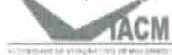


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AIC – International  
08/17  
02 November

**ADVISORY**

**COLOURS FOR AERONAUTICAL GROUND LIGHTS, MARKINGS, SIGNS,  
PANELS AND AERONAUTICAL GROUND LIGHT CHARACTERISTICS**

**1. Authority**

This Circular is issued under the authority of the Chairman of the Board of Directors of the Civil Aviation Institute of Mozambique (IACM), pursuant to Article 19 of Law 05/2016 of 14 June and the paragraph p) of Article 9 of Decree 70/2017 of 30 December.

**2. Basis**

To establish the Guidance Materials, supplementary to the MOZ-CATS 139 Volume I (Guidance Material Supplementary to the MOZ-CATS 139 Volume I).

**3. Objective**

This circular is to publish the established specifications defining the chromaticity limits of colours to be used for aeronautical ground lights, markings, signs, panels and ground light characteristics.

**4. Applicability**

The Guidance Materials, supplementary to the MOZ-CATS 139 Volume I (Guidance Material Supplementary to the MOZ-CATS 139 Volume I) apply to all Aerodrome Operators, who operate in Mozambique.

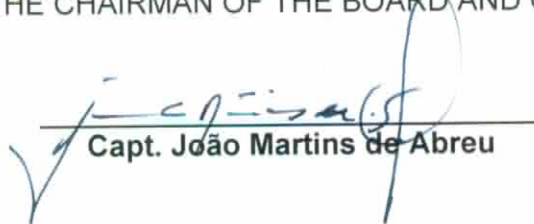
## 5. Changes

This Aeronautical Information Circular cancels the *AIC 09/15 Colors for Aeronautical Ground Lights, Markings, Signs, Panels and Aeronautical Characteristics*.

Maputo, 02 November 2017

INSTITUTE OF CIVIL AVIATION OF MOZAMBIQUE

THE CHAIRMAN OF THE BOARD AND CEO

  
Capt. João Martins de Abreu

## APPENDIX 1. COLOURS FOR AERONAUTICAL GROUND LIGHTS, MARKINGS, SIGNS AND PANELS

### 1. General

*Introductory Note.— The following specifications define the chromaticity limits of colours to be used for aeronautical ground lights, markings, signs and panels. The specifications are in accord with the 1983 specifications of the International Commission on Illumination (CIE), except for the colour orange in Figure A1-2.*

*It is not possible to establish specifications for colours such that there is no possibility of confusion. For reasonably certain recognition, it is important that the eye illumination be well above the threshold of perception, that the colour not be greatly modified by selective atmospheric attenuations and that the observer's colour vision be adequate. There is also a risk of confusion of colour at an extremely high level of eye illumination such as may be obtained from a high-intensity source at very close range. Experience indicates that satisfactory recognition can be achieved if due attention is given to these factors.*

*The chromaticities are expressed in terms of the standard observer and coordinate system adopted by the International Commission on Illumination (CIE) at its Eighth Session at Cambridge, England, in 1931.<sup>1</sup>*

*The chromaticities for solid state lighting (e.g. LED) are based upon the boundaries given in the standard S 004/E-2001 of the International Commission on Illumination (CIE), except for the blue boundary of white.*

### 2. Colours for aeronautical ground lights

#### 2.1 Chromaticities for lights having filament-type light sources

2.1.1 The chromaticities of aeronautical ground lights with filament-type light sources shall be within the following boundaries: CIE Equations (see Figure A1-1a):

- |                 |  |
|-----------------|--|
| a) Red          |  |
| Purple boundary | $y = 0.980 - x$  |
| Yellow boundary | $y = 0.335$ , except for visual approach slope indicator systems |
| Yellow boundary | $y = 0.320$ , for visual approach slope indicator systems        |

*Note.— See 139.5.3.5.15 and 5.3.5.31.*

- |                 |                      |
|-----------------|----------------------|
| b) Yellow       |                      |
| Red boundary    | $y = 0.382$          |
| White boundary  | $y = 0.790 - 0.667x$ |
| Green boundary  | $y = x - 0.120$      |
| c) Green        |                      |
| Yellow boundary | $x = 0.360 - 0.080y$ |

<sup>1</sup> See CIE Publication No. 15, *Colorimetry* (1971).

White boundary	$x = 0.650y$
Blue boundary	$y = 0.390 - 0.171x$
d) Blue	
Green boundary	$y = 0.805x + 0.065$
White boundary	$y = 0.400 - x$
Purple boundary	$x = 0.600y + 0.133$
e) White	
Yellow boundary	$x = 0.500$
Blue boundary	$x = 0.285$
Green boundary	$y = 0.440$ and $y = 0.150 + 0.640x$
Purple boundary	$y = 0.050 + 0.750x$ and $y = 0.382$
f) Variable white	
Yellow boundary	$x = 0.255 + 0.750y$ and $y = 0.790 - 0.667x$
Blue boundary	$x = 0.285$
Green boundary	$y = 0.440$ and $y = 0.150 + 0.640x$
Purple boundary	$y = 0.050 + 0.750x$ and $y = 0.382$

*Note.— Guidance on chromaticity changes resulting from the effect of temperature on filtering elements is given in the Aerodrome Design Manual (Doc 9157), Part 4.*

2.1.2 Where dimming is not required, or where observers with defective colour vision must be able to determine the colour of the light, green signals shall be within the following boundaries:

Yellow boundary	$y = 0.726 - 0.726x$
White boundary	$x = 0.650y$
Blue boundary	$y = 0.390 - 0.171x$

*Note.— Where the colour signal is to be seen from long range, it has been the practice to use colours within the boundaries of 2.1.2.*

2.1.3 Where increased certainty of recognition from white is more important than maximum visual range, green signals shall be within the following boundaries:

<i>Yellow boundary</i>	$y = 0.726 - 0.726x$
<i>White boundary</i>	$x = 0.625y - 0.041$
<i>Blue boundary</i>	$y = 0.390 - 0.171x$

## 2.2 Discrimination between lights having filament-type sources

2.2.1 If there is a requirement to discriminate yellow and white from each other, they shall be displayed in close proximity of time or space as, for example, by being flashed successively from the same beacon.

2.2.2 If there is a requirement to discriminate yellow from green and/or white, as for example on exit taxiway centre line lights, the y coordinates of the yellow light shall not exceed a value of 0.40.

*Note.— The limits of white have been based on the assumption that they will be used in situations in which the characteristics (colour temperature) of the light source will be substantially constant.*

2.2.3 The colour variable white is intended to be used only for lights that are to be varied in intensity, e.g. to avoid dazzling. If this colour is to be discriminated from yellow, the lights shall be so designed and operated that:

- a) the x coordinate of the yellow is at least 0.050 greater than the x coordinate of the white; and
- b) the disposition of the lights will be such that the yellow lights are displayed simultaneously and in close proximity to the white lights.

### 2.3 Chromaticities for lights having a solid state light source

2.3.1 The chromaticities of aeronautical ground lights with solid state light sources, e.g. LEDs, shall be within the following boundaries:

CIE Equations (see Figure A1-1b):

- a) Red
  - Purple boundary  $y = 0.980 - x$
  - Yellow boundary  $y = 0.335$ , except for visual approach slope indicator systems
  - Yellow boundary  $y = 0.320$ , for visual approach slope indicator systems

*Note.— See 5.3.5.15 and 5.3.5.31.*

- b) Yellow
  - Red boundary  $y = 0.387$
  - White boundary  $y = 0.980 - x$
  - Green boundary  $y = 0.727x + 0.054$

- c) Green (also refer to 2.3.2 and 2.3.3)
  - Yellow boundary  $x = 0.310$
  - White boundary  $x = 0.625y - 0.041$
  - Blue boundary  $y = 0.400$

- d) Blue
  - Green boundary  $y = 1.141x - 0.037$
  - White boundary  $y = 0.400 - y$
  - Purple boundary  $x = 0.134 + 0.590y$

- e) White
  - Yellow boundary  $x = 0.440$
  - Blue boundary  $x = 0.320$
  - Green boundary  $y = 0.150 + 0.643x$
  - Purple boundary  $y = 0.050 + 0.757x$

- f) Variable white
 

The boundaries of variable white for solid state light sources are those of e) White above.

2.3.2 Where observers with defective colour vision must be able to determine the colour of the light, green signals shall be within the following boundaries:

- Yellow boundary  $y = 0.726 - 0.726x$
- White boundary  $x = 0.625y - 0.041$
- Blue boundary  $y = 0.400$

2.3.3 In order to avoid a large variation of shades of green, if colours within the boundaries below are selected, colours within the boundaries of 2.3.2 shall not be used.

- Yellow boundary  $x = 0.310$
- White boundary  $x = 0.625y - 0.041$
- Blue boundary  $y = 0.726 - 0.726x$

## 2.4 Colour measurement for filament-type and solid state-type light sources

2.4.1 The colour of aeronautical ground lights shall be verified as being within the boundaries specified in Figure A1-1a or A1-1b, as appropriate, by measurement at five points within the area limited by the innermost isocandela curve (isocandela diagrams in Appendix 2 refer), with operation at rated current or voltage. In the case of elliptical or circular isocandela curves, the colour measurements shall be taken at the centre and at the horizontal and vertical limits. In the case of rectangular isocandela curves, the colour measurements shall be taken at the centre and the limits of the diagonals (corners). In addition, the colour of the light shall be checked at the outermost isocandela curve to ensure that there is no colour shift that might cause signal confusion to the pilot.

*Note 1.— For the outermost isocandela curve, a measurement of colour coordinates should be made and recorded for review and judgement of acceptability by the State.*

*Note 2.— Certain light units may have application so that they may be viewed and used by pilots from directions beyond that of the outermost isocandela curve (e.g. stop bar lights at significantly wide runway-holding positions). In such instances, the State should assess the actual application and if necessary require a check of colour shift at angular ranges beyond the outermost curve.*

2.4.2 In the case of visual approach slope indicator systems and other light units having a colour transition sector, the colour shall be measured at points in accordance with 2.4.1, except that the colour areas shall be treated separately and no point shall be within 0.5 degrees of the transition sector.

### 3. Colours for markings, signs and panels

*Note 1.— The specifications of surface colours given below apply only to freshly coloured surfaces. Colours used for markings, signs and panels usually change with time and therefore require renewal.*

*Note 2.— Guidance on surface colours is contained in the CIE document entitled Recommendations for Surface Colours for Visual Signalling — Publication No. 39-2 (TC-106) 1983.*

*Note 3.— The specifications recommended in 3.4 for transilluminated panels are interim in nature and are based on the CIE specifications for transilluminated signs. It is intended that these specifications will be reviewed and updated as and when CIE develops specifications for transilluminated panels.*

3.1 The chromaticities and luminance factors of ordinary colours, colours of retroreflective materials and colours of transilluminated (internally illuminated) signs and panels shall be determined under the following standard conditions:

- a) angle of illumination: 45°;
- b) direction of view: perpendicular to surface; and
- c) illuminant: CIE standard illuminant D<sub>65</sub>.

3.2 The chromaticity and luminance factors of ordinary colours for markings and externally illuminated signs and panels shall be within the following boundaries when determined under standard conditions.

CIE Equations (see Figure A1-2):

- a) Red
  - Purple boundary  $y = 0.345 - 0.051x$
  - White boundary  $y = 0.910 - x$
  - Orange boundary  $y = 0.314 + 0.047x$
  - Luminance factor  $\beta = 0.07$  (mnm)

- b) Orange
- |                  |                      |
|------------------|----------------------|
| Red boundary     | $y = 0.285 + 0.100x$ |
| White boundary   | $y = 0.940 - x$      |
| Yellow boundary  | $y = 0.250 + 0.220x$ |
| Luminance factor | $\beta = 0.20$ (mnm) |
- c) Yellow
- |                  |                      |
|------------------|----------------------|
| Orange boundary  | $y = 0.108 + 0.707x$ |
| White boundary   | $y = 0.910 - x$      |
| Green boundary   | $y = 1.35x - 0.093$  |
| Luminance factor | $\beta = 0.45$ (mnm) |
- d) White
- |                  |                      |
|------------------|----------------------|
| Purple boundary  | $y = 0.010 + x$      |
| Blue boundary    | $y = 0.610 - x$      |
| Green boundary   | $y = 0.030 + x$      |
| Yellow boundary  | $y = 0.710 - x$      |
| Luminance factor | $\beta = 0.75$ (mnm) |
- e) Black
- |                  |                      |
|------------------|----------------------|
| Purple boundary  | $y = x - 0.030$      |
| Blue boundary    | $y = 0.570 - x$      |
| Green boundary   | $y = 0.050 + x$      |
| Yellow boundary  | $y = 0.740 - x$      |
| Luminance factor | $\beta = 0.03$ (max) |
- f) Yellowish green
- |                 |                    |
|-----------------|--------------------|
| Green boundary  | $y = 1.317x + 0.4$ |
| White boundary  | $y = 0.910 - x$    |
| Yellow boundary | $y = 0.867x + 0.4$ |
- g) Green
- |                  |                      |
|------------------|----------------------|
| Yellow boundary  | $x = 0.313$          |
| White boundary   | $y = 0.243 + 0.670x$ |
| Blue boundary    | $y = 0.493 - 0.524x$ |
| Luminance factor | $\beta = 0.10$ (mnm) |

*Note.— The small separation between surface red and surface orange is not sufficient to ensure the distinction of these colours when seen separately.*

3.3 The chromaticity and luminance factors of colours of retroreflective materials for markings, signs and panels shall be within the following boundaries when determined under standard conditions.

