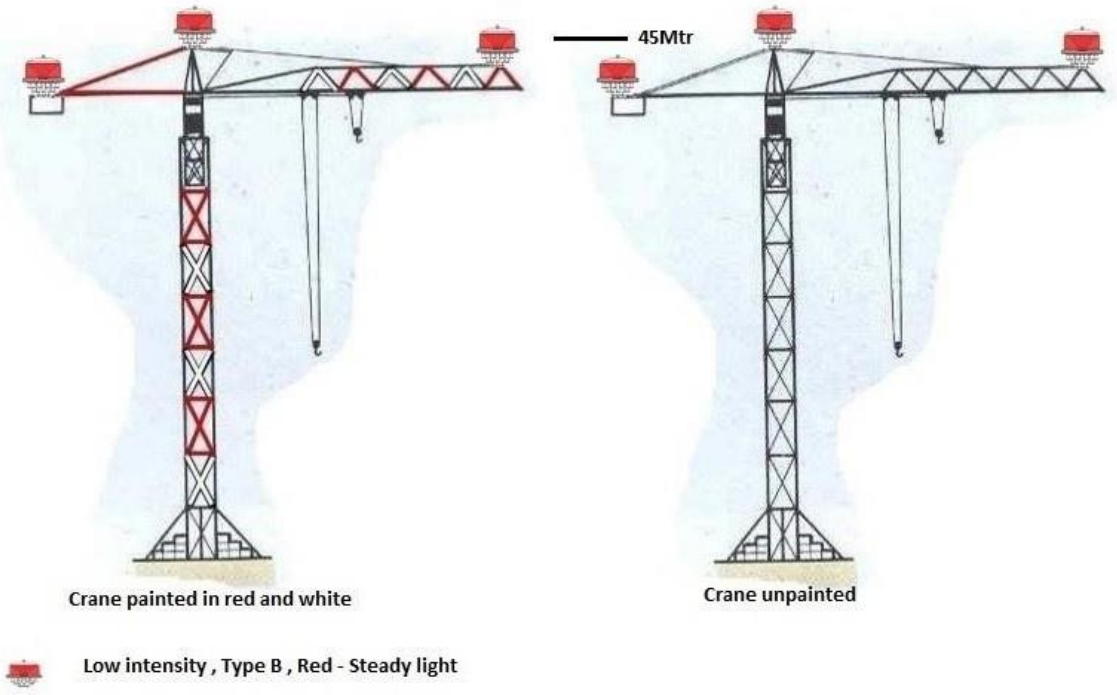


Figure 6

For crane painted red & white or not it is necessary to install low intensity type B – red steady light on the top, jib and counter jib of the crane . In case of power cut, an emergency insuring 12 hours of minimum autonomy is necessary.

ii. For Crane between 45mtr and 105 mtr above ground level (fig.7)

