CHAPTER 9: VISUAL AIDS PROVIDED BY AERODROME LIGHTING

Section 9.1: General

9.1.1 Application and Definitions

9.1.1.1 Existing installed lighting systems must be operated and maintained in accordance with existing procedures. The standards in this Chapter do not apply to an existing lighting facility until:

(a) the light fittings of a lighting system are being replaced with fittings of a different type. A lighting system in this case has the following meaning: lights on a section of taxiway (not all taxiways), lights on a threshold (not all thresholds) etc.

(b) the facility is upgraded;

(c) there is a change in the category of either:

(i) aerodrome layout; or

(ii) aerodrome traffic density; or

(d) in exceptional circumstances, CASA determines that in the interest of safety, a lighting facility has to meet the standards of this Chapter.

9.1.1.2 For aerodrome lighting purposes, words used in this Chapter have the following meaning:

(a) **Aerodrome layout.** This means the number of runways, taxiways and aprons at an aerodrome provided with lighting, and is divided into the following categories:

(i) **Basic** – an aerodrome with one runway, with one taxiway to one apron area;

(ii) **Simple** – an aerodrome with one runway, having more than one taxiway to one or more apron areas;

(iii) **Complex** – an aerodrome with more than one runway, having many taxiways to one or more apron areas.

(b) **Aerodrome traffic density.** This means the number of aircraft movements in the mean busy hour, and is divided into the following categories:

(i) **Light** – not greater than 15 movements per runway or typically less than 20 total aerodrome movements;

(ii) **Medium** – 16 to 25 movements per runway or typically between 20 to 35 total aerodrome movements;

(iii) **Heavy** – 26 or more movements per runway or typically more than 35 aerodrome movements.

> **Note:** 1: The number of movements in the mean busy hour is the arithmetic mean over the year of the number of movements in the daily busiest hour.
>
> 2: Either a take-off or a landing constitutes a movement.

(c) **Upgrade of a facility.** A facility is deemed to be upgraded if the improvement of the facility allows it to:

(i) accommodate aeroplanes from a higher reference code, such as from code 2 to code 3 runway or code 3 to code 4;

(ii) be used by aeroplanes flying under different approach conditions, such as:

(A) from non-instrument to non-precision instrument;

(B) from non-precision instrument to precision instrument;

(C) from precision category I to category II or III.

(d) **Practicable.** This term is used to allow CASA acceptance of variation to a standard due to insurmountable difficulties in the way of full compliance. If an aerodrome operator believes that compliance with a standard is impracticable, the onus rests with that operator to demonstrate the impracticability to the satisfaction of the relevant CASA office.

9.1.2 Standardisation of Aerodrome Lighting

9.1.2.1 It is important for pilot recognition and interpretation of aerodrome lighting systems, that standard configurations and colours be used. The pilot always views the aerodrome lighting systems in perspective, never in plan, and has to interpret the guidance provided, while travelling at high speed, often with only a limited segment of the lighting visible. As time will be limited to see and react to visual aids, particularly in the lower visibilities, simplicity of pattern, in addition to standardisation, is extremely important.

9.1.2.2 Pilot visual workload is best moderated by standardisation, balance and integrity of elements. A ragged system with many missing lights can break the pattern from the pilot's eye position, restricted as that position is by cockpit cut-off angles and possibly by patchy fog or other conditions.

9.1.2.3 For some aerodrome lighting systems, historic usage in various countries has resulted in more than one system being endorsed by ICAO. In these circumstances, CASA may have endorsed some, but not all, ICAO systems for use in Australia.

9.1.2.4 Those systems not included in the MOS are not endorsed by CASA for use in Australia. Australian pilot training gives pilots familiarity with Australian standard systems, but not with those systems that are not Australian standard. It is important that aerodrome owners do not introduce non-endorsed or non-standard aerodrome lighting systems.

9.1.2.5 If the aerodrome owner has any doubts about a new system for their aerodrome, they are to check with CASA before proceeding.

9.1.3 Lighting in the Vicinity of an Aerodrome

9.1.3.1 An existing or proposed non-aeronautical ground light in the vicinity of an aerodrome, which, by reason of its intensity, configuration or colour, might endanger the safety of aircraft, must be notified to the relevant CASA office for a safety assessment. In general, vicinity of the aerodrome can be taken as within a 6 km radius of the aerodrome. Within this 6 km area, the following specific areas are the most likely to cause problems to aircraft operations:

(a) for a code 4 instrument runway – within a rectangular area the length of which extends at least 4500 m before each threshold and the width of which is at least 750 m either side of the extended runway centreline;

(b) for a code 2 or 3 instrument runway, within an area with the same width as (a) with the length extending to at least 3000 m from the threshold;

(c) for other cases, within the approach area.

> **Note:** 1: Aerodrome operators should liaise with local electricity and planning authorities, so that they can be alerted of lighting proposals in the vicinity of their aerodromes.
>
> 2: Section 9.21 provides advice to lighting designers when planning lighting installations in the vicinity of an aerodrome.

9.1.4 Minimum Lighting System Requirements

9.1.4.1 At an aerodrome opened for night operations, at least the following facilities must be provided with appropriate lighting:

(a) runways, taxiways and aprons intended for night use;

(b) at least one wind direction indicator;

(c) if an obstacle within the applicable OLS area of the aerodrome is determined by CASA as requiring obstacle lighting, the obstacle lighting.

> **Note:** In the case of taxiways used only by aeroplanes of code A or B, taxiway reflective markers may be used in lieu of some taxiway lighting.

9.1.4.2 Where any approach end of a runway is intended to serve jet-propelled aeroplanes engaged in air transport operations, that approach end must be provided with an approved visual approach slope indicator system, in accordance with Paragraph 9.9.1. Additionally CASA may direct a runway to be provided with a visual approach slope indicator system if the circumstances surrounding the aerodrome require such an aid for aircraft safety purposes.

9.1.4.3 To avoid confusion at an aerodrome with more than one visual approach slope indicator system, the same type of approach slope indicator system must be used, in accordance with Paragraph 9.9.1.7.

9.1.4.4 A runway intended to serve Category I, II or III precision approach operations must be provided with an approach lighting system, where physically practicable, in accordance with the standards set out in this Chapter.

9.1.4.5 Movement area guidance signs intended for use at night must be illuminated in accordance with the standards set out in Chapter 8.

9.1.4.6 In certain circumstances additional lighting systems may be required at some aerodromes. For example, aerodrome beacons, visual docking guidance systems and runway threshold identification lights. Where provided, they shall be in compliance with the standards set out in this Chapter.

9.1.5 Primary Source of Electricity Supply

9.1.5.1 Unless it is impracticable to do so, except for Paragraph 9.1.5.3 below, an aerodrome lighting system must be an electrically connected installation, with the primary source of electric power supplied by the local electricity supply authority.

9.1.5.2 Where the power supply of an aerodrome lighting system has to be derived from a source other than the normal reticulated electricity supply, a note to that effect shall be included in ERSA.

9.1.5.3 If, at an aerodrome intended for use by aircraft with less than 10 passenger seats engaged in air transport operations, power supply cannot be supplied by normal reticulated electricity, the supply may be derived from stand-alone generators or solar charged batteries.

9.1.6 Electrical Circuitry

9.1.6.1 Where they are electrically connected, aerodrome ground lighting, which includes runway, taxiway, approach and visual approach slope indicator and MAGS lighting circuits, must be by means of the series current system.

> **Note:** Inter-leaf circuitry is recommended for aerodromes intended for precision approach operations. Guidance on this may be found in ICAO Aerodrome Design Manual Part 5.

9.1.6.2 Feeder cables and series isolating transformers must be installed below ground, being:

(a) directly buried; or

(b) in pits, ducts or similar receptacles.

> **Note:** Section 9.22 provides information on the use of unarmoured cables on an aerodrome.

9.1.6.3 Other electrical equipment and wiring, except for a light or light fitting, must not be installed above ground level in the manoeuvring area.

9.1.7 Secondary Power Supply

9.1.7.1 Secondary power supply means electricity power supply which is connected to the load automatically on the failure of the primary power source. This may be derived by either of the following:

(a) independent public power, which is a source of power supplying the aerodrome service from a substation other than the normal substation through a transmission line following a route different from the normal power supply route and such that the possibility of a simultaneous failure of the normal and independent public power supplies is extremely remote; or

(b) generators, batteries etc. from which electric power can be obtained.

9.1.7.2 Secondary power must be provided to at least one runway at an aerodrome intended for Cat I precision approach operations, which would allow the operation of the following lighting systems:

(a) approach lighting;

(b) visual approach slope indicator;

(c) runway edge;

(d) runway threshold;

(e) runway end;

(f) essential taxiway and runway guard lights;

(g) apron; and

(h) obstacles, if any, lighting of which has been determined by CASA as essential for the safety of aircraft operations.

Note: Not applicable in general to off-aerodrome obstacle lighting, the status of lighting availability of which is subject to aerodrome operator monitor.

9.1.7.3 In addition to Paragraph 9.1.7.2 above, for an aerodrome intended for Cat II and III precision approach operations, the secondary power must be adequate for the lighting of the following:

(a) runway centreline lights;

(b) touchdown zone lights; and

(c) all stop bars.

9.1.8 Switch-over Time

9.1.8.1 The time interval between failure of the normal source of power and the complete restoration of the service following switch-over to secondary power is not to exceed, for:

(a) Precision Approach Cat I visual aids – 15 seconds.

(b) Precision Approach Cat II and III visual aids;

(i) essential obstacle lights - 15 seconds.

(ii) essential taxiway lights - 15 seconds.

(iii) all other visual aids - 1 second.

(c) Runways meant for take-off in RVR conditions less than a value of 800 m;

(i) essential obstacle lights - 15 seconds.

(ii) essential taxiway lights - 15 seconds.

(iii) runway edge lights, where runway center line lights are provided - 15 seconds.

(iv) runway edge lights, where runway center line lights are not provided - 1 second.

(v) runway end lights - 1 second.

(vi) runway center line lights - 1 second.

(vii) all stop bars - 1 second.

9.1.9 Standby Power Supply

Note: Operational credit is given to a runway lighting system notified in ERSA as provided with standby power or portable lighting. This is because when a flight is planned to land at night at an aerodrome with electric runway lighting, provision must be made for flight to an alternate aerodrome unless the destination aerodrome has standby power, or portable runway lights are available and arrangements have been made for a responsible person to be in attendance.

9.1.9.1 For lighting to be notified in ERSA as provided with standby power, the standby power supply may be either secondary power or standby generators which are manually activated.

9.1.9.2 Where the activation of the standby power is not automatic, procedures must be established to facilitate the introduction of standby power as soon as possible when the need arises.

Note: 1. For non-automatic activation the actual time required for activation of standby power should be notated in ERSA.

2. The procedures should allow standby power to be provided within 15 minutes of demand. Aircraft fuel management is the pilot's responsibility. CASA guidelines on fuel management are contained in CAAP 234-1(0). For aircraft operating at night with no alternate aerodrome, the recommended fuel reserves are; 45 minutes for propeller driven aeroplanes and 30 minutes for jet aeroplanes.

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9.1.10 Portable Lighting

9.1.10.1 Portable lights may comprise liquid fuel-burning flares or lamps, or battery powered electric lights.

9.1.10.2 When an aerodrome is notified in ERSA as provided with portable lighting, the portable lights must be kept in a state of readiness and serviceable condition with clean glasses, and appropriate persons must be trained such that the lights can be deployed and put into operation without delay, when the need arises.

> **Note:** Due to the time required to deploy portable lights, the ERSA entry should include a notation that prior notice is required.

9.1.10.3 The portable lights must be placed at the same spacing as installed lights.

> **Note:** To allow speedy deployment, the locations of the portable lights should be clearly marked, and the surface appropriately treated and maintained.

9.1.10.4 When required, they must be lit or switched on at least 30 minutes before the estimated time of arrival.

> **Note:** The portable lights should be so deployed such that an aircraft can land into the wind.

9.1.10.5 For aircraft departing, the portable lights must be lit or switched on at least 10 minutes before the time of departure and to be retained for at least 30 minutes after take off, or if air-ground communications do not exist, for at least one hour after take-off, in case the aeroplane needs to return to the aerodrome.

9.1.11 Light Fixtures and Supporting Structures

9.1.11.1 All aerodrome light fixtures and supporting structures must be of minimum weight while being fit for the function, and frangible.

> **Note:** ICAO Aerodrome Design Manual Part 4 provides guidelines on frangibility for visual aids.

9.1.11.2 Supporting structures for approach lights also need to be of minimum weight and frangible, except that, in that portion of the approach lighting system beyond 300 m from the runway threshold:

(a) where the height of a supporting structure exceeds 12 m, the frangibility requirement need apply to the top 12 m only; and

(b) where a supporting structure is surrounded by non-frangible objects, only that part of the structure that extends above the surrounding objects need be frangible.

9.1.11.3 Where an approach light fixture or supporting structure is not in itself sufficiently conspicuous, it is to be suitably marked.

9.1.12 Elevated and Inset Lights

9.1.12.1 Elevated lights must be frangible and sufficiently low to preserve clearance for propellers and the engine pods of jet aircraft. In general, they should not be more than 360 mm above the ground.

9.1.12.2 Elevated lights, in general, are preferable to inset lights, because they provide a larger aperture from which light signals can be seen. Elevated lights must be used in all cases except:

(a) where the use of inset lights is specified in this Chapter, or

(b) where it is not practicable to use elevated lights.

Note: Elevated lights are not practicable on pavements where aircraft or vehicles travel or in areas subject to significant jet blast.

9.1.12.3 Inset lights, also known as in-pavement lights, must not:

(a) be constructed with sharp edges;

(b) project more than 25 mm above the surrounding surface at locations where the lights will not normally come into contact with aircraft wheels, such as threshold lights, runway end lights and runway edge lights;

(c) project more than 13 mm above the surrounding surface at locations which will normally come into contact with aircraft wheels, such as runway centreline lights, touch down zone lights and taxiway centreline lights.

9.1.12.4 The maximum surface temperature attained by an inset light must not exceed 160°C over a period of 10 minutes, if operating at maximum intensity while covered by an aircraft wheel.

9.1.12.5 The standard colour of the casings of elevated light units is yellow.

9.1.13 Colour of Light Shown

9.1.13.1 The colour of the light shown must be in accordance with the applicable standard specified in Section 9.2.

9.1.13.2 To ensure uniformity of visual appearance, light fittings using different filter technology must not be mixed (e.g. dichroic filters, other absorption filters, light emitting diode (LED), etc.) in such a way as to create inconsistency in either light colour or intensity when viewed by pilots from a moving aircraft on a runway or taxiway.

9.1.14 Light intensity and Control

9.1.14.1 At an aerodrome with an air traffic service (ATS), the following lighting systems, if provided, must be equipped with an intensity control so that the ATS can select light output to suit ambient conditions and avoid dazzling pilots:

(a) approach lighting system;

(b) approach slope guidance system;

(c) runway edge, threshold and end lights;

(d) runway centreline lights;

(e) runway touchdown zone lights;

(f) taxiway lights.

9.1.14.2 At an aerodrome with a Certified Air-Ground Radio Operator (CAGRO), a Unicom operator, or similar responsible person with 2-way radio communications with aircraft, the aerodrome may choose to provide aerodrome lighting intensity control for use by that person.

9.1.14.3 Intensity must be capable of being varied in 5 or 6 stages, for the following systems:

(a) approach lighting systems

(b) visual approach slope indicator systems;

(c) high intensity runway edge, threshold and end lights;

(d) runway centreline lights;

(e) runway touchdown zone lights.

Note: Currently the Airservices Australia air traffic control system uses 6-stage intensity control.

9.1.14.4 Intensity must be capable of being varied in at least 3 stages, for medium intensity runway edge, threshold and end lights.