*CIE Equations (see Figure A1-3):*

- a) Red
- |                  |                      |
|------------------|----------------------|
| Purple boundary  | $y = 0.345 - 0.051x$ |
| White boundary   | $y = 0.910 - x$      |
| Orange boundary  | $y = 0.314 + 0.047x$ |
| Luminance factor | $\beta = 0.03$ (mnm) |
- b) Orange
- |                  |                      |
|------------------|----------------------|
| Red boundary     | $y = 0.265 + 0.205x$ |
| White boundary   | $y = 0.910 - x$      |
| Yellow boundary  | $y = 0.207 + 0.390x$ |
| Luminance factor | $\beta = 0.14$ (mnm) |

- c) *Yellow*
- |                         |                      |
|-------------------------|----------------------|
| <i>Orange boundary</i>  | $y = 0.160 + 0.540x$ |
| <i>White boundary</i>   | $y = 0.910 - x$      |
| <i>Green boundary</i>   | $y = 1.35x - 0.093$  |
| <i>Luminance factor</i> | $\beta = 0.16$ (mnm) |
- d) *White*
- |                         |                      |
|-------------------------|----------------------|
| <i>Purple boundary</i>  | $y = x$              |
| <i>Blue boundary</i>    | $y = 0.610 - x$      |
| <i>Green boundary</i>   | $y = 0.040 + x$      |
| <i>Yellow boundary</i>  | $y = 0.710 - x$      |
| <i>Luminance factor</i> | $\beta = 0.27$ (mnm) |
- e) *Blue*
- |                         |                      |
|-------------------------|----------------------|
| <i>Green boundary</i>   | $y = 0.118 + 0.675x$ |
| <i>White boundary</i>   | $y = 0.370 - x$      |
| <i>Purple boundary</i>  | $y = 1.65x - 0.187$  |
| <i>Luminance factor</i> | $\beta = 0.01$ (mnm) |
- f) *Green*
- |                         |                      |
|-------------------------|----------------------|
| <i>Yellow boundary</i>  | $y = 0.711 - 1.22x$  |
| <i>White boundary</i>   | $y = 0.243 + 0.670x$ |
| <i>Blue boundary</i>    | $y = 0.405 - 0.243x$ |
| <i>Luminance factor</i> | $\beta = 0.03$ (mnm) |

3.4 The chromaticity and luminance factors of colours for luminescent or transilluminated (internally illuminated) signs and panels shall be within the following boundaries when determined under standard conditions.

*CIE Equations (see Figure A1-4):*

- a) *Red*
- |                           |                      |
|---------------------------|----------------------|
| <i>Purple boundary</i>    | $y = 0.345 - 0.051x$ |
| <i>White boundary</i>     | $y = 0.910 - x$      |
| <i>Orange boundary</i>    | $y = 0.314 + 0.047x$ |
| <i>Luminance factor</i>   | $\beta = 0.07$ (mnm) |
| <i>(day condition)</i>    |                      |
| <i>Relative luminance</i> | $5\%$ (mnm)          |
| <i>to white (night</i>    | $20\%$ (max)         |
| <i>condition)</i>         |                      |
- b) *Yellow*
- |                           |                      |
|---------------------------|----------------------|
| <i>Orange boundary</i>    | $y = 0.108 + 0.707x$ |
| <i>White boundary</i>     | $y = 0.910 - x$      |
| <i>Green boundary</i>     | $y = 1.35x - 0.093$  |
| <i>Luminance factor</i>   | $\beta = 0.45$ (mnm) |
| <i>(day condition)</i>    |                      |
| <i>Relative luminance</i> | $30\%$ (mnm)         |
| <i>to white (night</i>    | $80\%$ (max)         |
| <i>condition)</i>         |                      |

- c) *White*
- |  |                      |
|--|----------------------|
| <i>Purple boundary</i>   | $y = 0.010 + x$      |
| <i>Blue boundary</i>   | $y = 0.610 - x$      |
| <i>Green boundary</i>  | $y = 0.030 + x$      |
| <i>Yellow boundary</i>   | $y = 0.710 - x$      |
| <i>Luminance factor</i><br><i>(day condition)</i>                        | $\beta = 0.75$ (mmm) |
| <i>Relative luminance</i><br><i>to white (night</i><br><i>condition)</i> | 100%                 |
- d) *Black*
- |  |                      |
|--|----------------------|
| <i>Purple boundary</i>   | $y = x - 0.030$      |
| <i>Blue boundary</i>   | $y = 0.570 - x$      |
| <i>Green boundary</i>  | $y = 0.050 + x$      |
| <i>Yellow boundary</i>   | $y = 0.740 - x$      |
| <i>Luminance factor</i><br><i>(day condition)</i>                        | $\beta = 0.03$ (max) |
| <i>Relative luminance</i><br><i>to white (night</i><br><i>condition)</i> | 0% (mnm)<br>2% (max) |
- e) *Green*
- |  |   |
|--|---|
| <i>Yellow boundary :</i>   | $x = 0.313$                             |
| <i>White boundary:</i>   | $y = 0.243 + 0.670x$                    |
| <i>Blue boundary:</i>  | $y = 0.493 - 0.524x$                    |
| <i>Luminance factor:</i>   | $\beta = 0.10$ minimum (day conditions) |
| <i>Relative luminance:</i><br><i>to white (night</i><br><i>conditions)</i> | 5% (minimum)<br>30% (maximum)           |

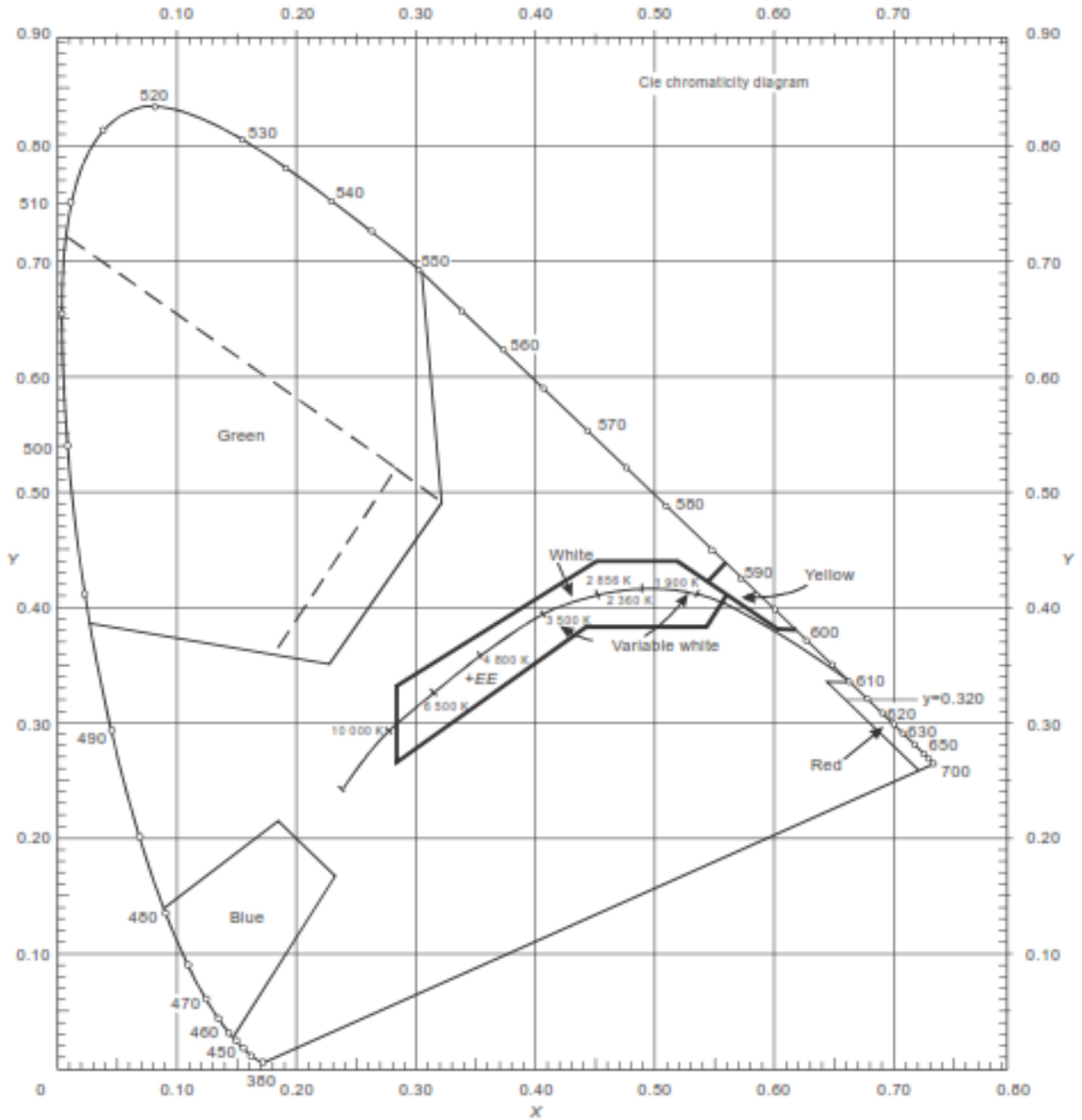


Figure A1-1a. Colours for aeronautical ground lights (filament-type lamps)

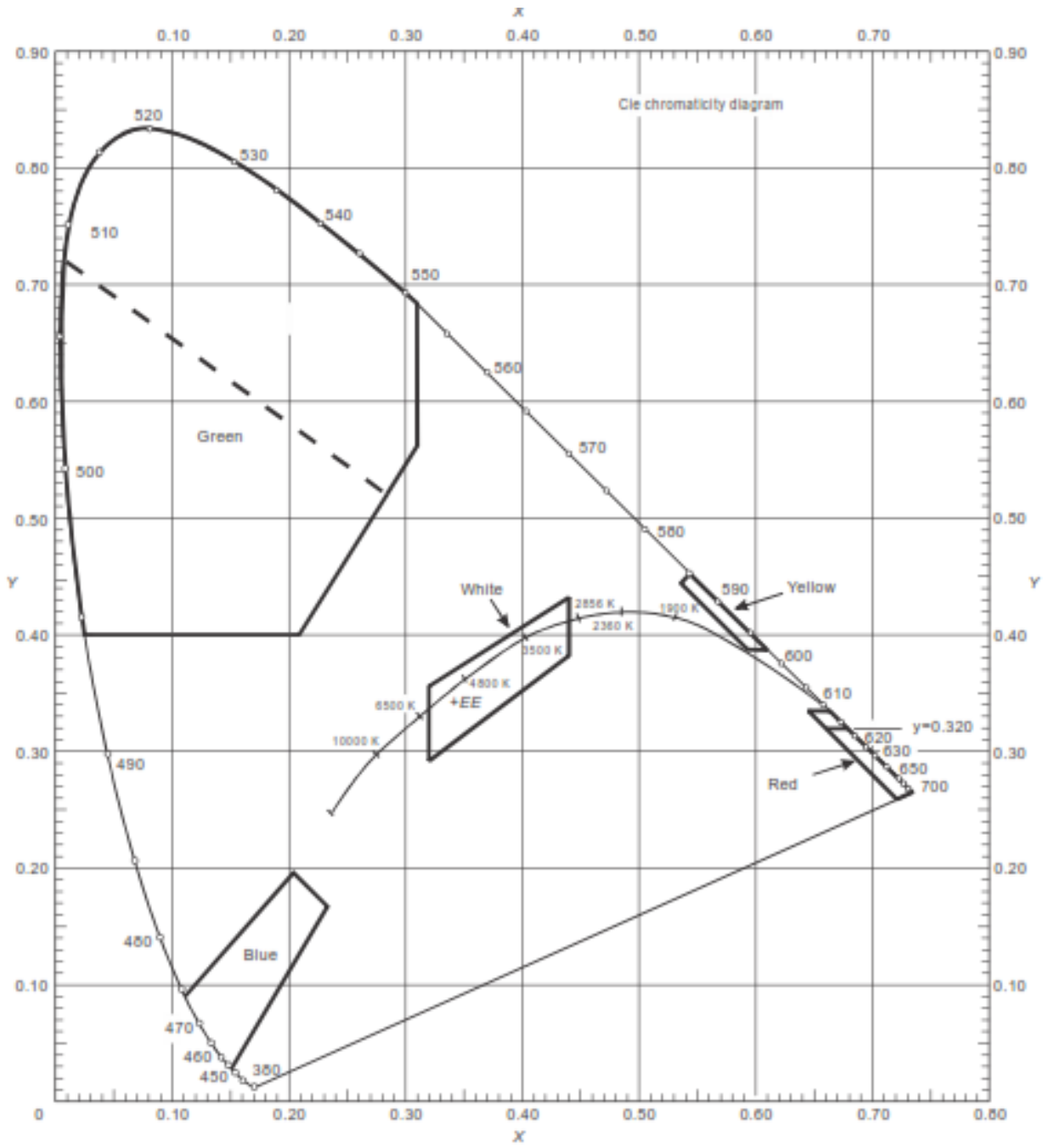


Figure A1-1b. Colours for aeronautical ground lights (solid state lighting)