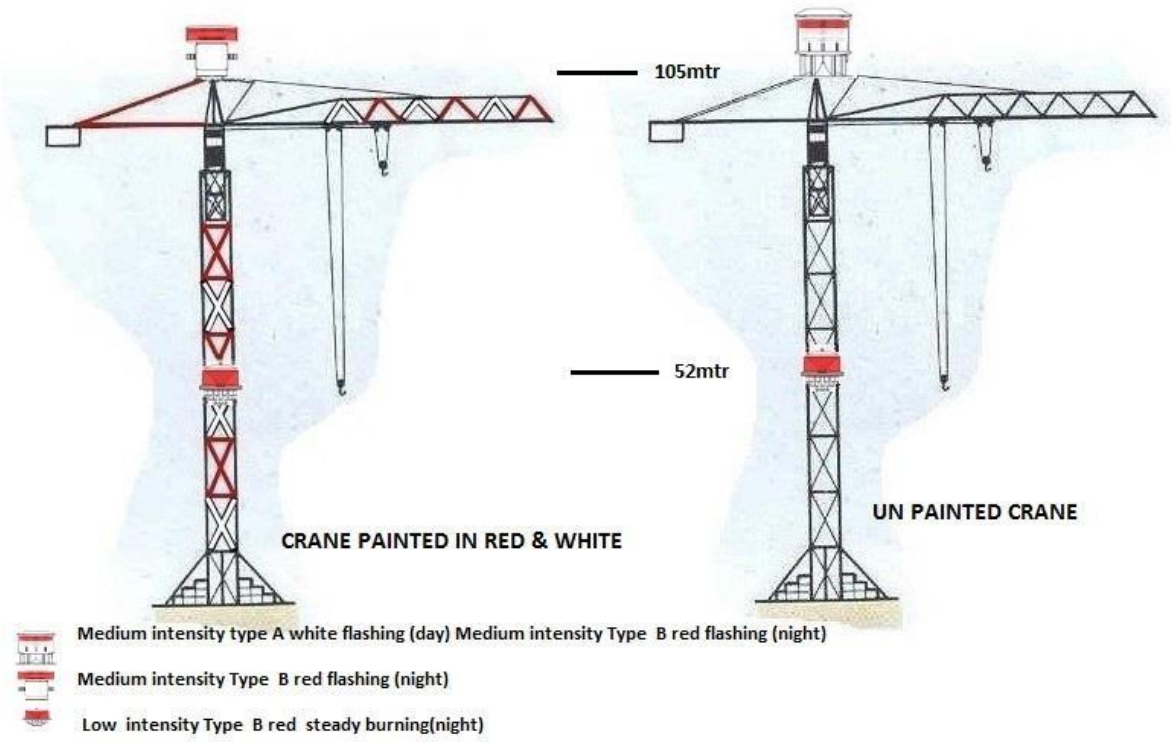


Figure 7

The cranes painted red and white have to be fitted with a medium intensity obstruction light (red flashing lights), and a low intensity obstacle light (red steady burning light) is advised on the middle of the crane.

For unpainted cranes, a medium intensity aircraft warning light with flashing lights (white for day / red for night) is necessary.

In case of power cut, an emergency insuring 12 hours of minimum autonomy is necessary.

iii. For crane of 150 mtr above ground level (Figure 8)

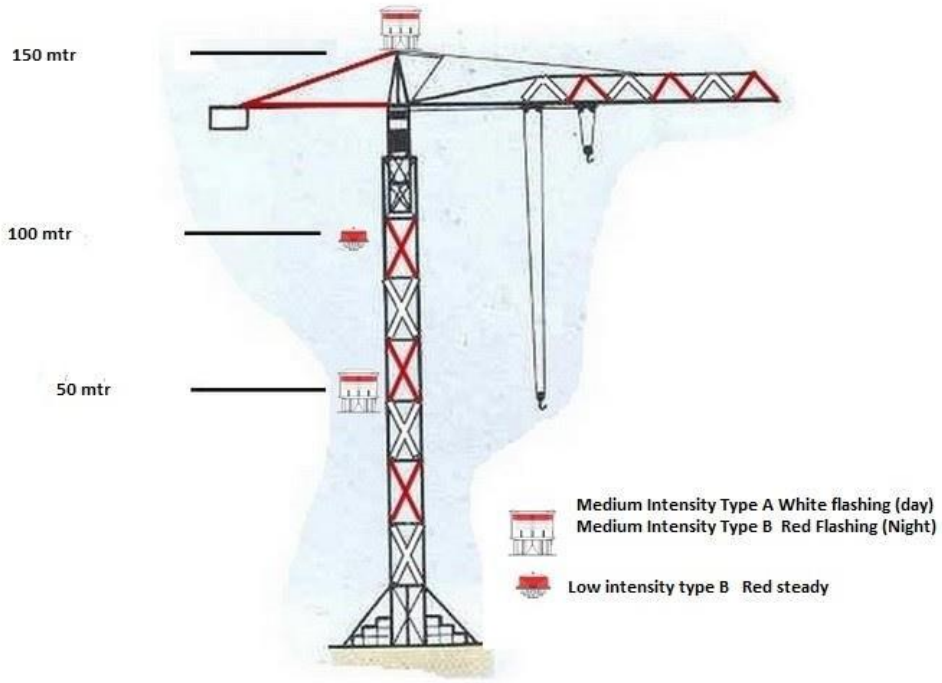


Figure 8

Above 150 meters, even if the crane is marked with red and white paintings, it has to be installed with aviation warning light during day and night. Two beaconing levels medium intensity type A & B are recommended: one level at the top, the second at 50 meters. At 100 meters, a low intensity obstacle light type B is to be installed.

iv. For crane 200 mtr above ground level (Figure 9)