9.1.14.5 If a runway is equipped with both high and medium intensity runway edge lighting, the 3 lowest intensity stages shall be provided by the medium intensity system.

9.1.14.6 For taxiway lights:

(a) Taxiway centreline lights with a main beam average intensity of the order of 50 cd or less, 3 stages of intensity control will normally be sufficient.

(b) Taxiway centreline lights with main beam average intensity of the order of 100 cd or greater will normally require more than 3 stages of intensity control, or alternatively to have the maximum light output permanently reduced by fixing the maximum intensity stage at less than 100% of the rated output of the light. One hundred percent output of these lights has been found to be too bright for normal Australian conditions.

(c) Taxiway edge lights do not normally require separate intensity control. It is common for taxiway edge lights to be installed on the same electrical circuit as the low or medium intensity runway edge lights, and to be controlled by the runway light control.

9.1.14.7 Intensity must be reduced from each successive stage to an order of 25-33%. This is based on the fact that a change of that magnitude is required for the human eye to detect that a change has occurred. For 6 stages of intensities, they should be of the order of: 100%, 30%, 10%, 3%, 1% and 0.3%.

9.1.14.8 At an aerodrome where the lighting is provided with intensity settings but the ATS, CAGRO, Unicom operator, or similar responsible person, does not provide 24 hours coverage and:

(a) the operator leaves the lights turned on all night; or

(b) the lights are controlled by a PAL out of hours;

the recommended stage of intensity, which provides adequate illumination but will not dazzle pilots is stage 2.

> **Note:** Guidance on selecting series currents for various intensity stages for some airport lighting systems is given in the Table 9.1-1 below. The guidance is only applicable to systems installed to the industry standard of 6.6 amps series current giving 100% intensity, except where noted otherwise in the Table.

9.1.14.9 Where lighting systems are operated by ATS, or similar responsible person, such systems shall be monitored automatically so as to provide an immediate indication of:

(a) those lighting systems that are on;

(b) the intensity of each lighting system; and

(c) any fault in a lighting system.

(d) This information is to be automatically relayed to the operator position.

9.1.14.10 At an aerodrome with Low Intensity Runway Edge Lighting Systems, in accordance with Paragraph 9.10.1.1(a), the light fittings used must be in compliance with Paragraph 9.10.6. However, it is permissible with these systems, at commissioning, to adjust and then set the system current to a value other than the rated current value. This is to enable the actual light output of the light units to be set to a suitable light level to match the specific conditions of the particular aerodrome, to harmonise with the intensity of visual approach slope indicators if present, and minimise the likelihood of dazzling pilots. Where the system current is set to a value other than the rated current, the actual value of current set must be recorded in the Aerodrome Manual.

Table 9.1-1: Guidance on selecting series line currents for various intensity stages

Lighting System	Nominal minimum intensity at rated output	Stage 6	Stage 5	Stage 4	Stage 3	Stage 2	Stage 1
Runway Edge Lights, Low Intensity	100 cd						100% 6.6 A
Runway Edge Lights, Medium Intensity	300 cd typical				100% 6.6 A	30% 5.4 A	10% 4.5 A
Runway Edge Lights, High Intensity	10,000 cd	100% 6.6 A	30% 5.4 A	10% 4.5 A			
Approach Lights * 12.5A/6.6A series isolating transformer * 6.6A/6.6A series isolating transformer	20,000 cd	100% 12.5 A 6.6 A	25% 9.5 A 5.3 A	6.5% 7.5 A 4.3 A	2% 6.2 A 3.6 A	0.5% 5.0 A 3.2 A	0.12% 4.0 A 3.0 A
Runway Centreline lights	5,000 cd	100% 6.6 A	25% 5.2 A	8% 4.4 A	2.5% 3.8 A	0.8% 3.3 A	0.25% 3.0 A
Runway Touchdown Zone lights	5,000 cd	100% 6.6 A	25% 5.2 A	8% 4.4 A	2.5% 3.8 A	0.8% 3.3 A	0.25% 3.0 A
Taxiway Centreline lights	50 cd				100% 6.6 A	40% 5.5 A	16% 4.8 A
PAPI	15,000 cd red light	100% 6.6 A	30% 5.5 A	10% 4.8 A	3% 3.85 A	1% 3.4 A	0.3% 3.0 A
T-VASIS	See Section 9.9 Paragraph 9.9.3.11.						

Notes:

1. All values are for the Industry Standard system of 6.6A series current for full rated light output, (except Approach Lights using 12.5 A/6.6 A series isolating transformers), and would not be relevant for lighting systems installed to other electrical parameters.
2. The current values are true root mean square (RMS) amperes.
3. The intensity percentages are approximate only. At the higher Stages (5 and 6) it is more important to maintain the intensity ratio to runway edge lights as given in paragraphs 9.8.1.2 and 9.11.1.4. At the lower intensity stages, as used during good visibility conditions, maintaining those intensity ratios tends to result in glare for pilots, and so lower ratios are suggested.

9.1.15 Commissioning of Lighting Systems

9.1.15.1 Commissioning means the formal process by which the performance of the lighting system is confirmed by CASA, or a qualified person, as meeting the specifications. Qualified person in this case means:

(a) **For ground check of compliance with electrical specifications and CASA standards** — electrical engineer or licensed electrician.

> **Note:** Evidence supplied by authoritative source that the light units are in compliance with the standards is acceptable.

(b) **For flight checking of compliance with operational specifications** — pilot approved by CASA as having the competency to conduct flight check.

9.1.15.2 All aerodrome lighting systems must be commissioned by ground check before they are brought into use.

9.1.15.3 The ground check of a visual approach slope indicator system must include verification of vertical and horizontal angles of light signal changes by a person having civil engineering or surveying qualification and experience.

9.1.15.4 The commissioning of the following lighting systems, in addition to the ground check, must include flight checks of:

(a) approach lighting system;

(b) runway lighting system for instrument runways;

(c) visual approach slope indicator system

(i) used by jet propelled aeroplanes engaged in air transport operations; or

(ii) installed on CASA direction, in accordance with Paragraph 9.9.1.1(b);

(d) pilot-activated lighting system (PAL).

9.1.15.5 For a visual approach slope indicator system specified in Paragraph 9.1.15.4, that is provided for temporary use only, for example due to a temporary displaced threshold, or during works in progress, the requirement for a flight check is waived.

9.1.15.6 For those systems specified in Paragraph 9.1.15.4, the aerodrome operator shall forward duly certified ground check and flight check reports to the relevant CASA office. If CASA is satisfied with the reports, CASA will approve the issue of a permanent NOTAM. Information to be supplied by aerodrome operator for inclusion in the permanent NOTAM includes:

(a) For visual approach slope indicator system;

(i) runway designation;

(ii) type of system, and for AT-VASIS and PAPI systems, the side of runway, as seen by approaching pilot, that the aid is installed;

(iii) where the axis of the system is not parallel to the runway centreline, the angle of displacement and the direction of displacement, i.e. left or right;

(iv) approach slope; and

(v) minimum eye height over threshold, for the on-slope signal.

(b) For a PAL;

(i) the PAL frequency; and

(ii) any notes explaining PAL operation, for example where the PAL only controls certain visual aids at the aerodrome.

9.1.15.7 For those systems not specified in Paragraph 9.1.15.4, the aerodrome operator must use the duly certified ground check as sufficient evidence of compliance with standards to initiate a permanent NOTAM.

9.1.15.8 At any time after commissioning, CASA may direct the ground checking and/or the flight checking of a lighting system specified in Paragraph 9.1.15.4, following substantial changes to the system, or on receipt of adverse reports on the performance of the system from pilots or aircraft operators. Examples of substantial changes to the system include:

(a) removal and replacement of 50% or more of the light fittings, at the same time, of an approach or runway lighting system;

(b) removal and replacement of one or more light units of a PAPI system;

(c) removal and replacement of two or more light units, at the same time, of an AT-VASIS system; and

(d) removal and replacement of the receiver unit from a PAL.

> **Note**: Before a runway is opened for night use, the status of obstacles need to be assessed for obstacle lighting purposes, particularly if the obstacles are within 3 km of the aerodrome.

Section 9.2: Colours for Aeronautical Ground Lights

9.2.1 General

9.2.1.1 The following specifications define the chromaticity limits of colours to be used for aerodrome lighting.

9.2.1.2 The chromaticities are expressed in terms of the standard observer and co-ordination system adopted by the International Commission on Illumination (CIE).

9.2.2 Chromaticities

9.2.2.1 The chromaticities of aerodrome lights must be within the following boundaries:

CIE Equation (see Figure 9.2-1)

(a) Red

Purple boundary	$y = 0.980 - x$
Yellow boundary	$y = 0.335$

(b) Yellow

Red boundary	$y = 0.382$
White boundary	$y = 0.790 - 0.667x$
Green boundary	$y = x - 0.120$

(c) Green

Yellow boundary	$y = 0.726 - 0.726x$
White boundary	$x = 0.650y$
(except for visual docking guidance systems)	
White boundary	$x = 0.625y - 0.041$
(for visual docking guidance systems)	
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 x = 1.185 - 1.500y
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

9.2.3 Discrimination Between Coloured Lights

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

9.2.3.2 If there is a requirement to discriminate yellow from green or white, as for example with exit taxiway centreline lights, the 'y' co-ordinate of the yellow light must 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.

9.2.3.3 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 these lights are to be discriminated from yellow lights, the lights must be designed and operated so that:

(a) the 'x' co-ordinate of the yellow is at least 0.050 greater than the 'x' co-ordinate of the white; and

(b) the disposition of the lights is such that the yellow lights are displayed simultaneously and in close proximity to the white lights.

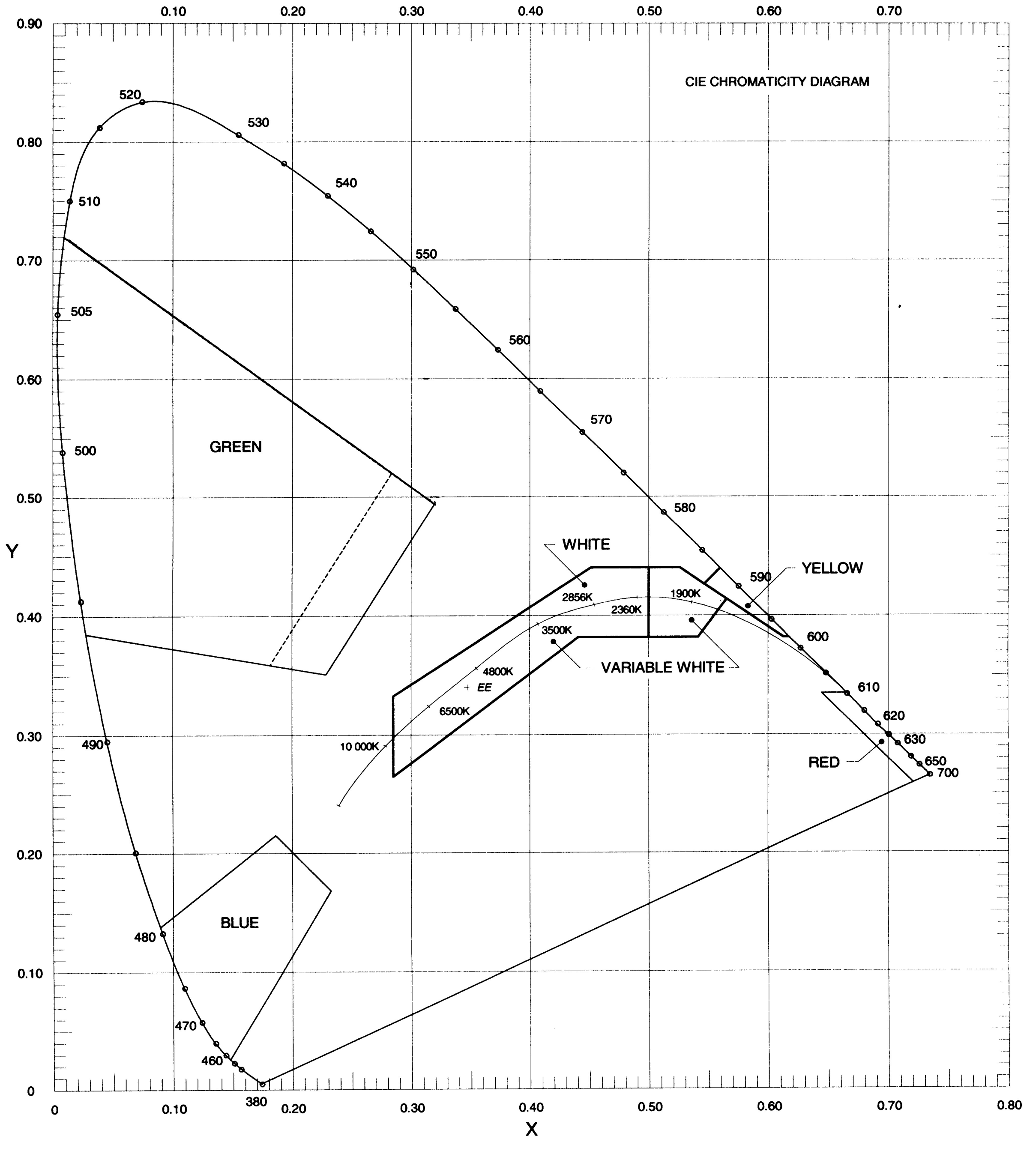

Figure 9.2-1: Colours for aeronautical ground lights

Section 9.3: Pilot Activated Lighting Systems

9.3.1 General

9.3.1.1 If a pilot activated lighting (PAL) system is used to activate aerodrome lighting, the PAL is to turn ON all the lighting facilities which are required to be illuminated for night operations, unless the illumination of a required facility is achieved by other means, e.g. obstacle lights activated by photo-electric switches.

9.3.1.2 Where PAL is used to activate visual approach slope guidance systems (T-VASIS or PAPI):

(a) activation of the PAL during daytime is to turn the visual approach slope guidance system ON to Day intensity, and leave all other aerodrome lighting extinguished;

(b) activation of the PAL during twilight is to turn the visual approach slope guidance system ON to Twilight intensity, and turn all other aerodrome lighting on to the only intensity available, or to Night intensity if multiple intensities are available;

> **Note:** The night intensity will avoid the effect of glare and is normally adequate for operations during twilight hours. However, if an aerodrome, due to local conditions, requires the aerodrome lights to be set at a higher intensity than night intensity, it is permissible to provide Twilight intensity provided it does not produce glare.

(c) activation of the PAL during night-time is to turn the visual approach slope guidance system ON to Night intensity, and turn all other aerodrome lighting on to the only intensity available, or to Night intensity if multiple intensities are available;

(d) once the lighting has been activated by the PAL, appropriate changes from Day to Twilight to Night intensities must take place automatically;

(e) the appropriate changes from Day to Twilight to Night operation shall take place under the control of a light sensitive switch or similar device.

9.3.1.3 The PAL must activate an aerodrome lighting system on detection of a coded carrier frequency signal from an aircraft air/ground VHF transmitter.

9.3.1.4 On receipt of the coded signal, the PAL control unit must go into the operate mode for a pre-set period. The minimum period that the lights remain ON shall be 30 minutes.

> **Note:** The length of the period should be adjustable as local aerodrome operating conditions may require the lights to remain ON for a longer period.

9.3.1.5 Ten minutes before the aerodrome lighting system is due to turn OFF, the PAL must cause the lights of at least the primary Illuminated Wind Direction Indicator (IWDI), in accordance with Paragraph 9.6.1.10, to commence to flash at approximately 50 cycles per minute (approximately 0.6 seconds ON and 0.6 seconds OFF), and continue to flash until either:

(a) the PAL system switches OFF, and all aerodrome lighting, including the IWDI lights, is extinguished; or

(b) the PAL system has been reset for another ON period.

9.3.1.6 When in operate mode (including the last 10 minutes) the receipt of another correctly coded signal must reset the PAL system to the beginning of the pre-set period.