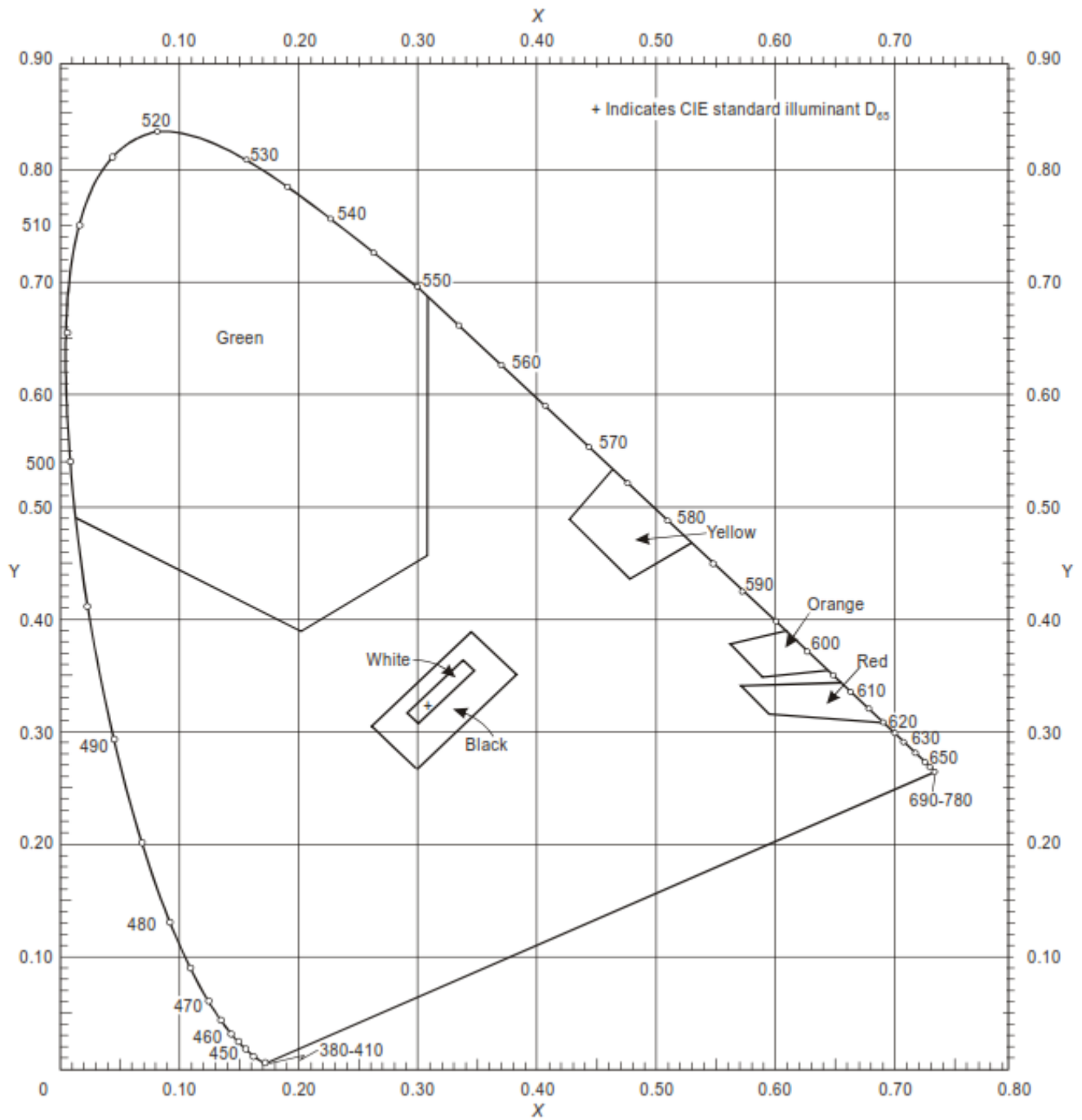


Figure A1-2. Ordinary colours for markings and externally illuminated signs and panels

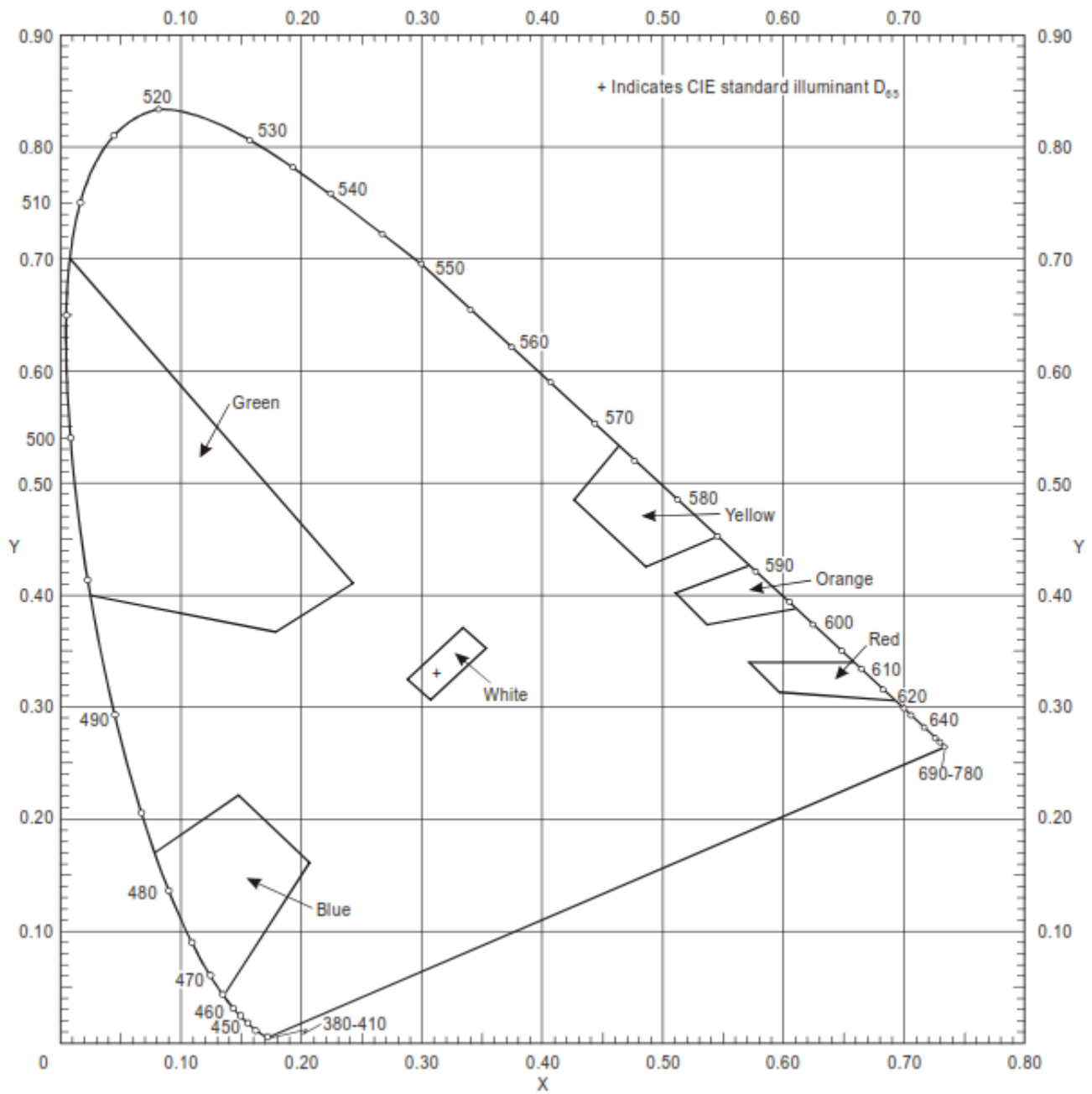
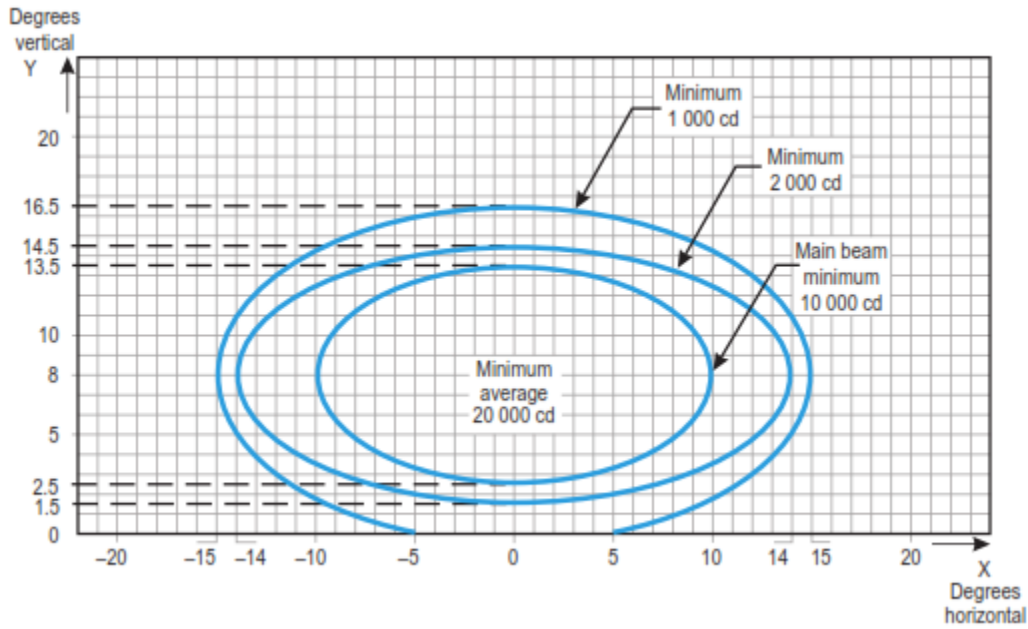


Figure A1-3. Colours of retroreflective materials for markings, signs and panels



## APPENDIX 2. AERONAUTICAL GROUND LIGHT CHARACTERISTICS



Notes:

1. Curves calculated on formula

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$$

a	10	14	15
b	5.5	6.5	8.5

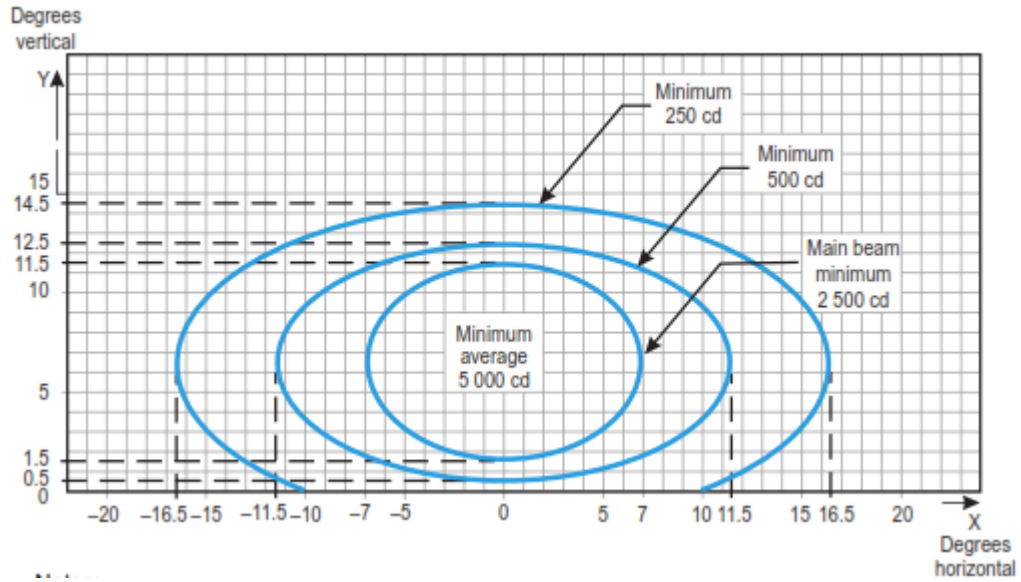
2. Vertical setting angles of the lights shall be such that the following vertical coverage of the main beam will be met:

distance from threshold      vertical main beam coverage

threshold to 315 m	0° — 11°
316 m to 475 m	0.5° — 11.5°
476 m to 640 m	1.5° — 12.5°
641 m and beyond	2.5° — 13.5° (as illustrated above)

3. Lights in crossbars beyond 22.5 m from the centre line shall be toed-in 2 degrees. All other lights shall be aligned parallel to the centre line of the runway.
4. See collective notes for Figures A2-1 to A2-11.

**Figure A2-1. Isocandela diagram for approach centre line light and crossbars (white light)**



Notes:

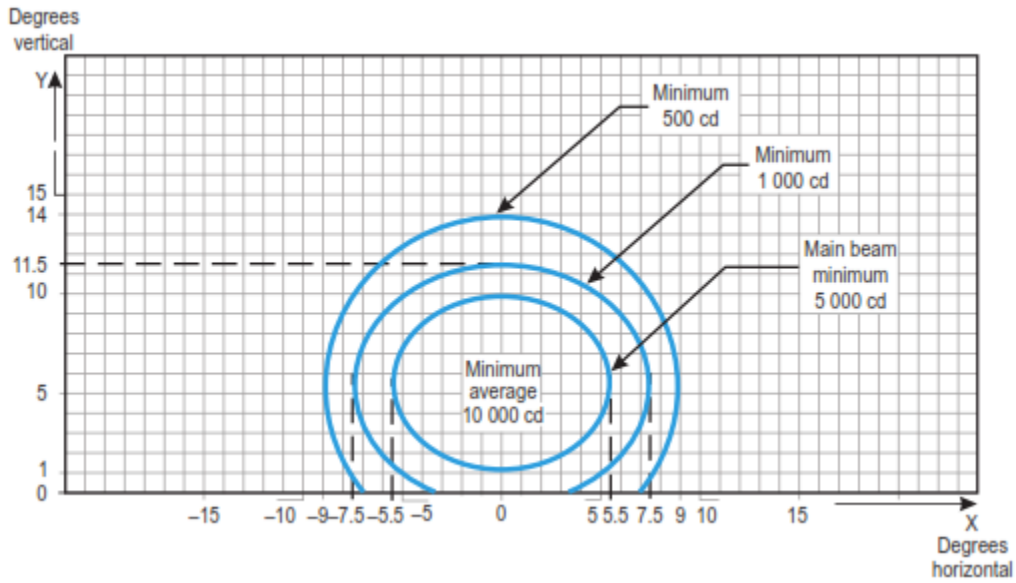
$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$$

a	7.0	11.5	16.5
b	5.0	6.0	8.0

1. Curves calculated on formula
2. Toe-in 2 degrees
3. Vertical setting angles of the lights shall be such that the following vertical coverage of the main beam will be met:
 

distance from threshold	vertical main beam coverage
threshold to 115 m	0.5° — 10.5°
116 m to 215 m	1° — 11°
216 m and beyond	1.5° — 11.5° (as illustrated above)
4. See collective notes for Figures A2-1 to A2-11.