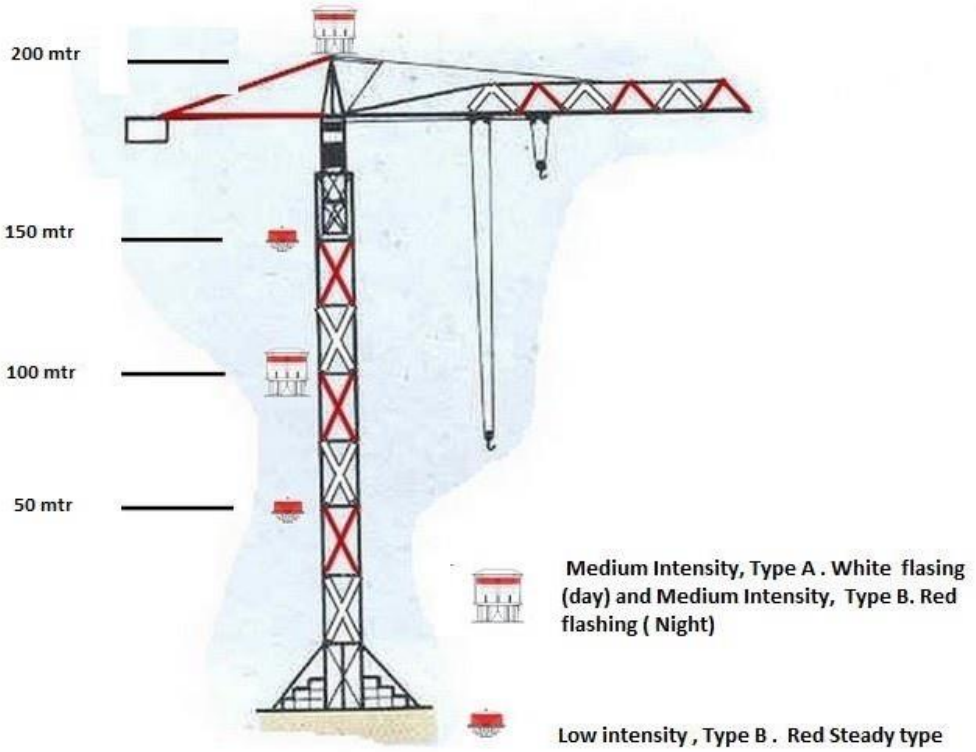


Figure 9

Above 200 meters, even if the crane is marked with red and white paintings, it has to be installed with aviation warning light during day and night. Two beaconing levels medium intensity type A&B are recommended on top middle of the crane .

Low intensity, Type B. red steady light shall be installed between the medium intensity light at equal interval.

For cranes of more than 200 m of overall height, additional marking and lighting may be required as determined by an aeronautical study.

8. Wind turbine generators (Wind farms)

A wind turbine generator is a special type of aviation obstruction due to the fact that at least the top third of the generator is continuously variable and offers a peculiar problem in as much marking by night is concerned.

When wind turbine generators are grouped in numbers of three or more they will be referred to as “Wind farms”.

Wind turbine shall be marked and/or lighted if it is determined to be an obstacle.

8.1 Wind Turbine Markings

The rotor blades, nacelle and upper 2/3 of the supporting mast of wind turbines should be painted in white, unless otherwise indicated by an aeronautical study.

8.2 Wind Turbine Lighting

The obstacle lights should be installed on the nacelle in such a manner as to provide an unobstructed view for aircraft approaching from any direction

For wind turbines of less than 150 m in overall height (hub height plus vertical blade height), medium-intensity lighting on the nacelle should be provided.

For wind turbines from 150 m to 315 m in overall height, in addition to the medium-intensity light installed on the nacelle, a second light serving as an alternate should be provided in case of failure of the operating light. The lights should be installed to assure that the output of either light is not blocked by the other.

For wind turbines from 150 m to 315 m in overall height, an intermediate level at half the nacelle height of at least three low-intensity Type E lights should be provided. If an aeronautical study shows that low-intensity Type E lights are not suitable, low-intensity Type A or B lights maybe used.

For wind turbines of more than 315 m of overall height, additional marking and lighting may be required as determined by an aeronautical study.