9.3.2 VHF Carrier Activation Code

9.3.2.1 The code required to activate the PAL system must be generated when the microphone button of the aircraft radio air/ground VHF transmitter is depressed and a radio frequency carrier signal is produced.

9.3.2.2 The correct code is to consist of three bursts of carrier signal each anywhere between 1 and 5 seconds long, with the last two code bursts completed within 24 seconds of the end of the first burst.

9.3.2.3 The gap between code bursts that the detector can tolerate shall be 0.1 seconds. (This is less than the time it takes to release and depress the aircraft microphone button.)

Note: Pilots are advised that the code they should send is three bursts of approximately 3 seconds, with at least 1 second between bursts, and the three bursts must be transmitted within 25 seconds.

9.3.3 VHF Carrier Detector Technical Requirements

9.3.3.1 The VHF carrier detector must accept a carrier signal over the frequency range of 118 MHz to 136 MHz.

9.3.3.2 The receiver must be crystal controlled at a single frequency within the frequency range, with a channel separation of 25 kHz.

9.3.3.3 Only allocated frequencies must be used, to maintain order in the air/ground VHF band, and prevent interference to other facilities or users in the vicinity.

Note: Frequencies are allocated by the responsible authority. At this time Airservices Australia has the authority to allocate aeronautical frequencies including PAL frequencies.

9.3.3.4 The frequency stability must be within ±0.0010% over the temperature range of -10°C to +70°C.

9.3.3.5 The minimum detectable input signal of the VHF carrier detector must be adjustable over a range to suit the operational requirements.

9.3.3.6 Under normal circumstances, to ensure activation of the PAL system by aircraft at approximately 15 NM from the aerodrome, the receiver sensitivity must be set at not less than 15 μV.

> **Note:** 1. The suitability of the receiver sensitivity from different azimuth of the aerodrome will be flight tested.
>
> 2. The upper range of the receiver sensitivity may be of the order of 50 to 65 mV, but may be adjusted downward depending on whether nuisance operation is experienced from aircraft using the same PAL frequency at other locations.

9.3.3.7 The VHF carrier detector bandwidth is to have the following characteristics:

±7.5 kHz within 3 dB of nominal

±16 kHz greater than 60 dB below nominal;

the spurious response is to be no less than 80 dB below nominal.

9.3.4 Inputs to the PAL

9.3.4.1 The PAL must be capable of having the following inputs:

(a) radio frequency activation signal, as described above;

(b) manual activation of the PAL. An ON/OFF switch must be provided for manual activation. When the switch is selected to ON the lighting system will be activated and remain on. When the switch is selected to OFF the PAL system must go into operate mode for the full timing cycle, including the ten minute turn-off warning. This is intended for use by authorised ground personnel, departing pilots, and maintenance technicians;

(c) remote control override of the PAL. If a PAL is provided at a controlled aerodrome, the circuitry of the PAL system must be such that when the controller is on duty, the PAL will be overridden by the controller.

9.3.5 Fail-safe Arrangements with PAL system

9.3.5.1 The circuitry of the PAL system must be so designed that if the PAL fails for whatever reason, the aerodrome lighting can still be provided. This can be achieved by either:

(a) the lighting facilities being automatically turned ON if the PAL fails; or

(b) the provision of a by-pass switch to allow manual activation of the lights.

9.3.5.2 The mains supply to the equipment may be subject to electrical transients, typical of rural electrical distribution systems. The PAL system must be so designed that the electrical transients have no effect on the PAL system.

9.3.5.3 Following a PAL failure, on restitution of power the PAL must automatically commence a complete ‘Light ON’ cycle.

9.3.6 Access to Manual Switches

9.3.6.1 If the manual switches provided for PAL are either key operated switches, or enclosed in an area that requires key access, sufficient numbers of keys must be provided to persons who may have reason to gain access to the manual switches in the event of the PAL failing to respond to aerial VHF signal from incoming aircraft.

> **Note**: The aerodrome operator is responsible for the allocation of access keys.

9.3.6.2 The following persons are likely to be called upon to manually activate the aerodrome lighting:

(a) the agents of the airlines using the aerodrome;

(b) a representative from local operators of flying schools, fuelling agents, or aircraft maintenance organisations;

(c) representatives from the local hospital and/or emergency services;

(d) local police;

(e) where available, responsible person or persons living close to the aerodrome.

9.3.7 Receiving Antenna

9.3.7.1 The PAL receiving antenna must be so located such that it will receive activating signals from aircraft both in the air and on the aerodrome movement area.

9.3.7.2 The PAL must be so designed that it will operate satisfactorily when connected to an antenna with the following specifications:

(a) unity gain with respect to a dipole;

(b) vertical polarisation;

(c) omnidirectional radiation pattern in the horizontal plane;

(d) voltage standing wave ratio when matched to the PAL antenna input of not greater than 1.5:1, over the frequency range of 118 to 136 MHz;

(e) height of the mounting above local ground level not less than 4.5 m.

9.3.8 PAL with Audio Acknowledgment

9.3.8.1 Aerodrome operators are encouraged to use a PAL with message acknowledgment capability, which can provide positive response on receipt of pilot transmission and caution if the lighting cycle is within the 10 minute switch off phase.

> **Note**: Such a PAL will require a radio transmitter licence.

9.3.8.2 Where provided, the broadcast message must be brief, to minimise congestion on the frequency.

> **Note**: Typical broadcast message should be of the form: “*Name of aerodrome* PAL ACTIVATED”.

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Section 9.4: Obstacle Lighting

9.4.1 General

9.4.1.1 Under the Civil Aviation Regulations, CASA may determine that an object or a proposed object which intrudes into navigable airspace requires, or will be required to be provided with, obstacle lighting. Responsibility for the provision and maintenance of obstacle lighting on a building or structure rests with the owner of the building or structure. Within the limits of the obstacle limitation surfaces of an aerodrome, responsibility for the provision and maintenance of obstacle lighting on natural terrain or vegetation, where determined necessary for aircraft operations at the aerodrome, rests with the aerodrome operator.

9.4.1.2 In general, an object in the following situations would require to be provided with obstacle lighting unless CASA, in an aeronautical study, assesses it as being shielded by another lit object or that it is of no operational significance:

(a) for a runway intended to be used at night:

- (i) if the object extends above the take-off climb surface within 3000 m of the inner edge of the take-off climb surface;
- (ii) if the object extends above the approach or transitional surface within 3000 m of the inner edge of the approach surface;
- (iii) if the object extends above the applicable inner, conical or outer horizontal surfaces;
- (iv) if the object extends above the obstacle protection surface of the T-VASIS or PAPI installed at the aerodrome;
- (v) a vehicle or other mobile objects, excluding aircraft, on the movement area, except aircraft service equipment and vehicles used only on aprons;
- (vi) obstacles in the vicinity of taxiways, apron taxiways or taxilanes, except that obstacle lights are not to be installed on elevated ground lights or signs in the movement area.

(b) outside the obstacle limitation surfaces of an aerodrome, if the object is or will be more than 110 m above ground level.

9.4.1.3 Owners of tall buildings or structures below the obstacle limitation surfaces, or less than 110 m above ground level, may, of their own volition, provide obstacle lighting to indicate the presence of such buildings or structures at night. To ensure consistency and avoid any confusion to pilots, the obstacle lighting provided needs to conform with the standards specified in this Chapter.

9.4.1.4 In circumstances where the provision of obstacle marking is impracticable, obstacle lighting may be used during the day in lieu of obstacle marking.

9.4.2 Types of Obstacle Lighting and Their Use

9.4.2.1 Three types of lights are used for lighting obstacles. These are low intensity, medium intensity and high intensity lights, or a combination of such lights.

9.4.2.2 Low intensity obstacle lights are steady red lights and are to be used on non-extensive objects whose height above the surrounding ground is less than 45 m.

> **Note**: A group of trees or buildings is regarded as an extensive object.

9.4.2.3 Medium intensity obstacle lights are to be used either alone or in combination with low intensity lights, where:

(a) the object is an extensive one;

(b) the top of the object is 45 m or more above the surrounding ground; or

(c) CASA determines that early warning to pilots of the presence of the object is desirable.

9.4.2.4 There are three types of medium intensity obstacle lights:

(a) Flashing white light. Likely to be unsuitable for use in environmentally sensitive locations, and near built-up areas. May be used in lieu of obstacle markings during the day to indicate temporary obstacles in the vicinity of an aerodrome, for example construction cranes, etc. and are not to be used in other applications without specific CASA agreement.

(b) Flashing red light, also known as a hazard beacon. Is suitable for all applications, and is extensively used to mark terrain obstacles such as high ground.

(c) Steady red light. May be used where there is opposition to the use of a flashing red light, for example in environmentally sensitive locations.

9.4.2.5 High intensity obstacle lights are flashing white lights used on obstacles that are in excess of 150 m in height. As high intensity obstacle lights have a significant environmental impact on people and animals, it is necessary to consult with interested parties about their use. High intensity obstacle lights may also be used during the day, in lieu of obstacle markings, on obstacles that are in excess of 150 m in height, or are difficult to be seen from the air because of their skeletal nature, such as towers with overhead wires and cables spanning across roads, valleys or waterways.

9.4.3 Location of Obstacle Lights

9.4.3.1 One or more obstacle lights are to be located as close as practicable to the top of the object. The top lights are to be arranged so as to at least indicate the points or edges of the object highest above the obstacle limitation surface.

9.4.3.2 In the case of a chimney or other structure of like function, the top lights are to be placed sufficiently below the top (nominally 1.5 m to 3 m) so as to minimise contamination by smoke, etc.

9.4.3.3 In the case of a tower or antenna structure to be provided with high intensity obstacle lights, and the structure has an appurtenance such as a rod or antenna extending greater than 12 m above the structure, and it is not practicable to locate the high intensity obstacle light on top of the appurtenance, the high intensity obstacle light is to be located at the highest practicable point and, if practicable, have a medium intensity obstacle light (flashing white) mounted on the top.

9.4.3.4 In the case of an extensive object or a group of closely spaced objects, top lights are to be displayed at least on the points or edges highest in relation to the obstacle limitation surfaces, so as to indicate the general definition and extent of the objects. If two or more edges are at the same height, the edge nearest the runway threshold is to be lit. Where low intensity lights are used, they are to be spaced at longitudinal intervals not exceeding 45 m. Where medium intensity lights are used, they are to be spaced at longitudinal intervals not exceeding 900 m, and at least three are to be displayed on one side of the extensive obstacle to indicate a line of lights.

9.4.3.5 When the obstacle limitation surface concerned is sloping and the highest point above the obstacle limitation surface is not the highest point of the object, additional obstacle lights are to be placed on the highest part of the object.

9.4.3.6 When the top of the obstacle is more than 45 m above the level of the surrounding ground or the elevation of the tops of nearby buildings (when the obstacle is surrounded by buildings), the top lights are to be medium intensity lights. Additional low intensity lights are to be provided at lower levels to indicate the full height of the structure. These additional lights are to be spaced as equally as possible, between the top lights and ground level or the level of tops of nearby buildings, as appropriate. The spacing between the lights is not to exceed 45 m.

9.4.3.7 Where high intensity obstacle lights are used on an object other than a tower supporting overhead wires or cables, the spacing between the lights is not to exceed 105 m. Where the high intensity obstacle lights are used on a tower supporting wires or cables, they are to be located on three levels:

(a) at the top of the tower;

(b) at the lowest level of the catenary of the wires or cables; and

(c) at approximately midway between the two levels.

> **Note**: In some cases this may require the bottom and middle lights to be located off the tower.

9.4.3.8 The number and arrangement of lights at each level to be marked is to be such that the obstacle is indicated from every angle of azimuth. Where a light is shielded in any direction by an adjacent object, the light so shielded may be omitted but additional lights may be required in such a way so as to retain the general definition of the obstacle.

9.4.3.9 Illustrations of typical lighting of obstacles are shown below.

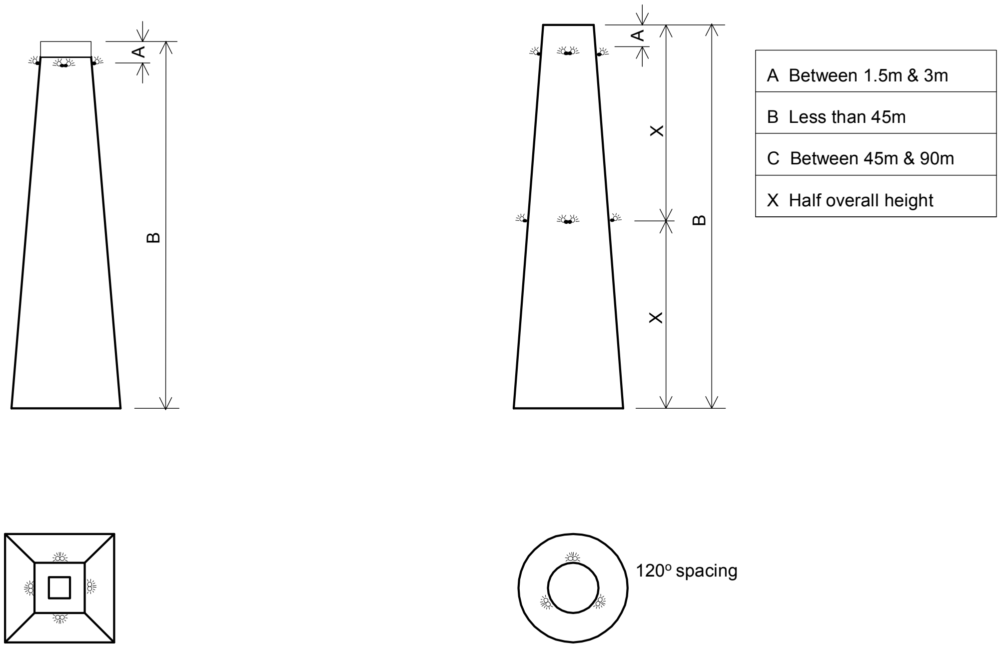
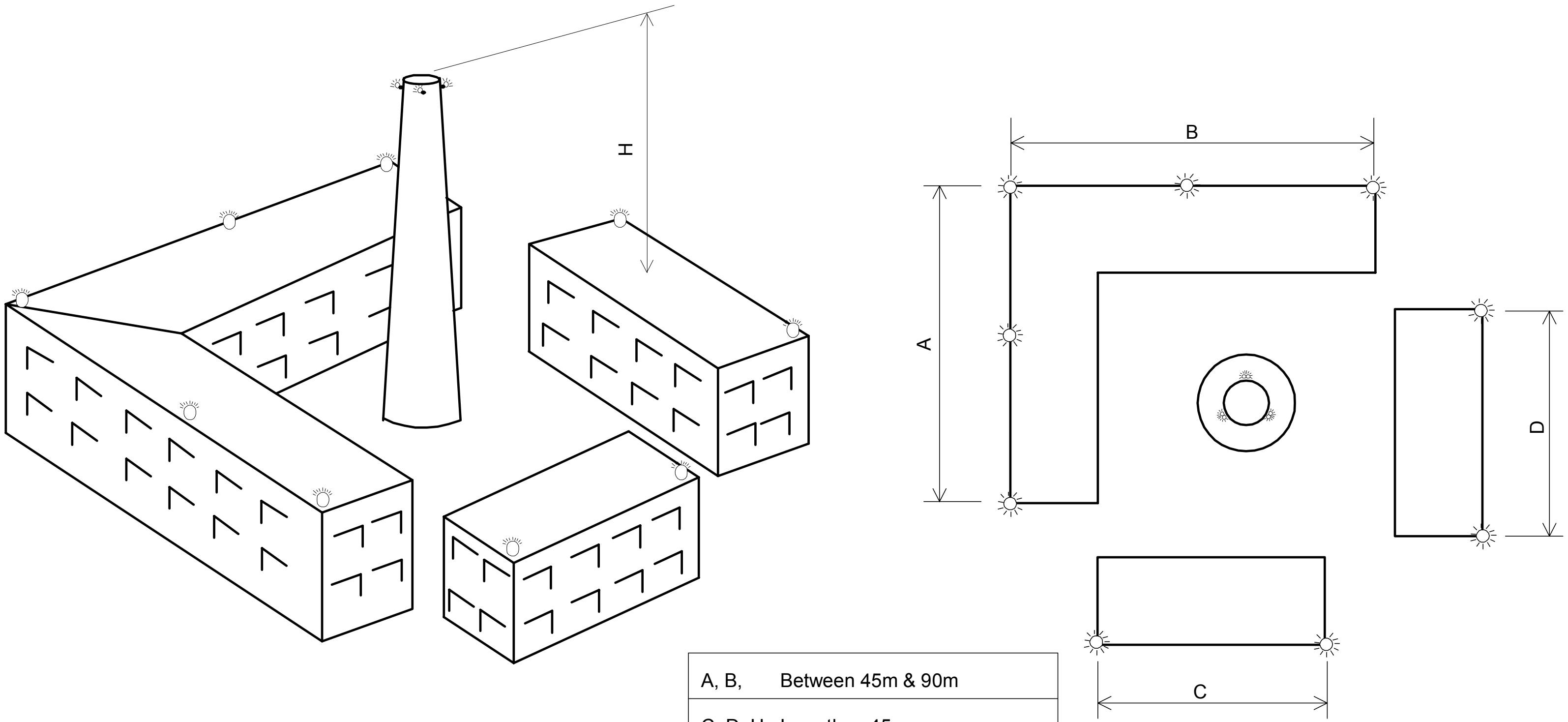