**Figure A2-2. Isocandela diagram for approach side row light (red light)**



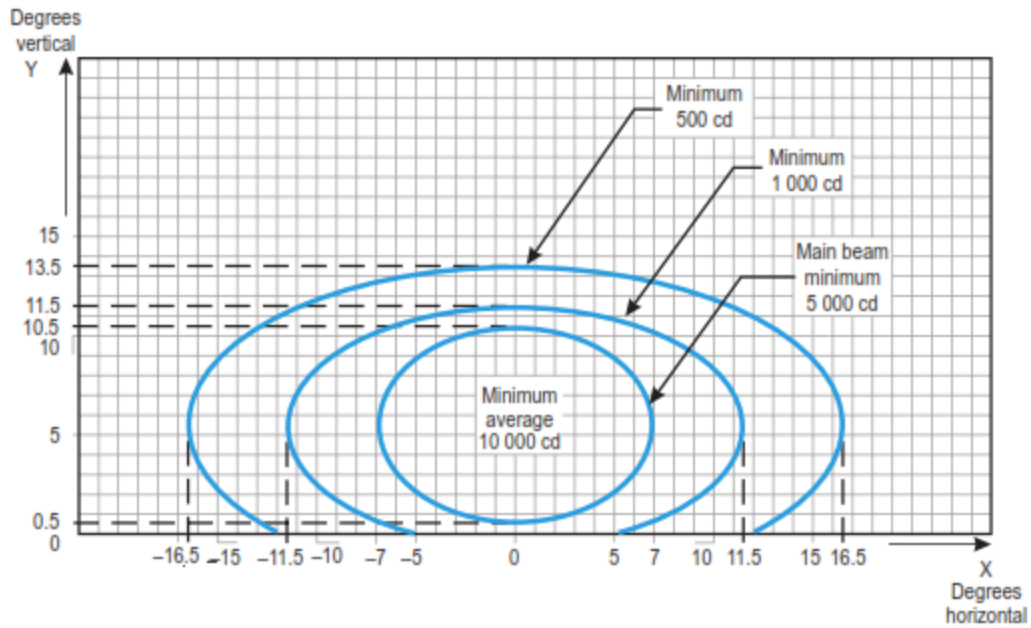
Notes:

1. Curves calculated on formula
2. Toe-in 3.5 degrees
3. See collective notes for Figures A2-1 to A2-11.

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$$

a	5.5	7.5	9.0
b	4.5	6.0	8.5

**Figure A2-3. Isocandela diagram for threshold light (green light)**



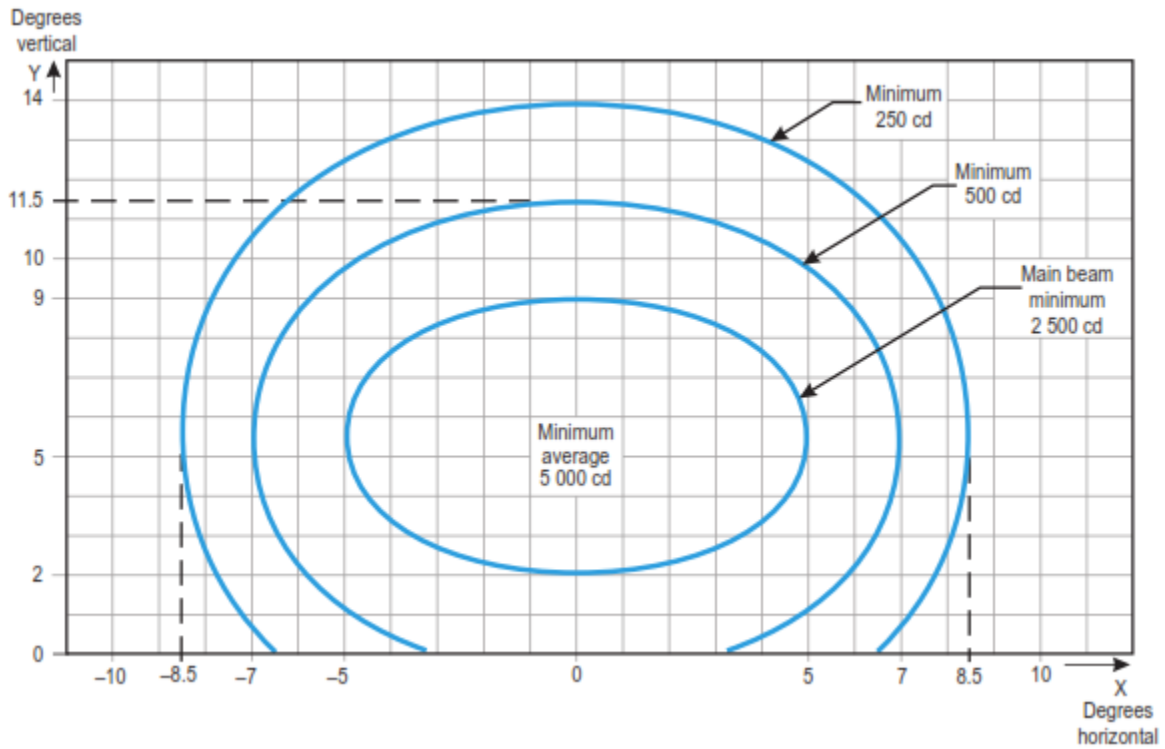
Notes:

1. Curves calculated on formula
2. Toe-in 2 degrees
3. See collective notes for Figures A2-1 to A2-11.

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$$

a	7.0	11.5	16.5
b	5.0	6.0	8.0

**Figure A2-4. Isocandela diagram for threshold wing bar light (green light)**



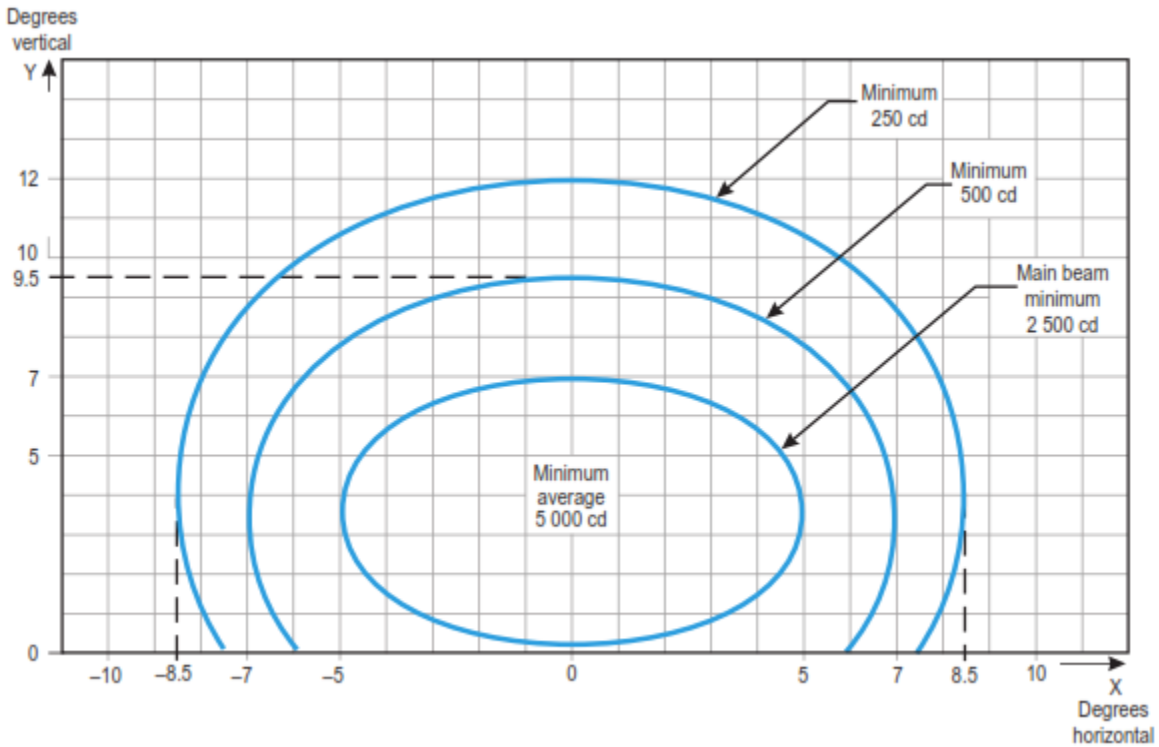
Notes:

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$$

a	5.0	7.0	8.5
b	3.5	6.0	8.5

1. Curves calculated on formula
2. Toe-in 4 degrees
3. See collective notes for Figures A2-1 to A2-11.

**Figure A2-5. Isocandela diagram for touchdown zone light (white light)**



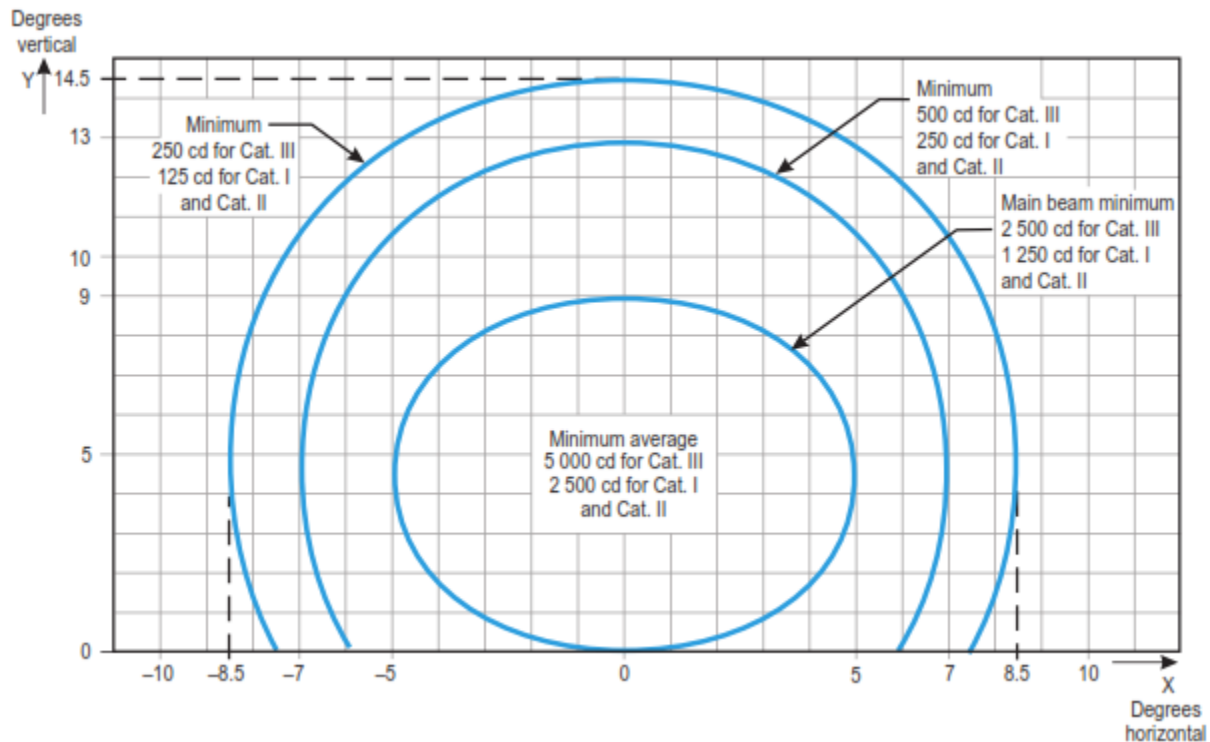
Notes:

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$$

a	5.0	7.0	8.5
b	3.5	6.0	8.5

1. Curves calculated on formula
2. For red light, multiply values by 0.15.
3. For yellow light, multiply values by 0.40.
4. See collective notes for Figures A2-1 to A2-11.

**Figure A2-6. Isocandela diagram for runway centre line light with 30 m longitudinal spacing (white light) and rapid exit taxiway indicator light (yellow light)**



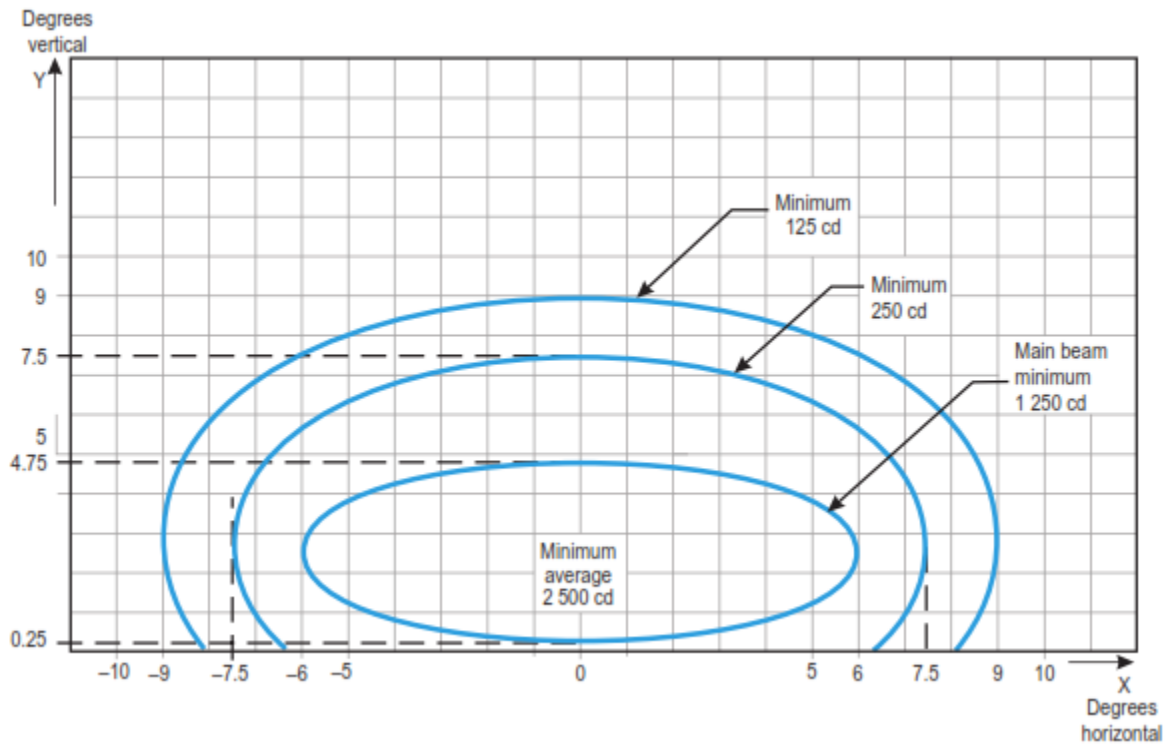
Notes:

1. Curves calculated on formula
2. For red light, multiply values by 0.15.
3. For yellow light, multiply values by 0.40.
4. See collective notes for Figures A2-1 to A2-11.