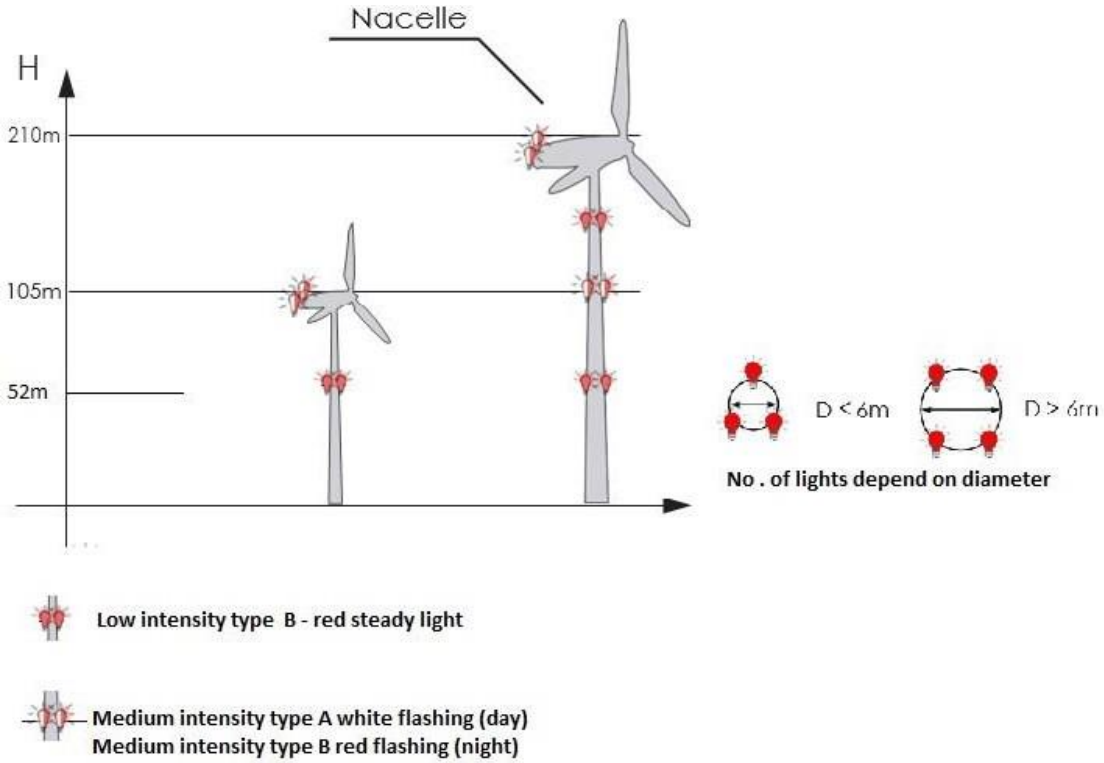
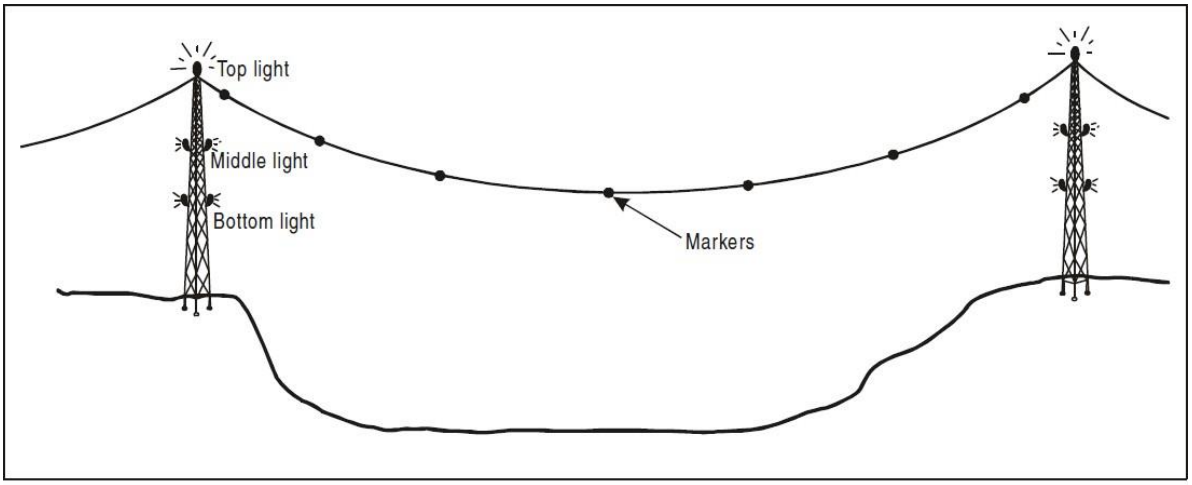


Figure 10

A typical standard using medium intensity dual obstacle lighting system, Type A & B and an intermediate low intensity type B Obstacle lights in compliance with ICAO standard Appendix 5. (Fig. A5-4) is recommended by BCAA. (refer figure 10)

9. Overhead wires, cables, etc., and support towers



Location of high-intensity obstacle lights on towers supporting overhead wires

Figure 11

High-intensity obstacle lights are also used on the support structures of overhead transmission lines (see figure 11). In this use, the lights are flashed in a specific, vertical, coded sequence which is used not only to identify both the towers and the presence of transmission lines but also to advise pilots that they are approaching a complex obstacle, not an isolated one.

This Page Intentionally Left Blank