Figure 9.4-1: Typical lighting of tall obstructions



A, B,	Between 45m & 90m
C, D, H,	Less than 45m

Figure 9.4-2: Typical lighting of a group of obstructions

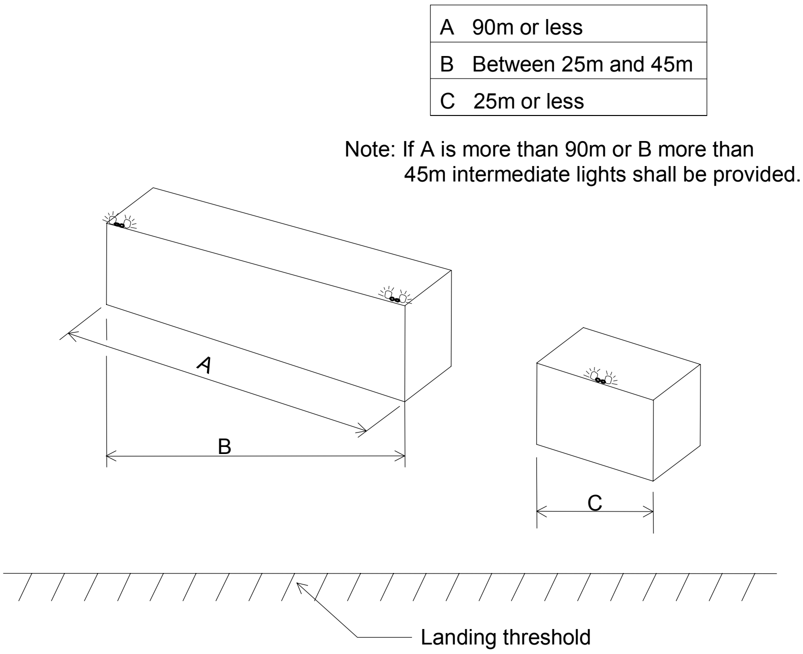


Figure 9.4-3: Typical lighting of horizontally extended obstructions

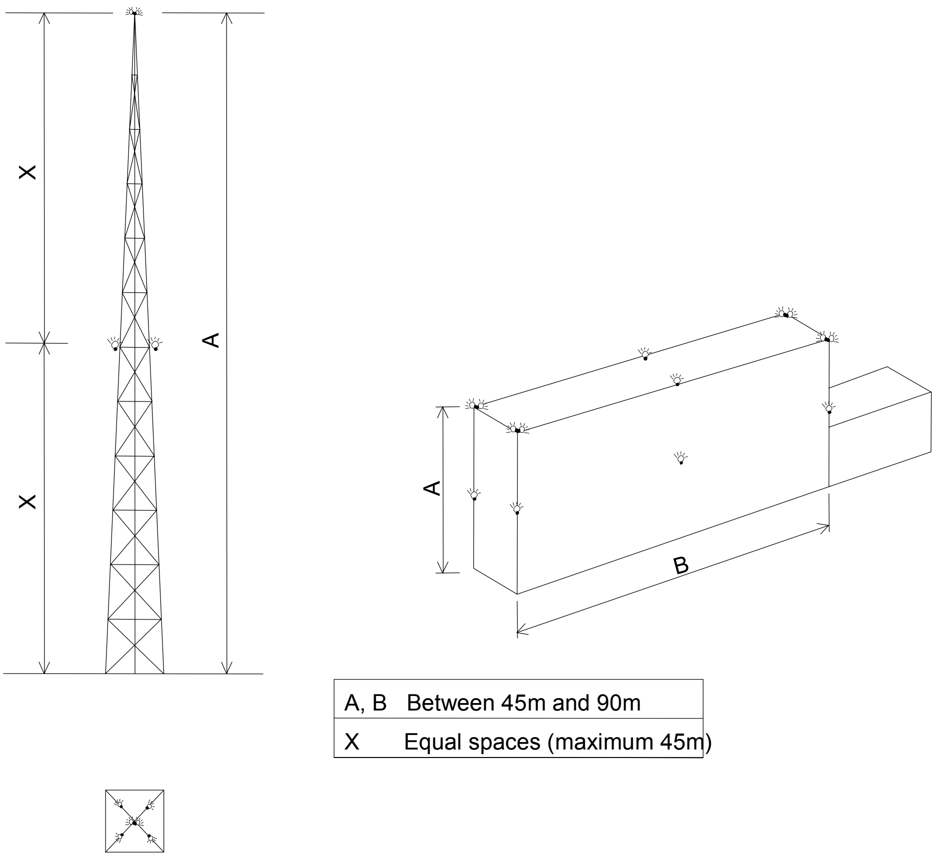


Figure 9.4-4: Typical lighting of towers and large obstructions

9.4.4 Natural Obstacles

9.4.4.1 Natural obstacles such as terrain and vegetation are normally extensive and the need for obstacle lighting will be assessed by CASA on an individual case basis. Where required, obstacle lights are to be provided as follows:

(a) if the obstacle is located within the approach area, the portion of the obstacle which is within the approach area is to be treated in the same manner as man-made obstacles for the provision of obstacle lights;

(b) if the obstacle is located outside the approach area, it is to be marked by sufficient number of lights on the highest and most prominent features, so placed that the obstacle can be readily identified.

9.4.5 Temporary Obstacles

9.4.5.1 At night and in poor visibility conditions, temporary obstacles in the approach area or on the movement area are to be marked with permanent or temporary red obstacle lights. The lights are to be so arranged that they clearly mark the height, limits and extent of the obstacle.

9.4.6 Characteristics of Low Intensity Obstacle Lights

9.4.6.1 Low intensity obstacle lights, for general applications, are to have the following characteristics:

(a) fixed lights showing red;

(b) a horizontal beam spread that results in 360° coverage around obstacle;

(c) a peak intensity of 100 cd minimum;

(d) a vertical beam spread (to 50% of peak intensity) of 10°;

(e) a vertical distribution with 100 cd minimum at +6° and +10° above the horizontal; and

(f) not less than 10 cd at all elevation angles between –3° and +90° above the horizontal.

Notes:

1. The intensity level is higher than ICAO standards because in Australia only obstacles assessed as significant to aircraft operations are required to be provided with obstacle lighting.
2. Currently the intensity requirement is normally met by a double-bodied light fitting which also provides a degree of redundancy.
3. Double-bodied light fittings should be orientated so that they show the maximum illuminated surface towards the predominant, or more critical, direction of aircraft approach.

Notes: (Contd.)

4. For objects that do not infringe the obstacle limitation surfaces, and where CASA has not determined that obstacle lights are required, if the object owner wishes, of their own volition, to provide obstacle lights, it is sufficient for these low intensity obstacle lights to have the following intensity distribution: peak intensity 32 cd minimum, vertical beam spread of 10°, and 32 cd minimum at +6° and +10° elevation.

9.4.6.2 Low intensity obstacle lights, used to indicate taxiway obstacles or unserviceable areas of the movement area, are to have a peak intensity of 10 cd minimum.

9.4.7 Characteristics of Medium Intensity Obstacle Lights

9.4.7.1 Medium intensity obstacle lights are to be flashing or steady red lights or flashing white lights, visible in all directions in azimuth.

9.4.7.2 The frequency of flashes is to be between 20 and 60 flashes per minute.

9.4.7.3 The peak effective intensity is to be 2,000 ± 25% cd with a vertical distribution as follows:

(a) vertical beam spread is to be 3° minimum (beam spread is defined as the angle between two directions in a plane for which the intensity is equal to 50% of the lower tolerance value of the peak intensity);

(b) at -1° elevation, the intensity is to be 50% minimum and 75% maximum of lower tolerance value of the peak intensity; and

(c) at 0° elevation, the intensity is to be 100% minimum of the lower tolerance value of the peak intensity.

9.4.7.4 Where the flashing white light is used in lieu of obstacle marking during the day to indicate temporary obstacles in the vicinity of an aerodrome, in accordance with Paragraph 9.4.2.4(a), the peak effective intensity is to be increased to 20,000 ± 25% cd when the background luminance is 50 cd/m² or greater.

9.4.8 Characteristics of High Intensity Obstacle Lights

9.4.8.1 High intensity obstacle lights are flashing white lights.

9.4.8.2 The effective intensity of a high intensity obstacle light located on an object other than a tower supporting overhead wires or cables is to vary depending on background luminance as follows:

(a) 200,000 ± 25% cd effective intensity at a background luminance of above 500 cd/m² (day);

(b) 20,000 ± 25% cd effective intensity at a background luminance of between 50-500 cd/m² (dusk or dawn);

(c) 2,000 ± 25% cd effective intensity at a background luminance of below 50 cd/m² (night).

9.4.8.3 The effective intensity of a high intensity obstacle light located on a tower supporting overhead wires or cables is to vary depending on background luminance as follows:

(a) 100,000 ± 25% cd effective intensity at a background luminance of above 500 cd/m² (day);

(b) 20,000 ± 25% cd effective intensity at a background luminance of between 50-500 cd/m² (dusk or dawn);

(c) 2,000 ± 25% cd effective intensity at a background luminance of below 50 cd/m² (night).

9.4.8.4 High intensity obstacle lights located on an object other than a tower supporting overhead wires or cables are to flash simultaneously at a rate between 40-60 flashes per minute.

9.4.8.5 High intensity obstacle lights located on a tower supporting overhead wires or cables are to flash sequentially; first the middle light, second the top light, and last the bottom light. Cycle frequency is to be 40 - 60 per minute and the intervals between flashes of lights are to approximate the following ratios:

Table 9.4-1

Flash interval between:	Ratio of cycle time
middle and top light	1/13
top and bottom light	2/13
bottom and middle light	10/13

9.4.8.6 To minimise environmental impact, unless otherwise directed by CASA, the installation setting angles for high intensity obstacle lights are to be:

Table 9.4-2

Height of light unit above terrain	Angle of the peak of the beam above the horizontal
greater than 151 m AGL	0°
122 m to 151 m AGL	1°
92 m to 122 m AGL	2°
less than 92 m AGL	3°

9.4.9 Floodlighting of Obstacles

9.4.9.1 Where the installation of normal obstacle lights is deemed impracticable or undesirable for aesthetic or other reasons, floodlighting of obstacles may be an acceptable alternative. However, floodlighting is not to be used unless with the concurrence of the relevant CASA office.

9.4.9.2 In general, floodlighting is not suitable if:

(a) the structure is skeletal as a substantially solid surface or cladding with satisfactory reflectance properties are required; or

(b) there is high background lighting level.

9.4.9.3 The floodlighting colour is to be white. Illumination of the obstacle is to cover all directions of azimuth over the full height portion of the obstacle which needs to be illuminated and is to be uniform around the circumferences of the obstacle.

9.4.9.4 The minimum level of luminance is to be 5 cd/m² at all points.

> **Note:** Based on a reflectance factor of 50% for white paint, this would require illuminance of at least 10 lux. For concrete with typical reflectance factor of 40%, the required illuminance would be at least 12.5 lux. Materials with reflectance factors less than 30% are unlikely to be suitable for floodlighting.

9.4.9.5 The light fittings are to be spaced evenly around the structure, at not more than 120° with at least two fittings at each location. At each location the fittings are to be on separate circuits and separately fused.

9.4.10 Ongoing Availability of Obstacle Lights

9.4.10.1 It is important that obstacle lights provided are in working condition when they are required to be on. The owners of obstacle lights needs to establish a pro-active maintenance program to minimise light outage.

9.4.10.2 For obstacle lights located within the obstacle limitation surface area of the aerodrome, the aerodrome operator is to establish a monitoring program, which is to include:

(a) visual observation of the obstacles lights at least once every 24 hours (see note); and

(b) where a medium or high intensity obstacle light is located such that it is not readily observable visually:

(i) establish a procedure whereby such a light would be visually monitored within every 24 hour period; or

(ii) install an automatic visual or audio alarm indicator at an aerodrome location generally occupied by aerodrome personnel.

> **Note**: At smaller aerodromes with a low level of night aircraft operations, this period may be extended with the agreement of the relevant CASA office.

9.4.10.3 For obstacles located within the obstacle limitation surface area of the aerodrome, in the event of an obstacle light outage, the aerodrome operator is to:

(a) notify the relevant CASA office immediately if the obstacle light has been determined by CASA as being a requirement for aircraft operations;

(b) in any case, initiate NOTAM action to advise pilots of such light outage;

(c) liaise with the owner of the obstacle light to effect a speedy repair.

9.4.10.4 For obstacles located outside the obstacle limitation surface area of an aerodrome, the owners of the lights need to establish a program to monitor the lights and report light failures. The reporting point for obstacle light failure is normally the nearest CASA office. When an obstacle light is unserviceable, the matter needs to be reported immediately to the relevant CASA office so that a NOTAM warning pilots of the light outage can be initiated.

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Section 9.5: Aerodrome Beacons

9.5.1 General

9.5.1.1 An aerodrome beacon is to be provided if it is determined by CASA that such a visual cue is operationally necessary.

9.5.1.2 The following factors will be used in determining operational necessity:

(a) whether the aerodrome is intended to be used at night by aircraft navigating predominantly by visual means;

(b) the type and quantity of air traffic;

(c) the presence of other visual or radio aids;

(d) whether the location is subject to frequent periods of reduced visibility;

(e) whether it is difficult to locate the aerodrome from the air due to surrounding lights or terrain.

9.5.1.3 Where provided, the aerodrome beacon is to be located on or adjacent to the aerodrome in an area of low ambient background lighting. In addition, the aerodrome beacon is to be sited so that it is neither shielded by obstacles nor dazzling to a pilot making an approach to land.

9.5.1.4 At international aerodromes or aerodromes in built-up areas, the aerodrome beacon is to show two flashes, one white and the other coloured, so that they produce alternate white and colour flashes. For land aerodromes, the colour is to be green, for water aerodromes, the colour is to be yellow.

9.5.1.5 At other locations, white flashes only is satisfactory.

9.5.1.6 The frequency of total flashes must be from 20 to 30 per minute.

> **Note**: Older beacons with a frequency of flashes in the range of 12 to 20 per minute are acceptable, until the next replacement or upgrade of the beacon.