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$$

a	5.0	7.0	8.5
b	4.5	8.5	10

**Figure A2-7. Isocandela diagram for runway centre line light with 15 m longitudinal spacing (white light) and rapid exit taxiway indicator light (yellow light)**



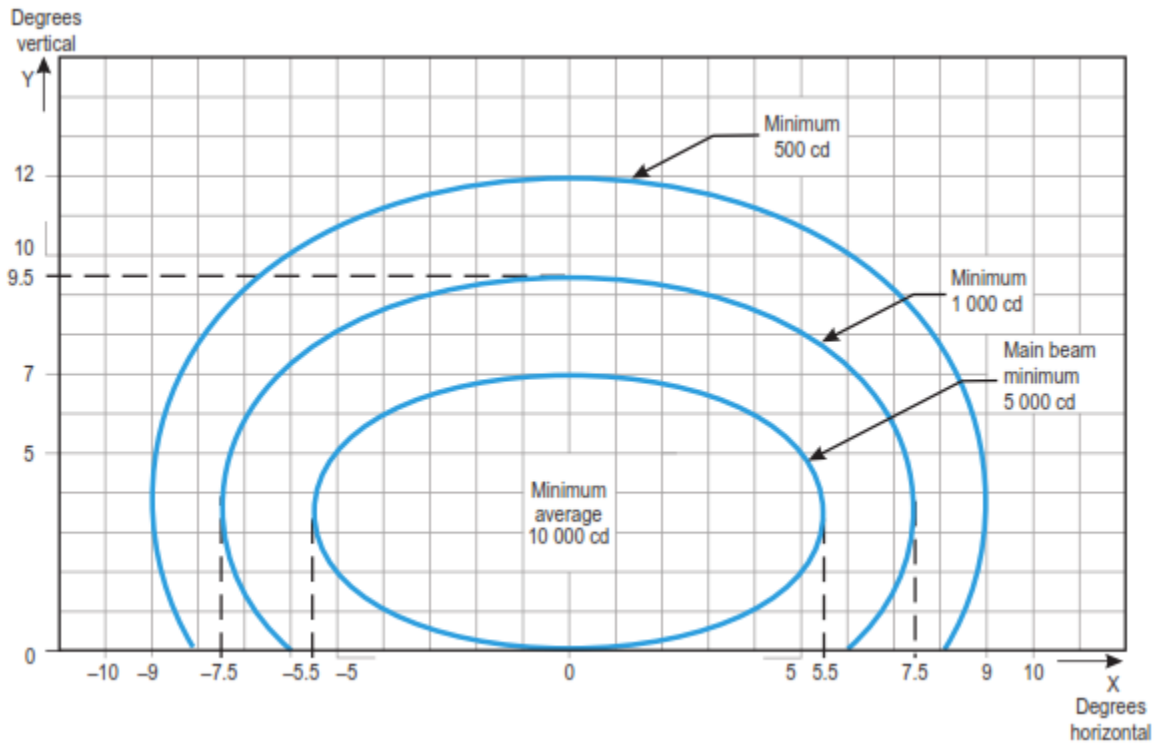
Notes:

1. Curves calculated on formula
2. See collective notes for Figures A2-1 to A2-11.

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$$

a	6.0	7.5	9.0
b	2.25	5.0	6.5

**Figure A2-8. Isocandela diagram for runway end light (red light)**

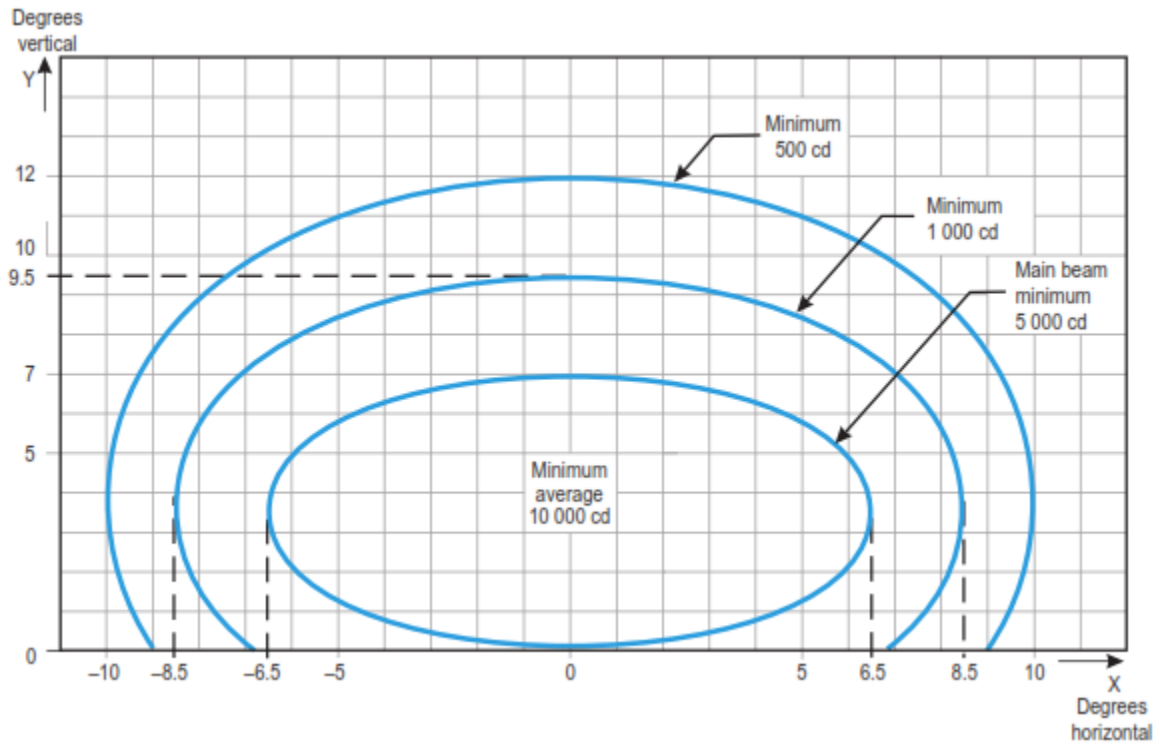


Notes:

1. Curves calculated on formula  $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$
2. Toe-in 3.5 degrees
3. For red light, multiply values by 0.15.
4. For yellow light, multiply values by 0.40.
5. See collective notes for Figures A2-1 to A2-11.

a	5.5	7.5	9.0
b	3.5	6.0	8.5

**Figure A2-9. Isocandela diagram for runway edge light where width of runway is 45 m (white light)**



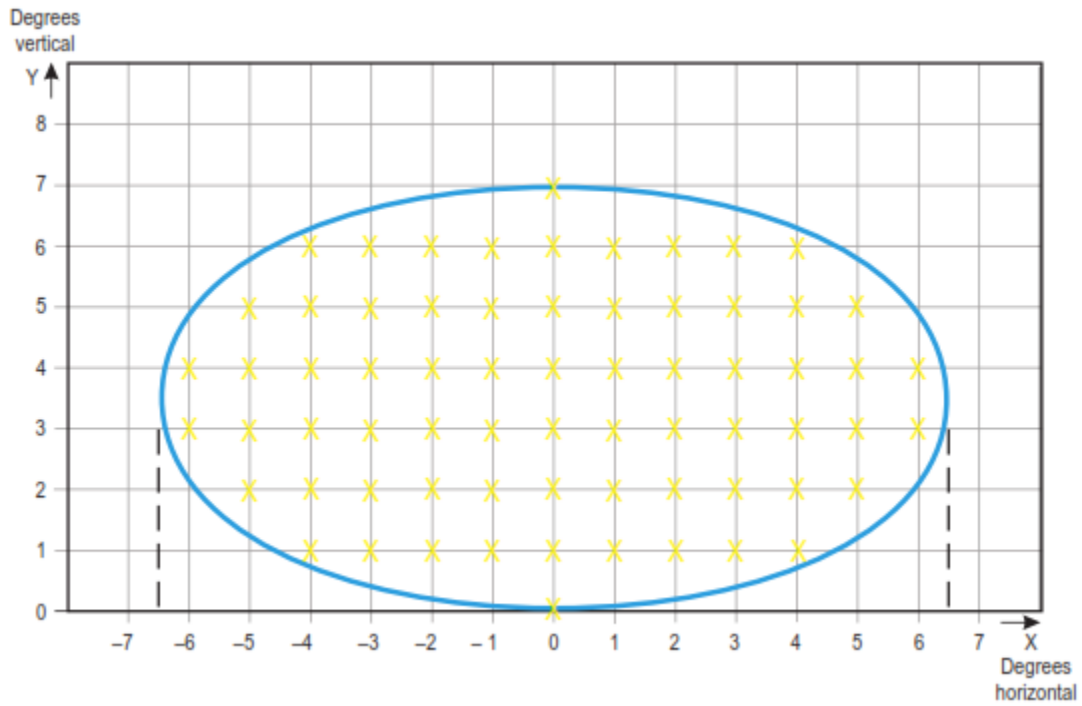
Notes:

1. Curves calculated on formula
2. Toe-in 4.5 degrees
3. For red light, multiply values by 0.15.
4. For yellow light, multiply values by 0.40.
5. See collective notes for Figures A2-1 to A2-11.

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$$

a	6.5	8.5	10.0
b	3.5	6.0	8.5

**Figure A2-10. Isocandela diagram for runway edge light where width of runway is 60 m (white light)**



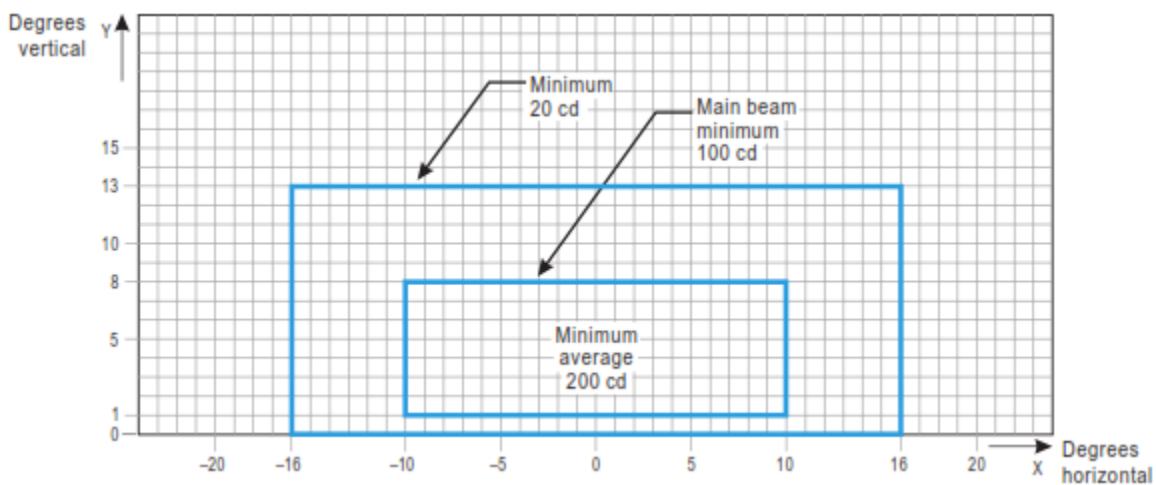
**Figure A2-11. Grid points to be used for the calculation of average intensity of approach and runway lights**

*Collective notes to Figures A2-1 to A2-11*

1. The ellipses in each figure are symmetrical about the common vertical and horizontal axes.
2. Figures A2-1 to A2-10 show the minimum allowable light intensities. The average intensity of the main beam is calculated by establishing grid points as shown in Figure A2-11 and using the intensity value measures at all grid points located within and on the perimeter of the ellipse representing the main beam. The average value is the arithmetic average of light intensities measured at all considered grid points.
3. No deviations are acceptable in the main beam pattern when the lighting fixture is properly aimed.
4. Average intensity ratio. The ratio between the average intensity within the ellipse defining the main beam of a typical new light and the average light intensity of the main beam of a new runway edge light shall be as follows:

Figure A2-1	Approach centre line and crossbars	1.5 to 2.0 (white light)
Figure A2-2	Approach side row	0.5 to 1.0 (red light)
Figure A2-3	Threshold	1.0 to 1.5 (green light)
Figure A2-4	Threshold wing bar	1.0 to 1.5 (green light)
Figure A2-5	Touchdown zone	0.5 to 1.0 (white light)
Figure A2-6	Runway centre line (longitudinal spacing 30 m)	0.5 to 1.0 (white light)
Figure A2-7	Runway centre line (longitudinal spacing 15 m)	0.5 to 1.0 for CAT III (white light)
		0.25 to 0.5 for CAT I, II (white light)
Figure A2-8	Runway end	0.25 to 0.5 (red light)
Figure A2-9	Runway edge (45 m runway width)	1.0 (white light)
Figure A2-10	Runway edge (60 m runway width)	1.0 (white light)

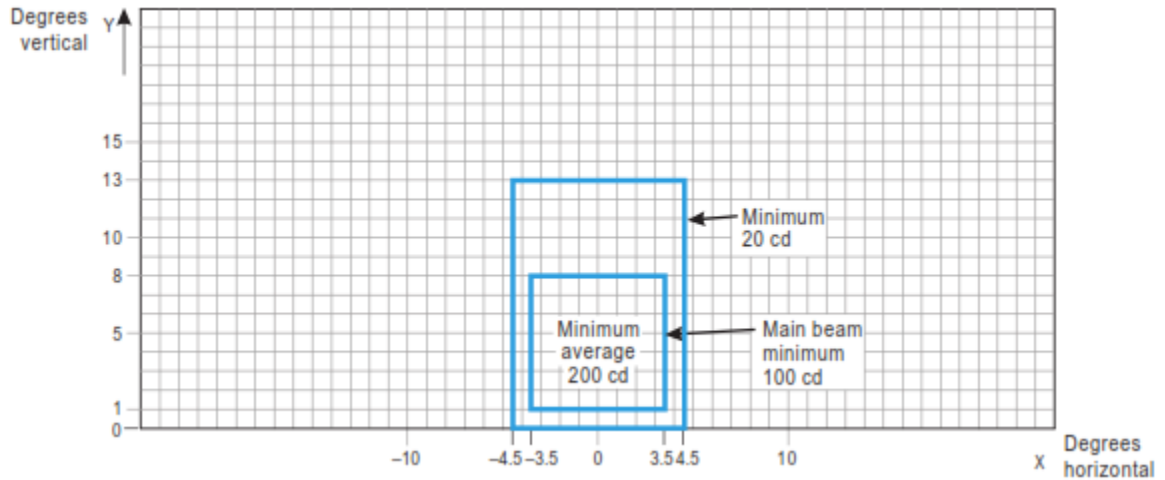
5. The beam coverages in the figures provide the necessary guidance for approaches down to an RVR of the order of 150 m and take-offs down to an RVR of the order of 100 m.
6. Horizontal angles are measured with respect to the vertical plane through the runway centre line. For lights other than centre line lights, the direction towards the runway centre line is considered positive. Vertical angles are measured with respect to the horizontal plane.
7. Where, for approach centre line lights and crossbars and for approach side row lights, inset lights are used in lieu of elevated lights, e.g. on a runway with a displaced threshold, the intensity requirements can be met by installing two or three fittings (lower intensity) at each position.
8. The importance of adequate maintenance cannot be overemphasized. The average intensity should never fall to a value less than 50 per cent of the value shown in the figures, and it should be the aim of airport authorities to maintain a level of light output close to the specified minimum average intensity.
9. The light unit shall be installed so that the main beam is aligned within one-half degree of the specified requirement.



Notes:

1. These beam coverages allow for displacement of the cockpit from the centre line up to distances of the order of 12 m and are intended for use before and after curves.
2. See collective notes for Figures A2-12 to A2-21.
3. Increased intensities for enhanced rapid exit taxiway centre line lights as recommended in 5.3.16.9 are four times the respective intensities in the figure (i.e. 800 cd for minimum average main beam).

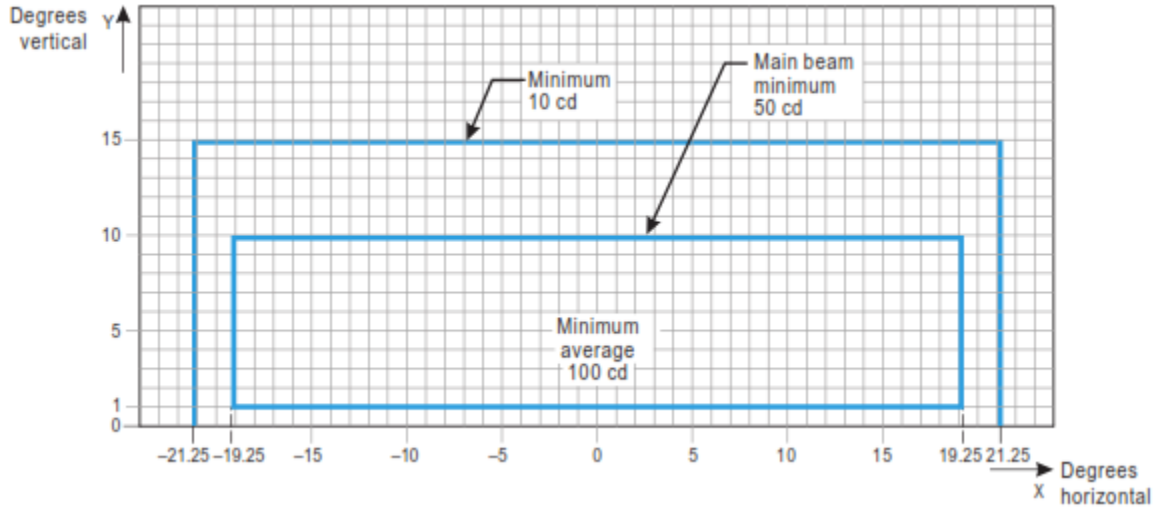
**Figure A2-12. Isocandela diagram for taxiway centre line (15 m spacing), RELs, no-entry bar and stop bar lights in straight sections intended for use in runway visual range conditions of less than a value of 350 m where large offsets can occur and for low-intensity runway guard lights, Configuration B**



Notes:

1. These beam coverages are generally satisfactory and cater for a normal displacement of the cockpit from the centre line of approximately 3 m.
2. See collective notes for Figures A2-12 to A2-21.

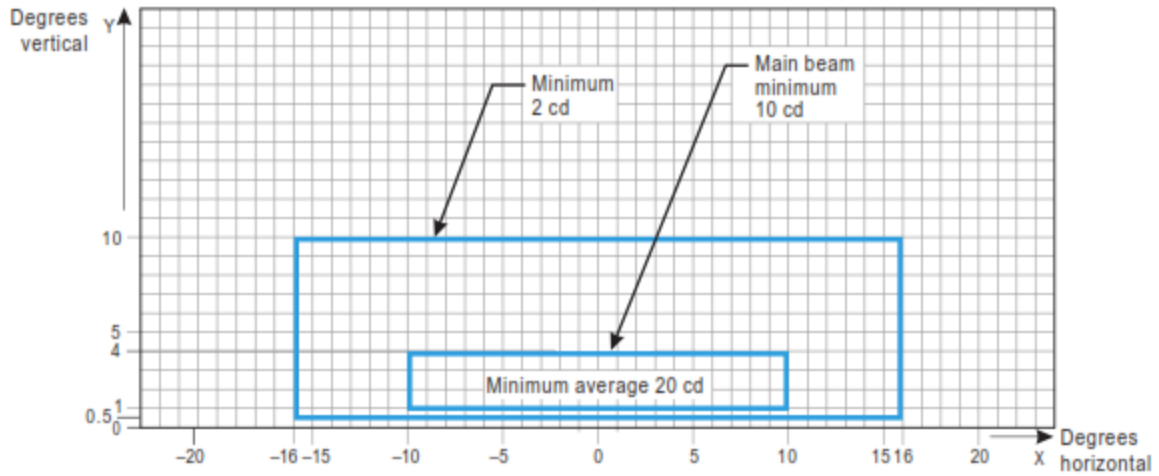
**Figure A2-13. Isocandela diagram for taxiway centre line (15 m spacing), no-entry bar and stop bar lights in straight sections intended for use in runway visual range conditions of less than a value of 350 m**



Notes:

1. Lights on curves to be toed-in 15.75 degrees with respect to the tangent of the curve. This does not apply to runway entrance lights (RELs)
2. Increased intensities for RELs shall be twice the specified intensities, i.e., minimum 20 cd, main beam minimum 100 cd and minimum average 200 cd.
3. See collective notes for Figures A2-12 to A2-21.

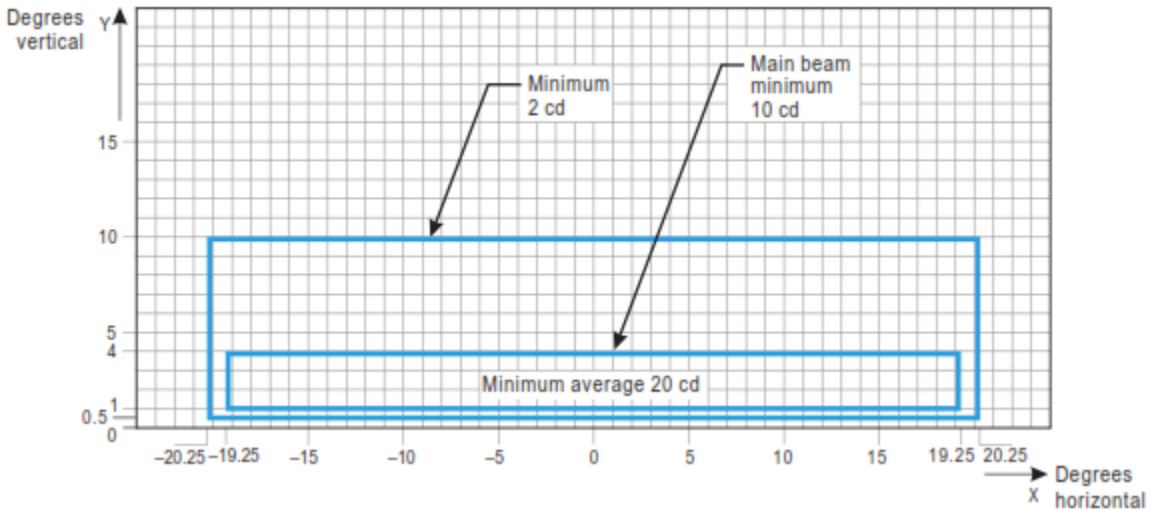
**Figure A2-14. Isocandela diagram for taxiway centre line (7.5 m spacing), RELs, no-entry bar and stop bar lights in curved sections intended for use in runway visual range conditions of less than a value of 350 m**



Notes:

1. At locations where high background luminance is usual and where deterioration of light output resulting from dust, snow and local contamination is a significant factor, the cd-values should be multiplied by 2.5.
2. Where omnidirectional lights are used they shall comply with the vertical beam requirements in this figure.
3. See collective notes for Figures A2-12 to A2-21.

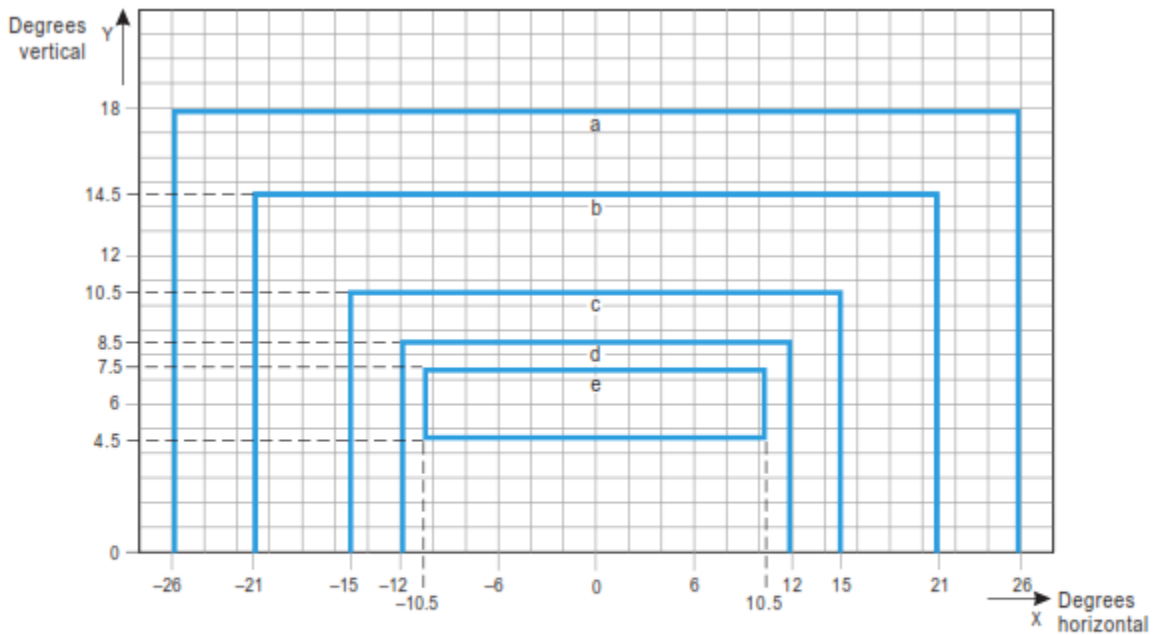
**Figure A2-15. Isocandela diagram for taxiway centre line (30 m, 60 m spacing), no-entry bar and stop bar lights in straight sections intended for use in runway visual range conditions of 350 m or greater**



Notes:

1. Lights on curves to be toed-in 15.75 degrees with respect to the tangent of the curve.
2. At locations where high background luminance is usual and where deterioration of light output resulting from dust, snow and local contamination is a significant factor, the cd-values should be multiplied by 2.5.
3. These beam coverages allow for displacement of the cockpit from the centre line up to distances of the order of 12 m as could occur at the end of curves.
4. See collective notes for Figures A2-12 to A2-21.