9.5.1.7 The light from the beacon is to be visible from all angles of azimuth.

9.5.1.8 The light intensity distribution of the aerodrome beacon must be in accordance with Table 9.5-1:

Table 9.5-1: Aerodrome beacon light intensity distribution

Elevation angle (in degrees)	Minimum effective intensity of white flashes (in candelas)
1 to 2	25 000
2 to 8	50 000
8 to 10	25 000
10 to 15	5 000
15 to 20	1 000

9.5.1.9 The effective intensity of colour flashes is to be not less than 0.15 times the intensity of the white flashes at the corresponding angle of elevation.

9.5.1.10 Where provided, information on the colour coding, flash rate and location (if not in the immediate vicinity of the aerodrome) of the aerodrome beacon is to be published in the aerodrome ERSA entry.

Section 9.6: Illuminated Wind Direction Indicator

9.6.1 General

9.6.1.1 At an aerodrome intended for night use, at least one wind direction indicator is to be lit.

9.6.1.2 If a WDI is provided in the vicinity of a runway threshold to provide surface wind information for pilots engaged in instrument straight-in approach and landing operations, and such operations are to be conducted at night, then the wind direction indicator is to be lit.

9.6.1.3 The illumination of a wind direction indicator is to be achieved by providing floodlighting from above by means of:

(a) four 200W 240 V tungsten filament general purpose lamps in either vertical elliptical industry reflectors, or round deep bowl reflectors, between 1.8 m and 2.2 m above the mid-height of the sleeve mounting, and between 1.7 m and 1.9 m radial distance from the axis of rotation of the wind sleeve; or

(b) eight 120 W 240V PAR 38 flood lamps in reflectorless fittings, between 1.8 m and 2.2 m above the mid height of the wind sleeve mounting, and between 1.7 m and 1.9 m radial distance from the axis of the rotation of the wind sleeve; or

(c) some other method of floodlighting which produces lighting equivalent to what would be provided under sub Paragraph 9.6.1.3(a) or 9.6.1.3(b), with accurate colour rendering and no perceptible warm-up or restrike delay.

> **Note**: The standards prescribed above are equipment based. These may be replaced by photometric performance based standards later.

9.6.1.4 The floodlighting is to be aimed and shielded so as to:

(a) not cause any glare or distraction to pilots; and

(b) uniformly illuminate the maximum swept area of the wind sleeve.

> **Note**: A uniformity ratio in the horizontal plane through the mid height of the wind cone of not more than 4:1 (average to minimum) will be satisfactory.

9.6.1.5 If only one wind direction indicator is lit at an aerodrome and there are two or more lit runways, control of the lighting of the wind direction indicator is to be incorporated in the runway lighting control for each runway, so that energising any runway lighting system will automatically energise the lighting of the wind direction indicator.

9.6.1.6 Where more than one wind direction indicator can be lit, control of the lighting of each wind direction indicator is to be incorporated in the runway lighting control for the operationally related runway.

9.6.1.7 If the electricity supply to a wind direction indicator is provided from a runway lighting circuit for which intensity control is provided, a uniform intensity is required for the wind direction indicator irrespective of the intensity setting of the runway lighting.

9.6.1.8 Where a PAL is installed the wind direction indicator lighting is to be programmed in such a way that 10 minutes before the end of the aerodrome lighting 'ON' period, the lights of the wind direction indicator will commence to flash, at approximately 50 cycles per minute, and continue to flash until either:

(a) the PAL system switches off, and all aerodrome lighting, including the wind direction indicators, is extinguished; or

(b) the PAL system has been reset for another 'ON' period.

9.6.1.9 If the PAL system is reset for another 'ON' period, the lights of the wind direction indicator are to return to steady lighting.

9.6.1.10 At aerodromes with more than one lit wind direction indicator, it is sufficient for only the primary wind direction indicator to flash as part of the PAL system, provided that the flashing is clearly visible to pilots on all approaches to lit runways.

Section 9.7: Approach Lighting Systems

9.7.1 Simple Approach Lighting System

9.7.1.1 A simple approach lighting system is a lighting system intended for a non-instrument or a non-precision approach runway. Standards for this system are not included in this Chapter as there is no operational credit for such systems.

> **Note**: Standard runway edge and threshold lights, supplemented by a visual approach slope indicator system have been found adequate for non-instrument and non-precision approach runways.

9.7.2 Precision Approach Category I Lighting System

9.7.2.1 Where physically practicable, a precision approach Category I lighting system is to be provided to serve a Category I precision approach runway.

9.7.2.2 A precision approach Category I lighting system is to consist of a row of lights on the extended centreline of the runway extending, wherever possible, over a distance of 900 m prior to the threshold, with rows of lights forming 5 crossbars, as shown in Figure 9.7-1 below.

> **Notes:**
> 1. The installation of an approach lighting system of less than 900 m in length may result in operational limitations on the use of the runway.
> 2. Existing lights spaced in accordance with imperial measurements are deemed to comply with comparable metric measurements.

9.7.2.3 The lights forming the centreline are to be placed at longitudinal intervals of 30 m with the innermost light located 30 m from the threshold. Each centreline light position is to consist of a single light source in the innermost 300 m of the centreline, two light sources in the central 300 m of the centreline, and three light sources in the outer 300 m of the centreline, to provide distance information.

9.7.2.4 The lights forming the centreline light positions in the central 300 m and the outer 300 m of the centreline are to be spaced at 1.5 m apart.

9.7.2.5 The lights forming the 5 crossbars are to be placed at 150 m, 300 m, 450 m, 600 m and 750 m from the threshold. The lights forming each crossbar are to be as nearly as practicable in a horizontal straight line at right angles to, and bisected by, the line of the centreline lights. The lights of the crossbar are to be spaced so as to produce a linear effect, except that gaps may be left on each side of the centreline. The lights within each bar on either side of the centreline are to be uniformly spaced at intervals of not more than 2.7 m. The outer ends of the crossbars are to lie on two straight lines that converge to meet the runway centreline 300 m from the threshold.

9.7.2.6 The system is to lie as nearly as practicable in the horizontal plane passing through the threshold, provided that:

(a) no object other than an ILS antenna is to protrude through the plane of the approach lights within a distance of 60 m from the centreline of the system; and

(b) no light other than a light located within the central part of a crossbar, or a centreline light position, may be screened from an approaching aircraft.

9.7.2.7 Any ILS antenna protruding through the plane of the lights is to be treated as an obstacle and marked and lighted accordingly.

9.7.2.8 The centreline and crossbar lights of a precision approach Category I lighting system are to be fixed lights showing variable white.

9.7.2.9 The lights are to be in accordance with the specifications of Section 9.8, Figure 9.8-1.

9.7.3 Precision Approach Category II and III Lighting System

9.7.3.1 A precision approach Category II and III lighting system is to be provided to serve a Category II or III precision approach runway.

9.7.3.2 From paragraphs 9.7.3.8 and 9.7.3.9 below, it is implicit that where Category II and III approach lights are provided, touchdown zone lights must also be provided.

9.7.3.3 A precision approach Category II and III lighting system is to consist of a row of lights on the extended centreline of the runway extending, wherever possible, over a distance of 900 m from the runway threshold. In addition, the system is to have two side rows of lights, extending 270 m from the threshold, and 5 crossbars, at 150 m, 300 m, 450 m, 600 m and 750 m from the threshold, as shown in Figure 9.7-2.

> **Note**: The length of 900 m is based on providing guidance for operations under Cat I, II and III conditions. Reduced lengths may support Cat II and III operations but may impose limitations on Cat I operations.

9.7.3.4 The lights forming the centreline lights are to be placed at longitudinal intervals of 30 m with the innermost light located 30 m from the threshold.

9.7.3.5 The centreline for the first 300 m from the threshold is to consist of either:

(a) barrettes of five lights, uniformly spaced at intervals of 1 m; or

(b) single light sources where the threshold is displaced 300 m or more.

9.7.3.6 Beyond 300 m from the threshold, each centreline light position is to consist of two light sources in the central 300 m of the centreline and three light sources in the outer 300 m of the centreline.

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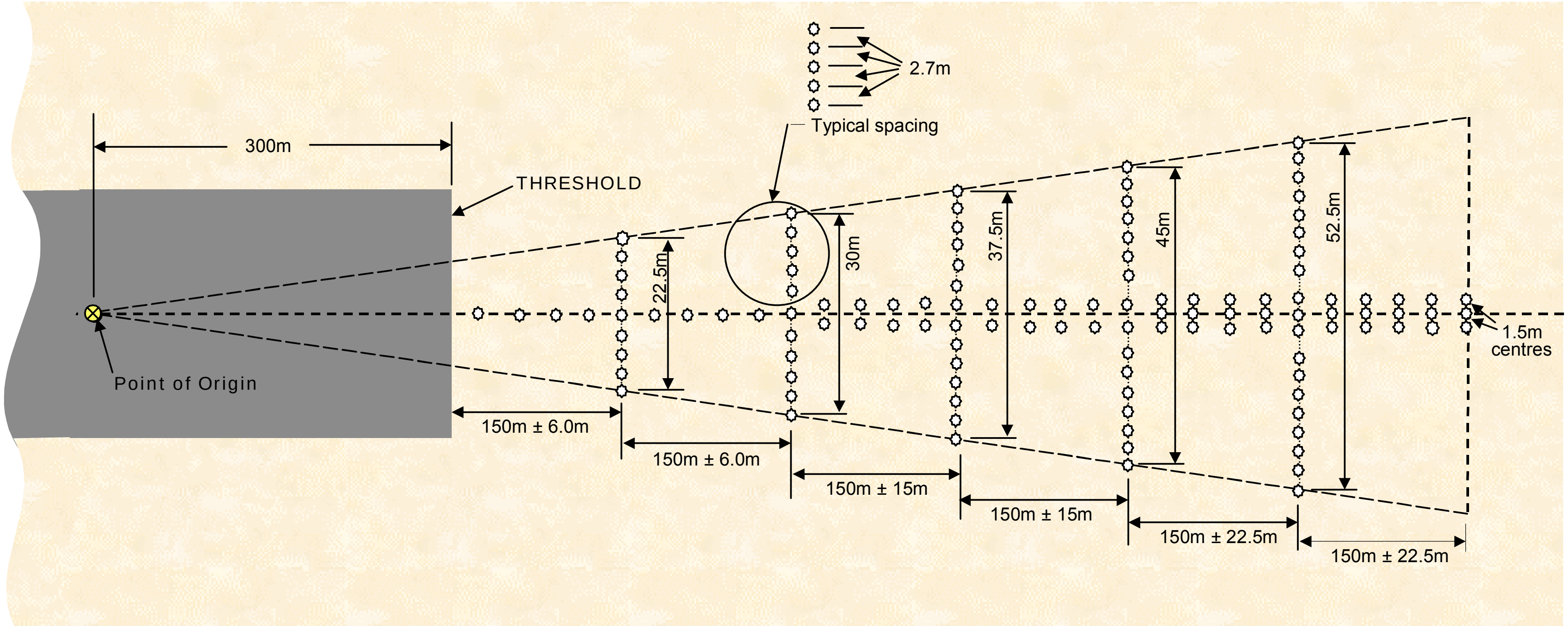

Figure 9.7-1: Illustration of a Category I approach lighting system

9.7.3.7 Where the centreline light position is either two or three light sources, the lights are to be spaced at 1.5 m apart.

9.7.3.8 The lights forming the side rows are to be placed on each side of the centreline. The rows are to be spaced at 30 m intervals, with the first row located 30 m from the threshold. The lateral spacing (or gauge) between the innermost lights of the side row is to be not less than 18 m nor more than 22.5 m, and preferably 18 m, but in any event is to be equal to that of the touchdown zone light barrettes.

9.7.3.9 The length of a side row barrette and the uniform spacing between its lights are to be equal to those of the touchdown zone light barrettes. (See Paragraph 9.10.25.4).

9.7.3.10 The crossbar provided at 150 m from the threshold is to fill in the gaps between the centreline and side row lights.

9.7.3.11 The crossbar provided at 300 m from the threshold is to extend on both sides of the centreline lights to a distance of 15 m from the centreline.

9.7.3.12 The crossbars provided at 450 m, 600 m, and 750 m from the threshold are to have the outer ends of the crossbars lie on two straight lines that converge to meet the runway centreline 300 m from the threshold. The lights are to be spaced so as to produce a linear effect, except that gaps may be left on each side of the centreline.

9.7.3.13 The lights forming the crossbars are to be uniformly spaced at intervals of not more than 2.7 m.

9.7.3.14 The system is to lie as nearly as practicable in the horizontal plane passing through the threshold, provided that:

(a) no object other than an ILS antenna is to protrude through the plane of the approach lights within a distance of 60 m from the centreline of the system; and

(b) no light other than a light located within the central part of a crossbar, or a centreline light position, may be screened from an approaching aircraft.

9.7.3.15 Any ILS antenna protruding through the plane of the lights is to be treated as obstacle and marked and lighted accordingly.

9.7.3.16 The centreline and crossbar lights of a precision approach Category II and III lighting system are to be fixed lights showing variable white.

9.7.3.17 The side row barrettes are to be fixed lights showing red. The intensity of the red light is to be compatible with the intensity of the white light.

9.7.3.18 The lights are to be in accordance with the specifications of Section 9.8, Figure 9.8-1 and Figure 9.8-2.

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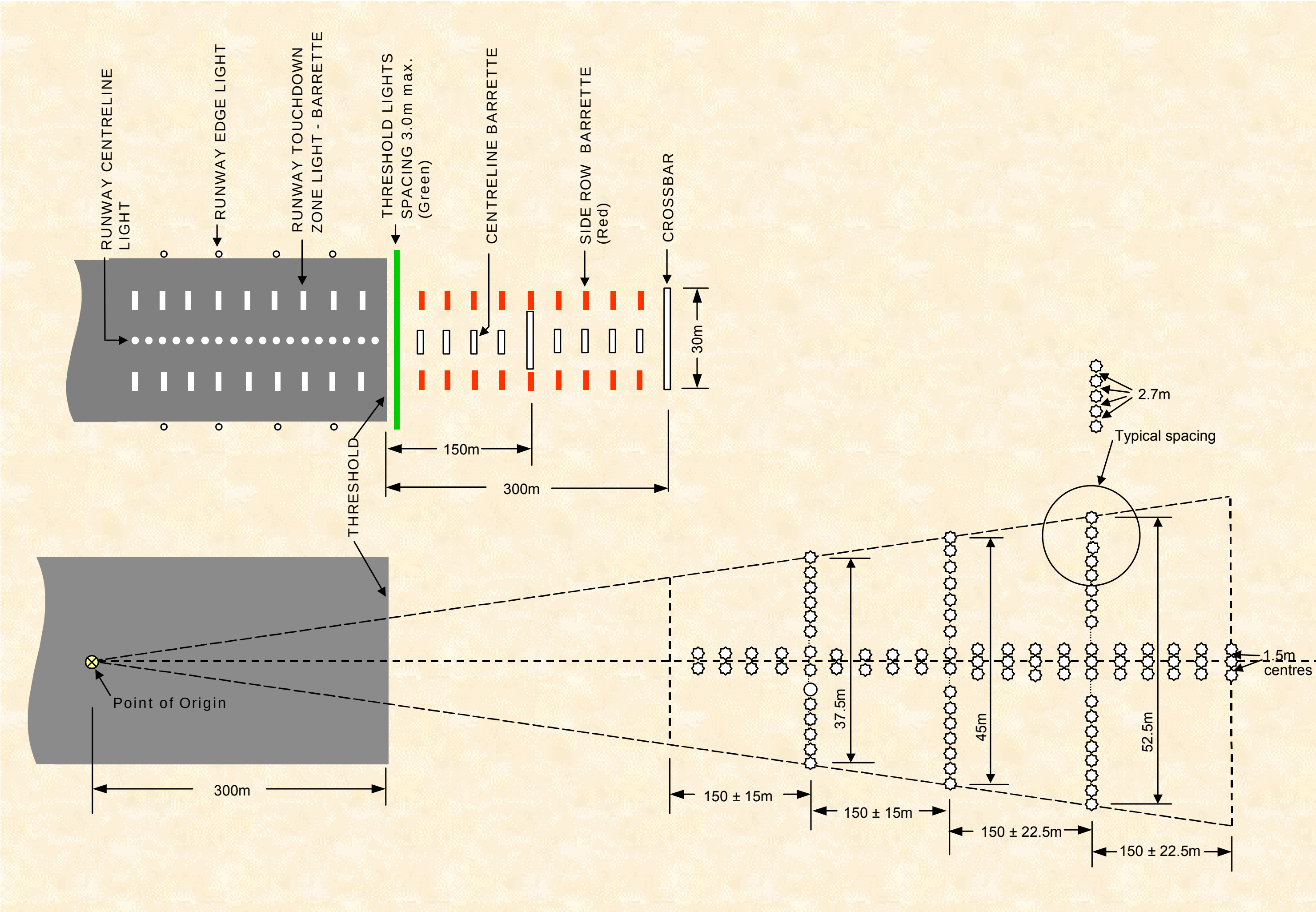

Figure 9.7-2: Illustration of category II and III approach lighting system

Section 9.8: Isocandela Diagrams of Approach Lighting

9.8.1 Collective Notes

9.8.1.1 Except for Paragraph 9.11.1.4, the collective notes for Section 9.11 apply to this Section.

9.8.1.2 **Average intensity ratio.** The ratio between the average intensity within the ellipse defining the main beam of a typical new light and the average intensity of the main beam of a new runway edge light is to be as follows:

(a) Figure 9.8-1 Approach centreline and crossbars — 1.5 to 2.0 (white light)

(b) Figure 9.8-2 Approach side row — 0.5 to 1.0 (red light)

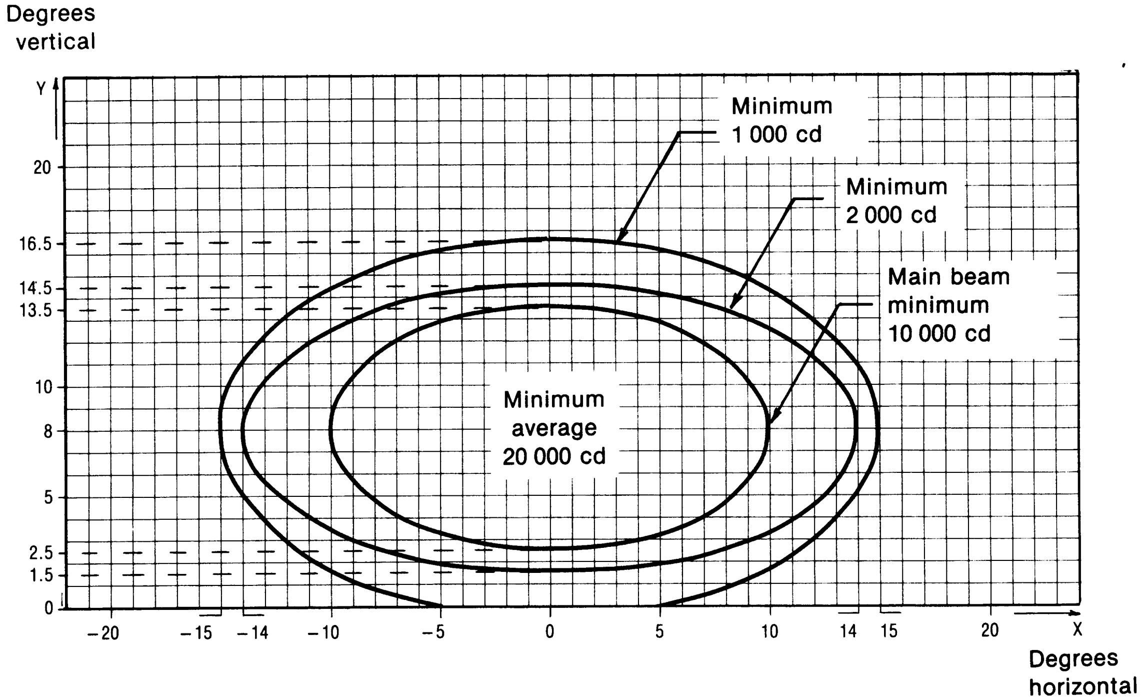

Figure 9.8-1: Isocandela diagram for approach centreline light and cross bars (white light)

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 must 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	0º – 11º
316 m to 475 m	0.5º – 11.5º
476 m to 640 m	1.5º – 12.5º
641 m and beyond	2.5º – 13.5º (as illustrated above)

3. Lights in crossbars beyond 22.5 m from the centre line must be toed-in 2 degrees. All other lights must be aligned parallel to the centre line of the runway.
4. See collective notes at Paragraph 9.8.1.

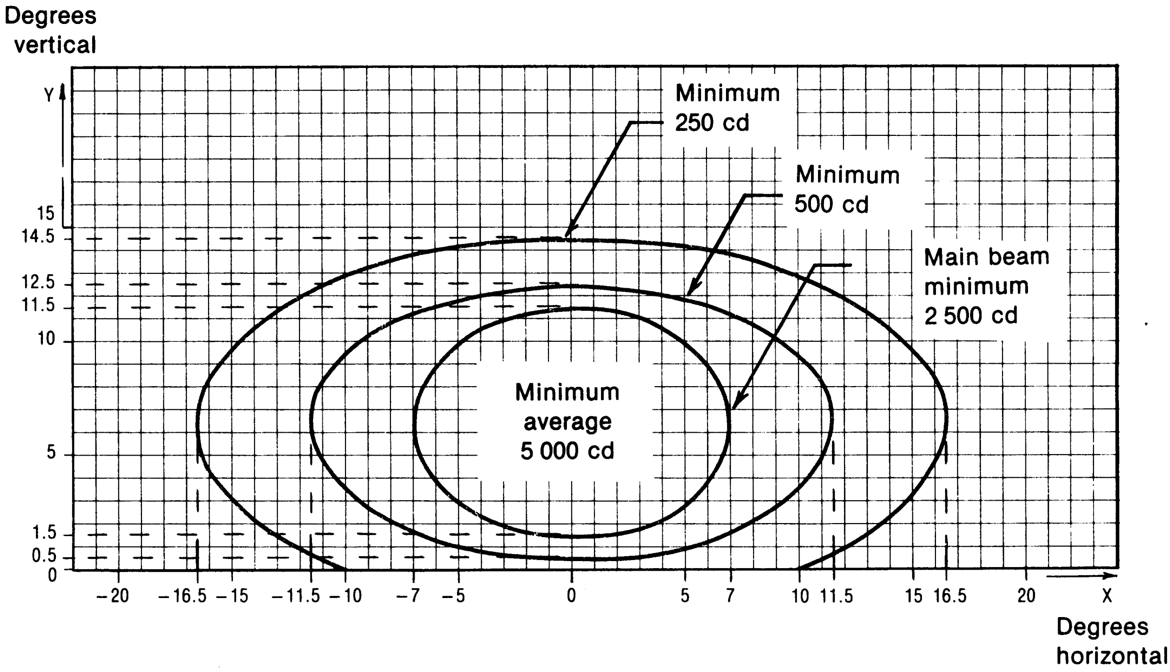

Figure 9.8-2: Isocandela Diagram for approach side row light (red light)

Notes: 1. Curves calculated on formula $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$

a	7.0	11.5	16.5
b	5.0	6.0	8.0

2. Toe-in 2 degrees
3. Vertical setting angles of the lights must 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	0.5º – 10.5º
116 m to 215 m	1.0º – 11º
216 m and beyond	1.5º – 11.5º (as illustrated above)

4. See collective notes at Paragraph 9.8.1.

Section 9.9: Visual Approach Slope Indicator Systems

9.9.1 General

9.9.1.1 A visual approach slope indicator system shall be provided to serve the approach to a runway, whether or not the runway is served by electronic approach slope guidance, where one of the following applies:

(a) The runway is regularly used by jet-propelled aeroplanes engaged in air transport operations.

(b) CASA directs that visual approach slope guidance be provided, because it has determined that such a visual aid is required for the safe operation of aircraft.

9.9.1.2 In making a determination that visual approach slope guidance is required, CASA will take into account the following:

(a) The runway is frequently used by other jet-propelled aeroplanes, or other aeroplanes with similar approach guidance requirements.

(b) The pilot of any type of aeroplane may have difficulty in judging the approach due to:

(i) inadequate visual guidance such as is experienced during an approach over water or featureless terrain by day or in the absence of sufficient extraneous lights in the approach area by night;

(ii) misleading approach information such as that produced by deceptive surrounding terrain, runway slope, or unusual combinations of runway width, length and light spacing;

(iii) a displaced threshold.

(c) The presence of objects in the approach area may involve serious hazard if an aeroplane descends below the normal approach path, particularly if there are no non-visual or other visual aids to give warning of such objects.

(d) Physical conditions at either end of the runway present a serious hazard in the event of an aeroplane undershooting or overrunning the runway.

(e) Terrain or prevalent meteorological conditions are such that the aeroplane may be subjected to unusual turbulence during approach.

9.9.1.3 CASA may direct that a visual approach slope indicator system be provided for temporary use only, for example due to a temporary displaced threshold, or during works in progress.

9.9.1.4 The following visual approach slope indicator systems are approved for use in Australian civil aerodromes:

(a) T-VASIS;

(b) AT-VASIS;

(c) Double-sided PAPI; and

(d) PAPI.

9.9.1.5 The standard installations must be:

(a) At international aerodromes, T-VASIS, or double-sided PAPI. Where this is impracticable, an AT-VASIS or PAPI is acceptable.

(b) At aerodromes other than international aerodromes, AT-VASIS or PAPI, except where (c) below applies.

(c) At aerodromes where CASA has determined that additional roll guidance is required, and/or high system integrity is necessary, T-VASIS or double-sided PAPI.

(d) AT-VASIS and PAPI must be installed on the left side of the runway, unless this is impracticable.

9.9.1.6 Where a T-VASIS is to be replaced by a PAPI, a double-sided PAPI must be provided.

9.9.1.7 Where more than one visual approach slope indicator system is provided at an aerodrome, to avoid confusion, the same type of approach slope indicator system must be used at each end of a runway. If there is more than one runway, the same type of approach slope indicator system must be used on all runways of similar reference code number.

9.9.1.8 Where a visual approach slope indicator system is provided for temporary use only, in accordance with 9.9.1.3, then 9.9.1.7 need not apply.

9.9.1.9 The choice of T-VASIS or PAPI is a matter between the aerodrome operator and airline operators using the runway. For capital city runways used by a range of medium and large jet aeroplanes, T-VASIS would be a better visual aid.

9.9.1.10 A visual approach slope indicator system must not be brought into service until it is appropriately commissioned and approved by CASA.

9.9.2 Obstacle Assessment Surface

9.9.2.1 An obstacle assessment surface (OAS) must be surveyed and assessed for obstacles for each end of the runway where a T-VASIS, AT-VASIS, double-sided PAPI or PAPI is to be provided. Standards of OAS are as follows and an OAS is illustrated below:

(a) Baseline: Width 150 m, coincident with the existing baseline for the approach surface;

(b) Slope: 1.9º;

(c) Splay: 7.5º outwards, commencing from the ends of the baseline;

(d) Length: 9 km from the baseline.

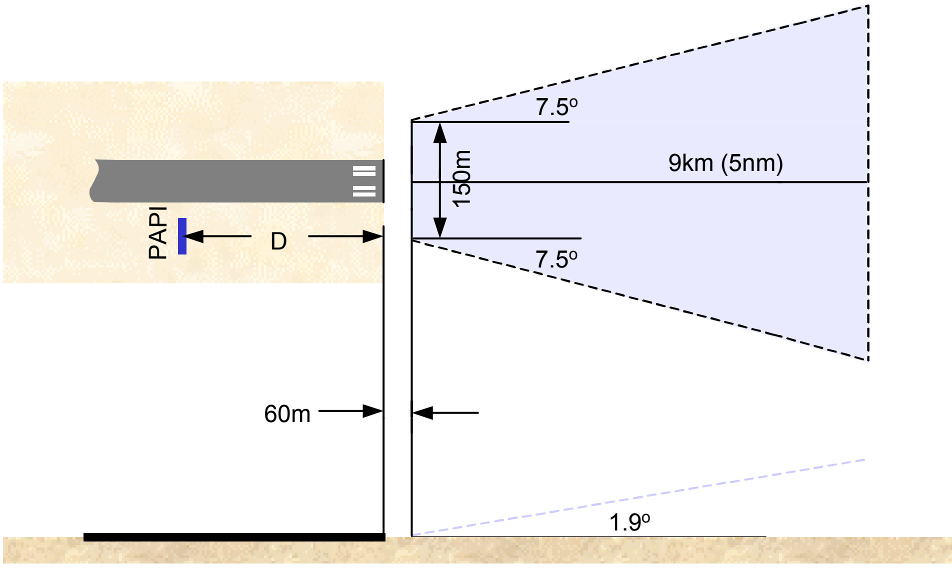

Figure 9.9-1: Illustration of an Obstacle Assessment Surface for 3° approach slope

9.9.2.2 The aerodrome operator must check any penetration by, or proximity to, objects such as radio masts, buildings etc. and terrain, of the Obstacle Assessment Surface as specified in Paragraph 9.9.2.1. Where one or more obstacles are found, or where high ground lies close to the approach path, the relevant CASA Office must be requested to conduct an aeronautical study to determine whether the obstacle(s) or terrain could adversely affect the safety of aircraft operations.

9.9.2.3 Where practicable, objects above the assessment surface must be removed, except where CASA determines that the object would not adversely affect the safety of operations.

9.9.2.4 If the study determines that safety could be adversely affected, and it is not practicable to remove the object, then one or more of the following measures should be undertaken:

(a) suitably raise the approach slope of the system – to a maximum of 3.3° where the runway is used by jet propelled aeroplanes, or 4° for other aeroplanes: the OAS slope can then be raised by the same amount, e.g. for a 3.3° slope the OAS can become 2.2° instead of 1.9°;

(b) reduce the azimuth spread so that the obstacle is outside the confines of the beam;

(c) displace the axis of the system and its associated OAS by up to 5°;

(d) suitably displace the threshold; and

(e) if (d) is impracticable, suitably displace the system upwind of the threshold to provide an increase in threshold crossing height equal to the height of the obstacle penetration.

9.9.3 T-VASIS and AT-VASIS

9.9.3.1 A T-Visual Approach Slope Indicator System (T-VASIS) is a set of lights so arranged that the pattern seen by the pilot varies according to his position (up or down, left or right) relative to the desired approach path. Where installed in the runway strip, it provides the pilot with visual cues about his or her actual descent path relative to the desired descent path.