**Figure A2-16. Isocandela diagram for taxiway centre line (7.5 m, 15 m, 30 m spacing), no-entry bar and stop bar lights in curved sections intended for use in runway visual range conditions of 350 m or greater**

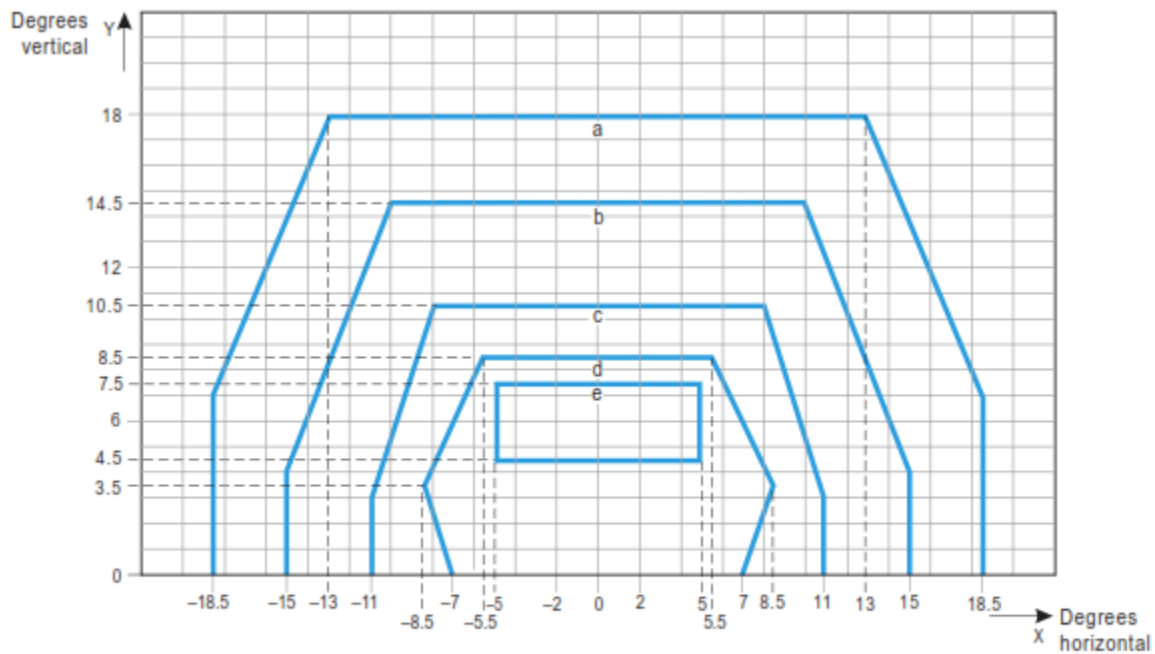


Curve	a	b	c	d	e
Intensity (cd)	8	20	100	450	1 800

Notes:

1. These beam coverages allow for displacement of the cockpit from the centre line up to distances of the order of 12 m and are intended for use before and after curves.
2. See collective notes for Figures A2-12 to A2-21.

**Figure A2-17. Isocandela diagram for high-intensity taxiway centre line (15 m spacing), no-entry bar and stop bar lights in straight sections intended for use in an advanced surface movement guidance and control system where higher light intensities are required and where large offsets can occur**

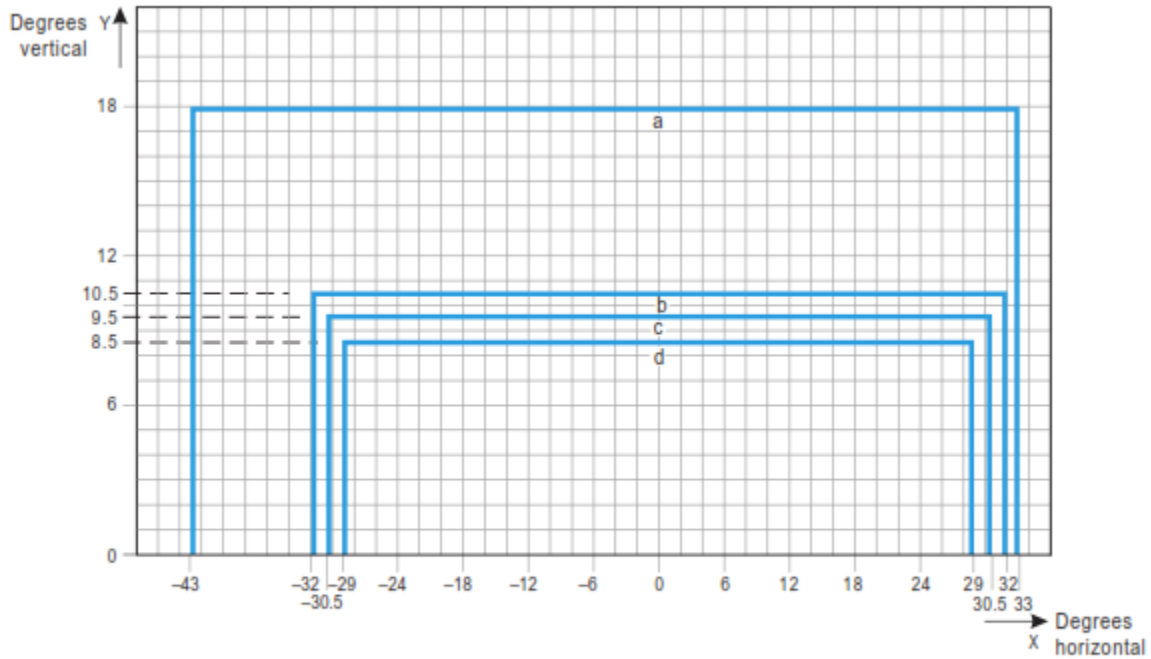


Curve	a	b	c	d	e
Intensity (cd)	8	20	100	450	1 800

Notes:

1. These beam coverages are generally satisfactory and cater for a normal displacement of the cockpit corresponding to the outer main gear wheel on the taxiway edge.
2. See collective notes for Figures A2-12 to A2-21.

**Figure A2-18. Isocandela diagram for high-intensity taxiway centre line (15 m spacing), no-entry bar and stop bar lights in straight sections intended for use in an advanced surface movement guidance and control system where higher light intensities are required**

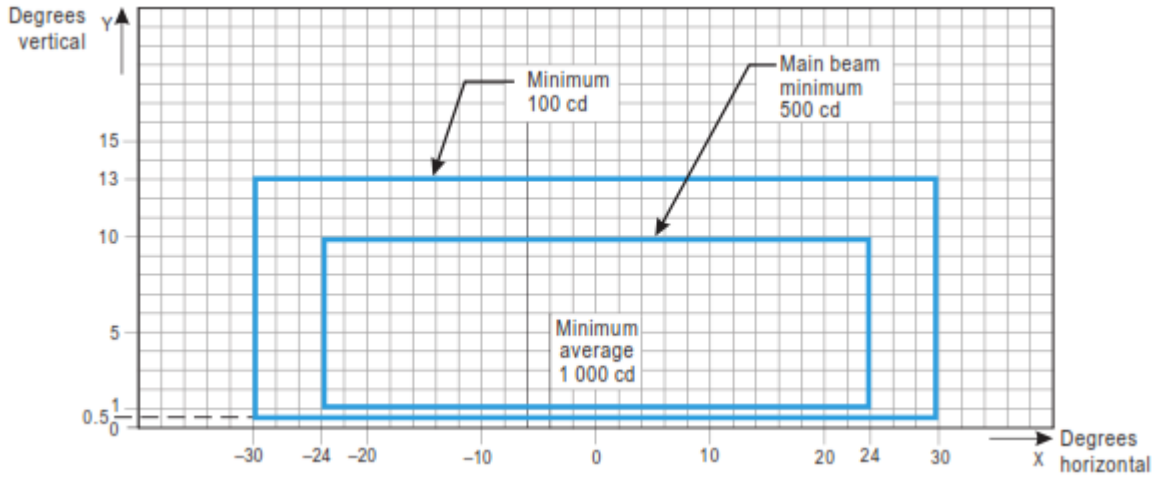


Curve	a	b	c	d
Intensity (cd)	8	100	200	400

Notes:

1. Lights on curves to be toed-in 17 degrees with respect to the tangent of the curve.
2. See collective notes for Figures A2-12 to A2-21.

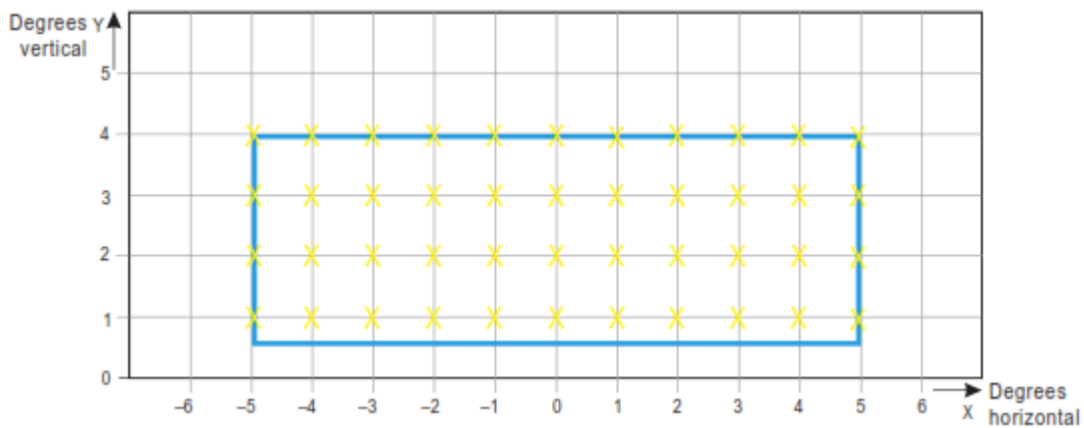
**Figure A2-19. Isocandela diagram for high-intensity taxiway centre line (7.5 m spacing), no-entry bar and stop bar lights in curved sections intended for use in an advanced surface movement guidance and control system where higher light intensities are required**



Notes:

1. Although the lights flash in normal operation, the light intensity is specified as if the lights were fixed for incandescent lamps.
2. See collective notes for Figures A2-12 to A2-21.

**Figure A2-20. Isocandela diagram for high-intensity runway guard lights, Configuration B**



**Figure A2-21. Grid points to be used for calculation of average intensity of taxiway centre line and stop bar lights**

*Collective notes to Figures A2-12 to A2-21*

1. The intensities specified in Figures A2-12 to A2-20 are in green and yellow light for taxiway centre line lights, yellow light for runway guard lights and red light for stop bar lights.

2. Figures A2-12 to A2-20 show the minimum allowable light intensities. The average intensity of the main beam is calculated by establishing grid points as shown in Figure A2-21 and using the intensity values measured at all grid points located within and on the perimeter of the rectangle representing the main beam. The average value is the arithmetic average of the light intensities measured at all considered grid points.