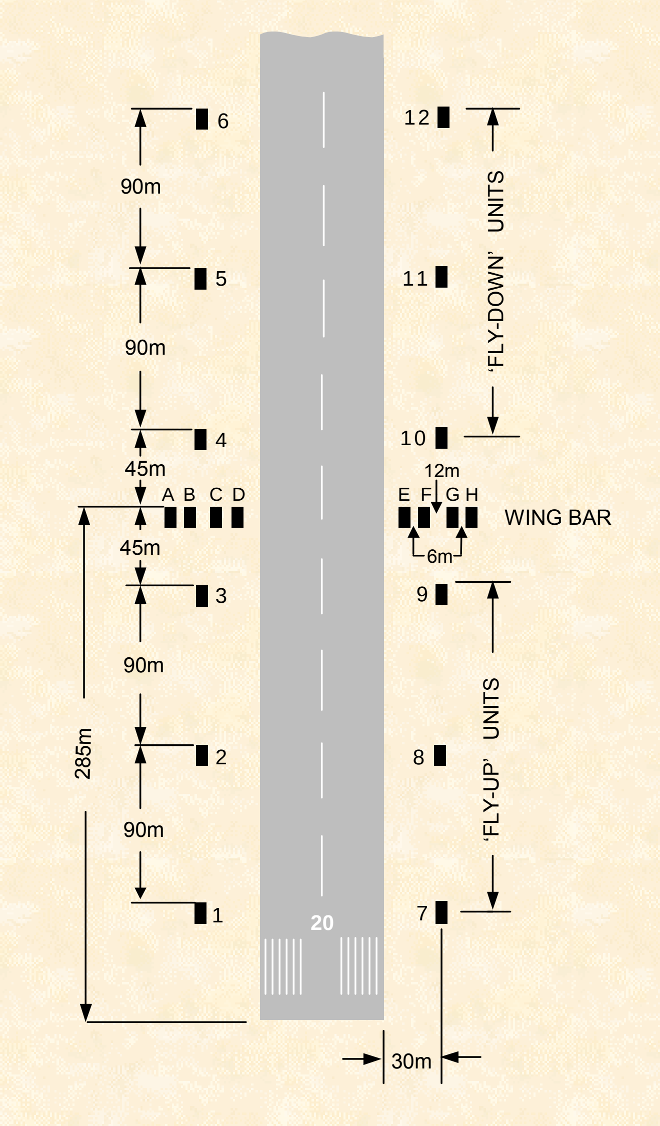

Figure 9.9-2: T-VASIS Layout

9.9.3.2 A T-VASIS must consist of twenty light units symmetrically disposed about the runway centreline in the form of two wing bars of four light units each, with bisecting longitudinal lines of six lights, and laid out as shown in Figure 9.9-2.

9.9.3.3 An AT-VASIS must consist of ten light units arranged on one side of the runway in the form of a single wing bar of four light units with a bisecting longitudinal line of six lights.

9.9.3.4 The light units must be constructed and arranged in such a manner that the pilot of an aeroplane during an approach will:

(a) When above the correct approach slope, see an inverted white 'T' pattern comprising the white wing bar(s) lights, and one, two or three white 'fly-down' lights, the more fly-down lights being visible, the higher the pilot is above the correct approach slope.

(b) When on the correct approach slope, see a line of white wing bar(s) lights.

(c) When below the correct approach slope, see a white 'T' pattern comprising the white wing bar(s) lights and one, two or three white 'fly-up' lights, the more fly-up lights being visible the lower the pilot is below the correct approach slope; and when well below the correct approach slope, see a red 'T' pattern with the wing bar(s) and the three fly-up lights showing red.

9.9.3.5 **Siting a T-VASIS or AT-VASIS.** The siting of a T-VASIS or AT-VASIS must be such that:

(a) The light units must be located as shown in Figure 9.9-2, subject to the tolerances given in Table 9.9-1.

(b) The light units forming the wing bars, or the light units forming a fly-down or a fly-up matched pair, must be mounted so as to appear to the pilot of an approaching aeroplane to be substantially in a horizontal line. The light units must be mounted as low as possible and must be frangible.

9.9.3.6 **Characteristics of the T-VASIS light units.** The characteristics of the T-VASIS light units must be such that:

(a) The system must be suitable for both day and night operations.

(b) A suitable intensity control must be provided to allow adjustments to meet the prevailing conditions and to avoid dazzling the pilot during approach and landing.

(c) The light distribution of the beam of each light unit must be of fan shape showing over a wide arc in azimuth in the approach direction. The wing bar light units shall produce a beam of white light from 1° 54' vertical angle up to 6° vertical angle and a beam of red light from 0° to 1° 54' vertical angle. The fly-down light units must produce a beam of white light extending from an elevation of 6° down to approximately the approach slope, where it must have a sharp cut-off. The fly-up light units must produce a beam of white light from approximately the approach slope down to 1° 54' vertical angle and a beam of red light below 1° 54' vertical angle. The angle of the top of the red beam in the wing bar units and fly-up units may be increased to provide obstacle clearance.

(d) The colour transition from white to red must be so as to appear to an observer at a distance of not less than 300 m, to occur over a vertical angle of not more than 15'. Immediately below this transition sector the intensity of the completely red beam must not be less than 15% of the intensity of the completely white beam immediately above the transition sector.

(e) The beam of light produced by the light units must show through an angle of at least 1° 30' above and below the approach slope both by day and by night and in azimuth through not less than 10° by day and not less than 15° by night. The effective visual range of the light units in clear weather must be at least 7.4 km over the above angles.

Notes: 1. Past practice in Australia has been to increase the night azimuth to 30°.

2. Where obstacles infringe into this wider azimuth, the obstacles should be removed where practicable. Alternatively, the azimuth spread may be suitably restricted.

(f) The light units must be so designed that deposits of condensation, dirt, etc. on optically transmitting or reflecting surfaces must interfere to the least possible extent with the light signals and must in no way affect the elevation of the beams or the contrast between the red and white signals. The construction of the light units must be such as to minimise the probability of the slots being wholly or partially blocked by snow or ice where these conditions are likely to be encountered.

9.9.3.7 **Approach slope and elevation settings of light beams.** The approach slope and elevation settings of light beams must be such that:

(a) An approach slope that is operationally satisfactory is to be selected for each runway. The standard approach slope is 3º (1:19 nominal), and with an eye height over threshold of 15 m.

(b) When the runway on which a T-VASIS is provided is equipped with an ILS, the siting and elevation of the light units must be such that the T-VASIS approach slope is compatible with the ILS glide path. A T-VASIS eye-height over the threshold 1 m higher than the ILS glide path has been found to satisfy most aeroplanes.

(c) The light beams from the corresponding light units on opposite sides of the runway must have the same recognition angle. The fly-up and fly-down light units of the 'T' must appear with uniform steps as the approach slope changes.

(d) The elevation of the beams of the wing bar light units on both sides of the runway must be the same. The elevation of the top of the beam of the fly-up light unit nearest to each wing bar, and the bottom of the beam of the fly-down light unit nearest to each wing bar, must be equal and must correspond to the approach slope. The cut-off angle of the top of the beams of successive fly-up units shall decrease by 5'(±½') of arc in angle of elevation at each successive unit away from the wing bar. The cut-in angle of the bottom of the beam of the fly-down light units must increase by 7'(±½') of arc at each successive unit away from the wing bar.

(e) The elevation setting of the top of the red light beams of the wing bar and fly-up light units must be such that, during an approach, the pilot of an aeroplane, to whom the wing bar and three fly-up units are visible, would clear all objects in the approach area by a safe margin, if any such light did not appear red.

9.9.3.8 **Clearance from movement areas.** Light unit must not be sited closer than 15 m from the edge of the runway. Light units should be sited at least 15 m from the edge of a taxiway but should circumstances require units to be closer than this distance the particular case should be referred to CASA.

9.9.3.9 **System dimensions.** Tabulated below are system dimensions, with allowable tolerances. These values apply to design, installation and subsequent maintenance:

Table 9.9-1

Item	Standard	Allowable Tolerance
Eye height over threshold	15 m [1,2]	+1 m –3 m
Approach slope [3]	3° (1: 19 nominal)	
Distance of longitudinal line of light units from runway edge [4]	30 m	±3 m
Leg light unit spacing	45 m 90 m	±4.5 m ±9 m
Clearance from pavements	15 m [5]	
Alignment of each light unit	Parallel to runway centreline	±1°
Light units in a wing bar Fronts of light units Height of light units	 Aligned Aligned	 ±25 mm ±25 mm
Levelling of light units	Level	To the accuracy of the precision engineers level. [6]

1 When the runway on which a T-VASIS is provided is equipped with an ILS, the siting and elevations of the T-VASIS shall be such that the visual approach slope conforms as closely as possible to the Glide Path of the ILS.
2 A T-VASIS eye height over threshold 1 m higher than the ILS Glide Path satisfies most aircraft.
3 The use of a different approach slope requires prior approval from CASA.
4 The edge of the runway is defined as the distance from the runway centreline, which is half the nominal width of the runway and ignores sealed shoulders.
5 A minimum clearance between any part of a T-VASIS light unit (but not the foundation slab) and an adjacent runway or taxiway pavement.
6 This includes end-for-ending the level to ensure no inaccuracy of the instrument.

9.9.3.10 The aerodrome operator must ensure that the immediate surround of each unit is kept free of grass. Tall grass immediately in front of the light unit could provide conflicting light signals. Grass growing near to the box on any side could result in the fine settings being disturbed during power mowing operations.

9.9.3.11 **Current settings.** The following information is provided for guidance only of aerodrome operators. For existing installations, the recommended lamp current, the approximate series current and approximate light intensities are shown in Table 9.9-2 and Table 9.9-3.

Table 9.9-2: Using 021027.8 (V1/418) Day Lamps and 020946-1 (V1/312) Night Lamps

Intensity stage	Lamp Current	Series Circuit Current	Light Unit Intensity
6	6.2 amps	6.2 amps	80,000 cd
5	5.0 amps	5.0 amps	20,000 cd
4	4.0 amps	4.0 amps	5,000 cd
3	2.4 amps	6.1 amps	450 cd
2	2.05 amps	5.2 amps	140 cd
1	1.65 amps	4.2 amps	50 cd
Note: For intensity stage 6, experiments have shown that lamp current down to 6.05 amps did not adversely affect visual acquisition from the 4 NM range in bright sunlight conditions. Hence if preservation of lamp life is desired, reduction of lamp current for stage 6 down to 6.05 amps is acceptable.			

Table 9.9-3: Using 020975.2 (V1/353) Day Lamps (with 074315.4 (Y9/1846) transformer) and 020946-1 (V1/312) Night Lamps

Intensity stage	Lamp Current	Series Circuit Current	Light Unit Intensity
6	6.85 amps	5.4 amps	80,000 cd
5	5.65 amps	4.5 amps	20,000 cd
4	4.8 amps	3.8 amps	5,000 cd
3	2.4 amps	6.1 amps	450 cd
2	2.05 amps	5.2 amps	140 cd
1	1.65 amps	4.2 amps	50 cd
Note: For intensity stage 6, experiments have shown that lamp current down to 6.35 amps did not adversely affect visual acquisition from the 4 NM range in bright sunlight conditions. Hence if preservation of lamp life is desired, reduction of lamp current for stage 6 down to 6.35 amps is acceptable.			

9.9.4 Precision Approach Path Indicator (PAPI) system

9.9.4.1 The PAPI system must consist of a row, also termed 'wing bar', of 4 equally spaced sharp transition multi-lamp (or paired single lamp) units. The system must be located on the left side of the runway, as viewed by an aircraft approaching to land, unless it is impracticable to do so.

9.9.4.2 The PAPI system must be sited and adjusted so that a pilot making an approach will:

(a) when on or close to the approach slope, see the two units nearest the runway as red and the two units farthest from the runway as white;

(b) when above the approach slope, see the one unit nearest the runway as red and the three units farthest from the runway as white; and when further above the approach slope, see all the units as white;

(c) when below the approach slope, see the three units nearest the runway as red and the unit farthest from the runway as white; and when further below the approach slope, see all the units as red.

9.9.4.3 Where it is impracticable to install the PAPI on the left side of the runway, and it has been installed on the right, the usual order of the light units must be reversed, so that the on-slope indication is still given by the two units nearest the runway showing red.

9.9.4.4 A double-sided PAPI system must consist of eight light units symmetrically disposed about the runway centre line in the form of two wing bars of four light units each. The indications seen by the pilot must be symmetrical, so that when on or close to the approach slope, the two light units nearest the runway, in both wing bars, show red.

9.9.4.5 **Siting a PAPI or a Double-sided PAPI.** The following requirements are applicable to the siting of a PAPI or a Double-sided PAPI:

(a) The light units must be located as in the basic configuration illustrated in Figure 9.9-3, subject to the installation tolerances given therein.

(b) The light units forming a wing bar must be mounted so as to appear to a pilot of an approaching aeroplane to be substantially in a horizontal line. The light units must be mounted as low as possible and must be frangible.

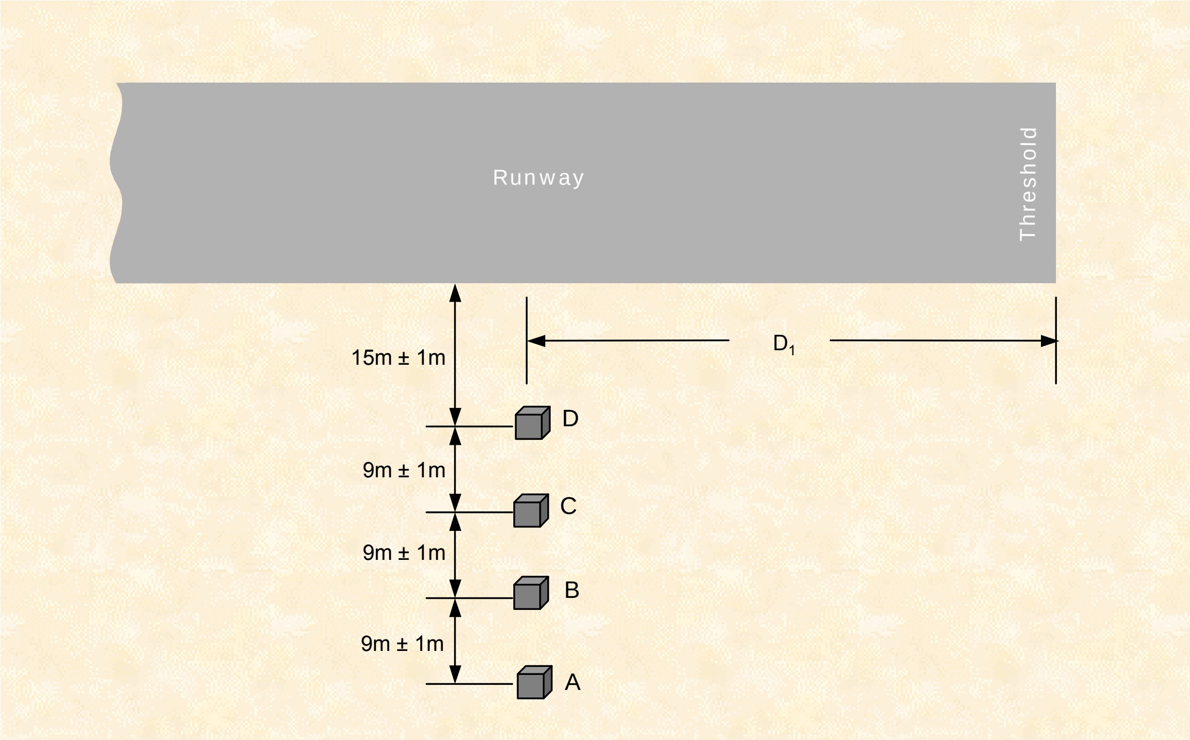

Figure 9.9-3: Siting of PAPI Light Units

Notes:
1. The edge of the runway is defined as the distance from the runway centreline, which is half the nominal width of the runway and ignores sealed shoulders.
2. In the case of runways where the row of edge lights is located beyond the standard 3 m specified in 9.10.5.1, for example those runways in accordance with the Note following 9.10.5.1, or those in accordance with 9.10.5.2, the PAPI should be located with the inner light unit 13 ±1 m from the line of the edge lights, rather than 15±1 m from the runway edge. (The reason for this is because reducing the spacing between PAPI light units results in a reduction in usable range of the system.) In the case of the Note following 9.10.5.1, when the runway edge lights are relocated to the standard location, the PAPI should also be relocated to the standard location.

9.9.4.6 **Characteristics of the PAPI light units.** The characteristics of the PAPI light units must be such that:

(a) The system must be suitable for both day and night operations.