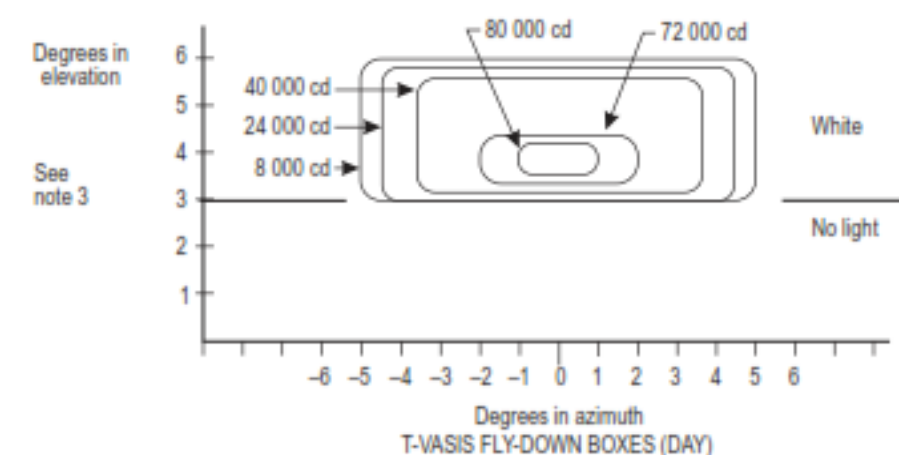
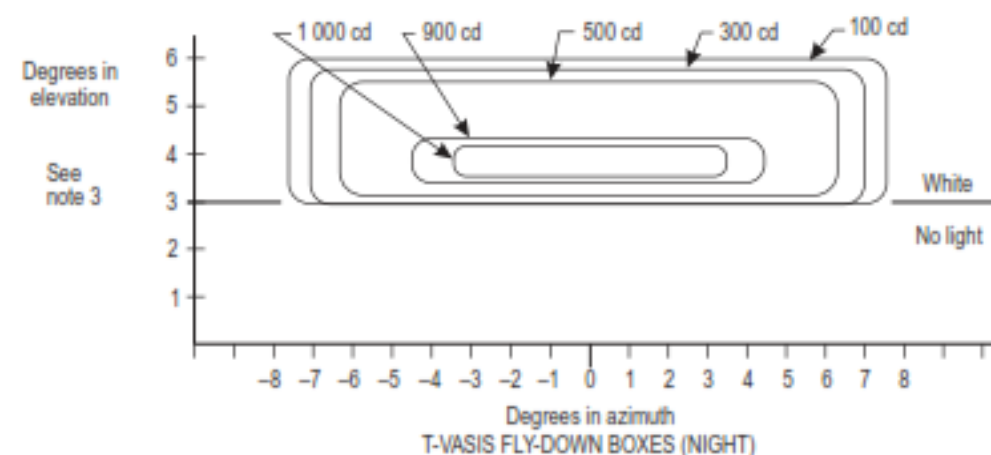
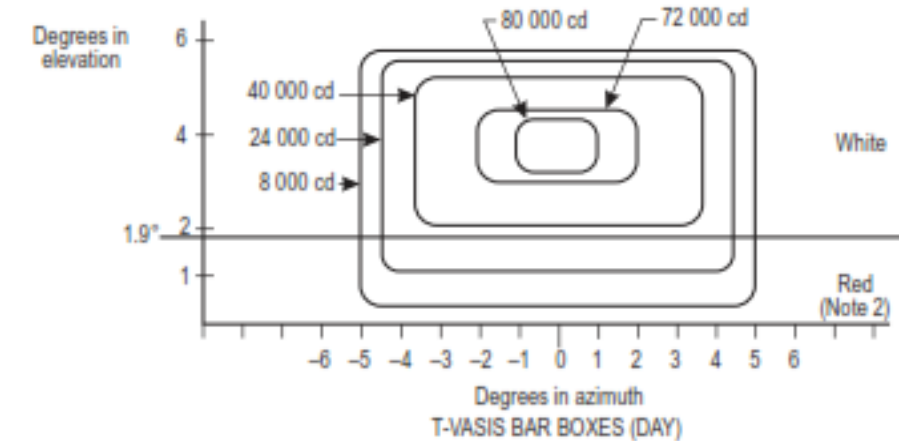
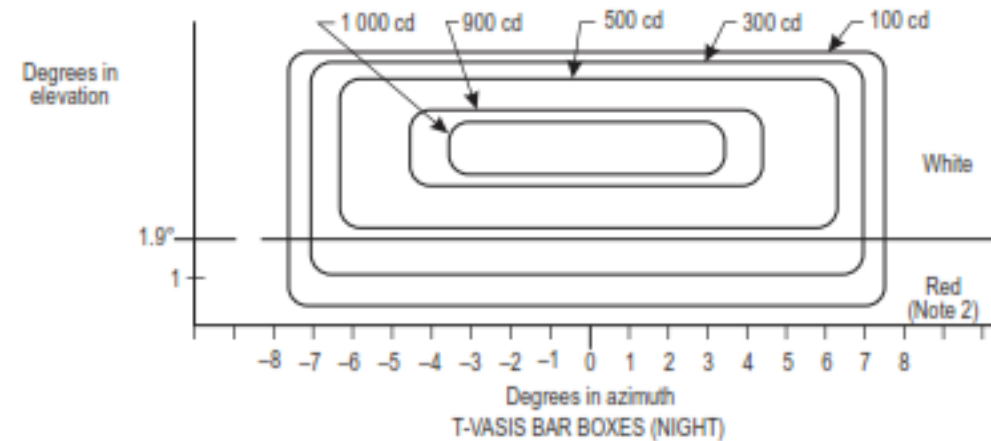
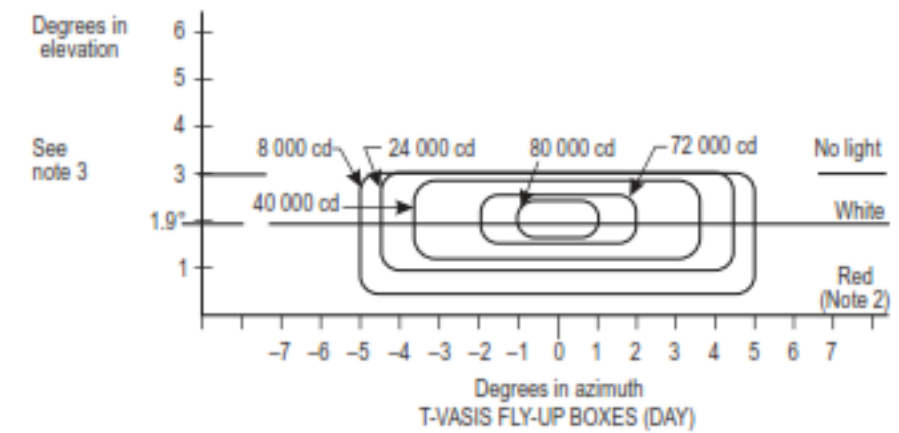
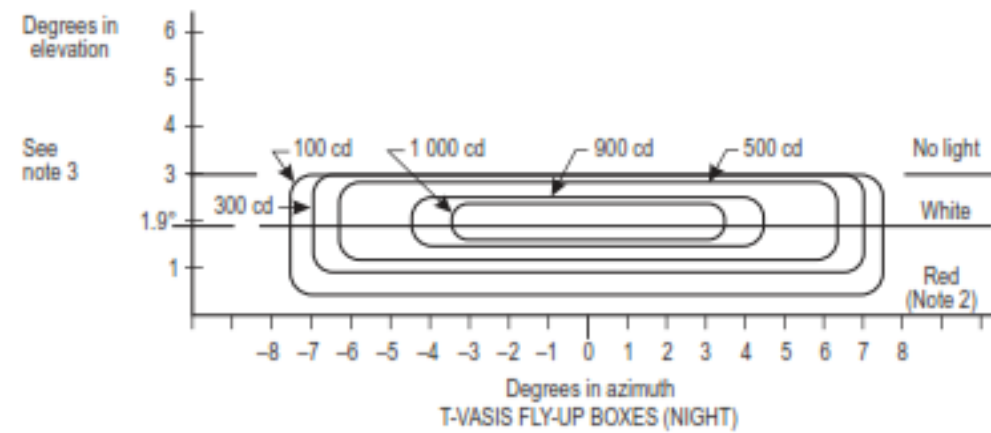
3. No deviations are acceptable in the main beam or in the innermost beam, as applicable, when the lighting fixture is properly aimed.

4. Horizontal angles are measured with respect to the vertical plane through the taxiway centre line except on curves where they are measured with respect to the tangent to the curve.

5. Vertical angles are measured from the longitudinal slope of the taxiway surface.

6. The importance of adequate maintenance cannot be overemphasized. The intensity, either average where applicable or as specified on the corresponding isocandela curves, should never fall to a value less than 50 per cent of the value shown in the figures, and it should be the aim of airport authorities to maintain a level of light output close to the specified minimum average intensity.

7. The light unit shall be installed so that the main beam or the innermost beam, as applicable, is aligned within one-half degree of the specified requirement.

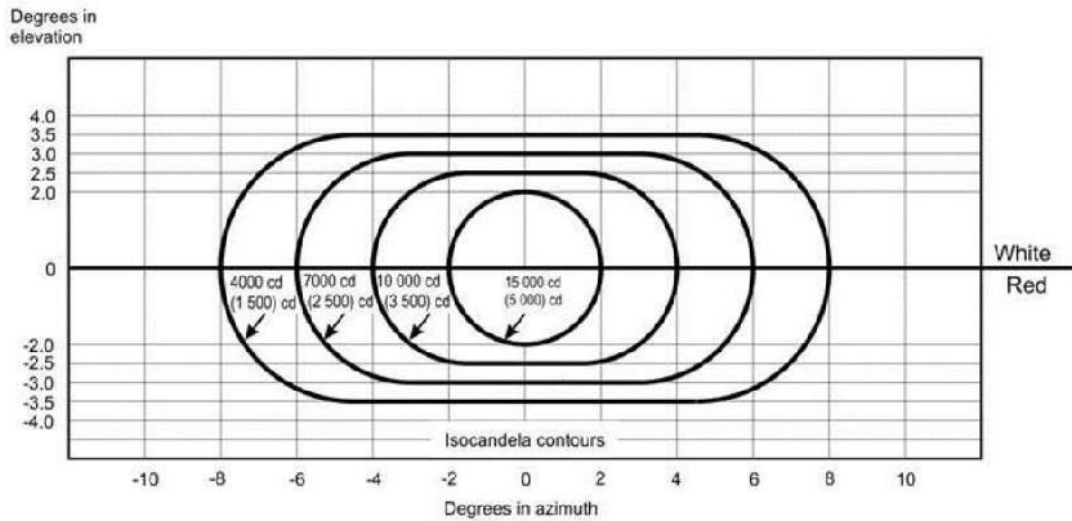


Note 1.— These curves are for minimum intensities in white light.

Note 2.— Filter transmissivity for all red signals is 15 per cent minimum at operating temperature.

Note 3.— A sharp transition from white to no light in elevation is essential to T-VASIS operation. For exact elevation settings, see Figure 5-18.

Figure A2-22. Light intensity distribution of T-VASIS and AT-VASIS



**Notes:**

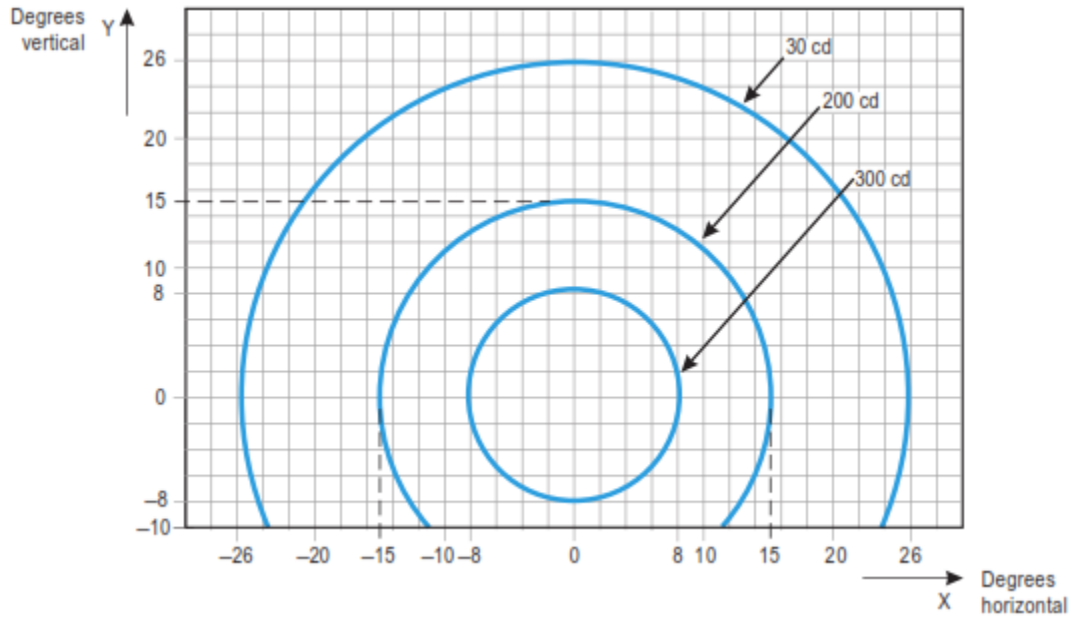
1. These curves are for minimum intensities in red light.
2. The intensity value in the white sector of the beam is no less than 2 and may be as high as 6.5 times the corresponding intensity in the red sector.
3. The intensity values shown in brackets are for APAPI.

**Figure A2-23. Light intensity distribution of PAPI and APAPI**

**Notes:**

1. These curves are for minimum intensities in red light.
2. The intensity value in the white sector of the beam is no less than 2 and may be as high as 6.5 times the corresponding intensity in the red sector.
3. The intensity values shown in brackets are for APAPI.

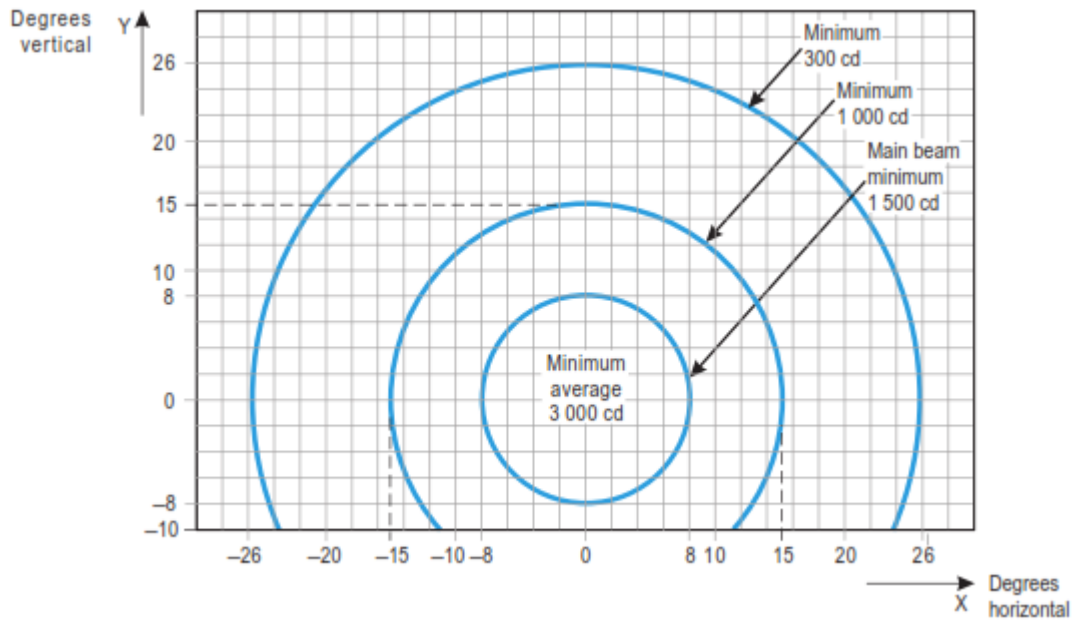
**Figure A2-23. Light intensity distribution of PAPI and APAPI**



Notes:

1. Although the lights flash in normal operation, the light intensity is specified as if the lights were fixed for incandescent lamps.
2. The intensities specified are in yellow light.

**Figure A2-24. Isocandela diagram for each light in low-intensity runway guard lights, Configuration A**



Notes:

1. Although the lights flash in normal operation, the light intensity is specified as if the lights were fixed for incandescent lamps.
2. The intensities specified are in yellow light.

**Figure A2-25. Isocandela diagram for each light in high-intensity runway guard lights, Configuration A**