(b) The colour transition from red to white in the vertical plane must be such that as to appear to an observer, at a distance of not less than 300 m, to occur within a vertical angle of not more than 3'.

(c) At full intensity the red light must have a Y co-ordinate not exceeding 0.320.

(d) The light intensity distribution of the light units must be as shown in Figure 9.9-4.

(e) Suitable intensity control must be provided to allow adjustment to meet the prevailing conditions and to avoid dazzling the pilot during approach and landing.

(f) Each light unit must be capable of adjustment in elevation so that the lower limit of the white part of the beam may be fixed at any desired angle of elevation between 1°30' and at least 4°30' above the horizontal.

(g) The light units must be so designed that deposits of condensation, snow, ice, dirt, etc., on optical transmitting or reflecting surfaces must interfere to the least possible extent with the light signals and must not affect the contrast between the red and white signals and the elevation of the transition sector.

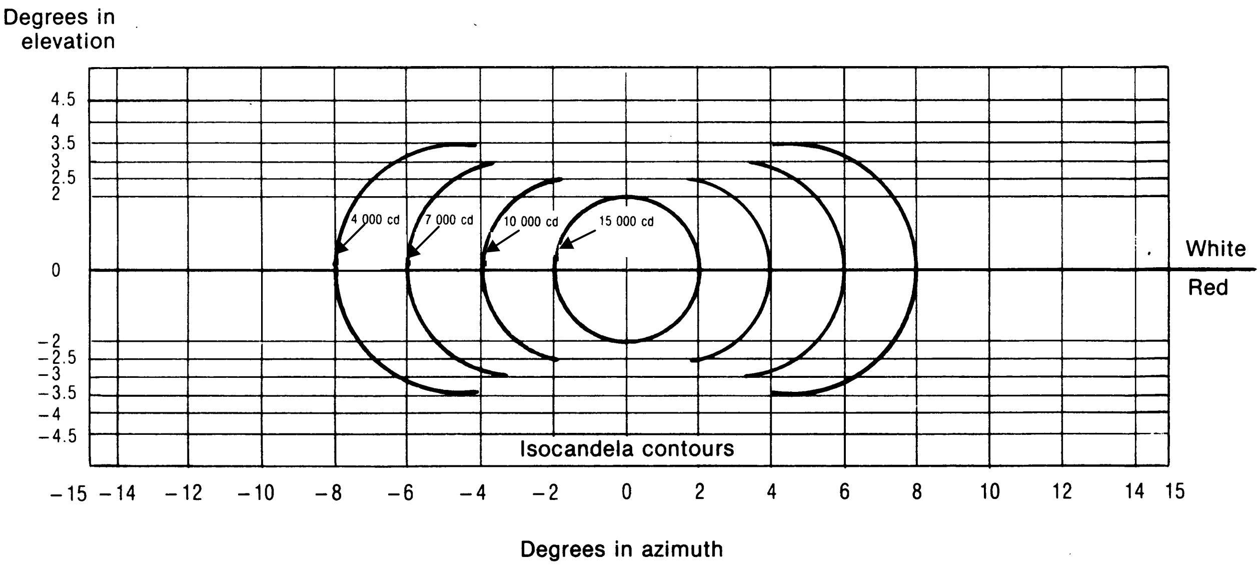

Figure 9.9-4: Light intensity distribution of PAPI

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.

9.9.4.7 **Approach slope and elevation setting of light units.** The requirements for the approach slope and elevation setting of light units are:

(a) The approach slope, as defined in Figure 9.9-5, must be appropriate for use by the aeroplanes using the approach. The standard approach slope is 3°.

(b) When the runway on which a PAPI is provided is equipped with an ILS, the siting and elevation of the light units must be such that the PAPI approach slope conforms as closely as possible with the ILS glide path.

(c) The angle of elevation settings of the light units in a PAPI wing bar must be such that, during an approach, the pilot of an aeroplane observing a signal of one white and three reds will clear all objects in the approach area by a safe margin. See 9.9.2.4(a) concerning the raising of the approach slope.

(d) The azimuth spread of the light beam must be suitably restricted where an object located outside the obstacle assessment surface of the PAPI system, but within the lateral limits of its light beam, is found to extend above the plane of the obstacle assessment surface and an aeronautical study indicates that the object could adversely affect the safety of operations. The extent of the restriction must be such that the object remains outside the confines of the light beam.

(e) Where a double-sided PAPI is provided, corresponding units must be seen at the same angle so that the signals of each wing bar change symmetrically at the same time.

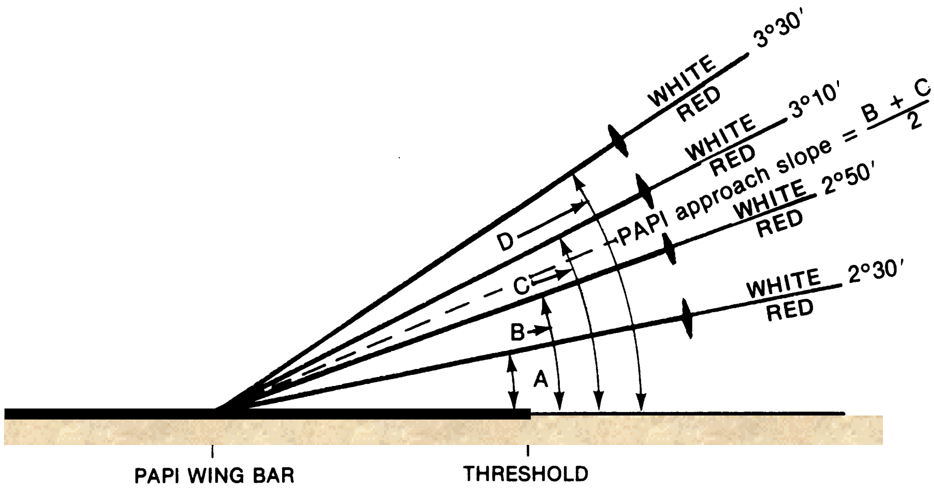

Figure 9.9-5: Light beams and angle of elevation setting for PAPI 3° approach slope

9.9.4.8 Determining PAPI wing bar distance from threshold

(a) The optimum distance of PAPI wing bar from the runway threshold is determined by:

(i) the requirement to provide adequate wheel clearance over the threshold for all types of aircraft landing on the runway;

(ii) the operational desirability that PAPI is compatible with any non-visual glide path down to the minimum possible range and height; and

(iii) any difference in elevation between the PAPI units and the runway threshold.

(b) The distance of the PAPI units from the threshold may have to be modified from the optimum after consideration of:

(i) the remaining length of runway available for stopping the aircraft; and

(ii) obstacle clearance.

(c) Table 9.9-4 specifies the standard wheel clearance over the threshold for the most demanding amongst the aircraft regularly using the runway, for four aircraft eye-to-wheel height groups. Where practicable, the standard wheel clearance shown in column (2) must be provided.

(d) Where the landing run may be limited, especially at smaller aerodromes, a reduction in wheel clearance over the threshold may be more acceptable than a loss of landing distance. The special minimum wheel clearance shown in column (3) may be used in such a situation, if an aeronautical study indicates such reduced clearances to be acceptable. As guidance, these wheel clearances are unlikely to be acceptable where there are objects under the approach near the threshold, such as approach light supporting structures, boundary fences, roads, etc.

(e) The final location of the units is determined by the relationship between the approach angle, the difference in levels between threshold and the units, and the minimum eye height over the threshold (MEHT). The angle M used to establish the MEHT is 2' of arc less than the setting angle of the unit which defines the lower boundary of the on-slope indication, i.e. unit B, the third unit from the runway. See Figure 9.9-6.

(f) Where a PAPI is installed on a runway not equipped with an ILS, the distance D_1 shall be calculated to ensure that the lowest height at which a pilot will see a correct approach path indication provides the wheel clearance over the threshold specified in Table 9.9-4 for the most demanding amongst aeroplanes regularly using the runway.

(g) Where a PAPI is installed on a runway equipped with an ILS, the distance D_1 shall be calculated to provide the optimum compatibility between the visual and non-visual aids for the range of eye-to-antenna heights of the aeroplanes regularly using the runway.

(h) If a wheel clearance greater than that that specified in 9.9.4.8(f) is required for specific aircraft, this can be achieved by increasing D_1.

(i) Distance D_1 shall be adjusted to compensate for differences in elevation between the lens centres of the light units and the threshold.

(j) PAPI units must be the minimum practicable height above ground, and not normally more than 0.9 m. All units of a wing bar should ideally lie in the same horizontal plane; however, to allow for any transverse slope, small height differences of no more than 50 mm between light units are acceptable. A lateral gradient not greater than 1.25% can be accepted provided it is uniformly applied across the units.

Table 9.9-4: Wheel clearance over threshold for PAPI

Eye-to-wheel height of aeroplane in the approach configuration [a]	Standard wheel clearance (metres)[b]	Special minimum wheel clearance (metres)[c, d]
(1)	(2)	(3)
Up to but not including 3 m	6	3
3 m up to but not including 5 m	9	4
5 m up to but not including 8 m	9	5
8 m up to but not including 14 m	9	6

[a] In selecting the eye-to-wheel height group, only aeroplanes meant to use the system on a regular basis shall be considered. The most demanding amongst such aeroplanes shall determine the eye-to-wheel height group.

[b] Where practicable, the standard wheel clearance shown in column (2) shall be provided.

[c] The wheel clearance may be reduced to not less than those in column (3) with specific agreement of CASA, where an aeronautical study indicates that such reduced wheel clearances are acceptable.

[d] Where the Special Minimum wheel clearance is provided at a displaced threshold it shall be ensured that the corresponding Standard wheel clearance specified in column (2) will be available when an aeroplane at the top end of the eye-to-wheel height group chosen overflies the extremity of the runway.

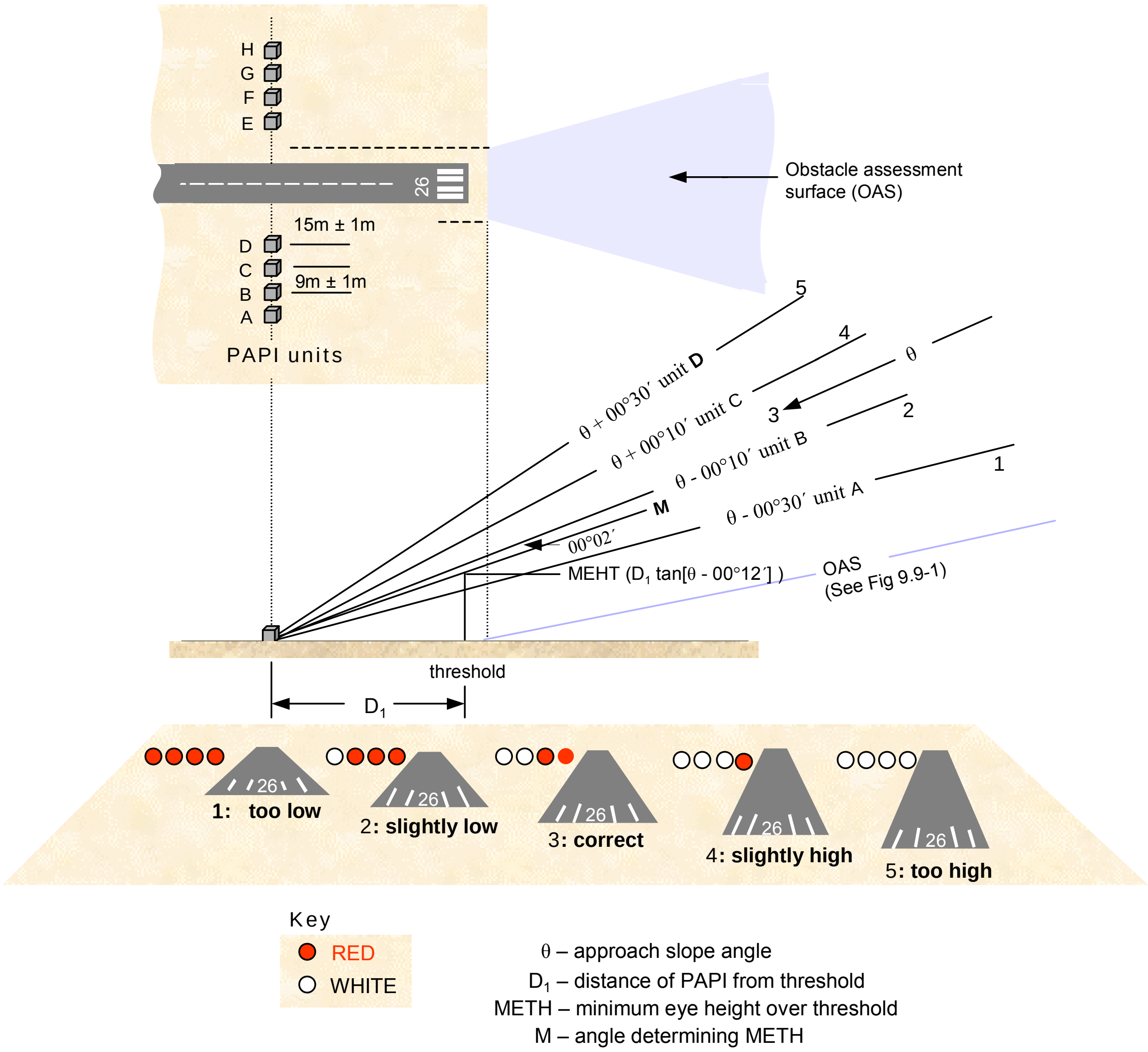

Figure 9.9-6: The arrangement of a PAPI system and the resulting display

9.9.4.9 Procedure for Establishing the Distance of the PAPI Wing Bar from the Runway Threshold

(a) Decide on the required approach slope. The standard approach slope is 3°.

(b) On runways where no ILS is installed, refer to Table 9.9-4 to determine the aeroplane eye-to-wheel group and the wheel clearance to be provided at the threshold. The MEHT, which provides the appropriate wheel clearance over the threshold, is established by adding the approach configuration eye-to-wheel height of the most demanding amongst the aircraft regularly using the runway to the required threshold wheel clearance.

(c) The calculation of the nominal position of the PAPI is made on the assumption that the PAPI units are at the same level as the runway centreline adjacent to them, and this level, in turn, is the same as that of the runway threshold. The nominal distance of the PAPI is derived by multiplying the required MEHT by the cotangent of the angle M in Figure 9.9-6.

(d) Where there is a difference in excess of 0.3 m between the elevation of the runway threshold and the elevation of unit B at the nominal distance from the threshold, it will be necessary to displace the PAPI from its nominal position. The distance will be increased if the proposed site is lower than the threshold and will be decreased if it is higher. The required displacement is determined by multiplying the difference in level by the cotangent of the angle M.

(e) Where a PAPI is installed on a runway equipped with an ILS, the distance D_1 must be equal to that between the threshold and the effective origin of the ILS glide path, plus a correction factor for the variation of eye-to-antenna heights of the aeroplanes concerned. The correction factor is obtained by multiplying the average eye-to-antenna height of those aeroplanes by the cotangent of the approach angle. The PAPI is then aimed at the same angle as the ILS glide slope. Harmonization of the PAPI signal and the ILS glide path to a point closer to the threshold may be achieved by increasing the width of the PAPI on-course sector from 20' to 30'. However, the distance D_1 must be such that in no case will the wheel clearance over the threshold be lower than specified in column (3) of Table 9.9-4.

Section 9.10: Runway Lighting

9.10.1 Types of Runway Edge Lighting Systems

9.10.1.1 A runway edge lighting system may be of the following type:

(a) low intensity – a single intensity lighting system suitable for a non-instrument runway or a non-precision approach runway. This is provided at an aerodrome where there is no appropriate person, such as an air traffic controller, certified air/ground radio operator, or similar, to adjust the intensity settings of the lights;

(b) medium intensity – a 3-stage intensity lighting system suitable for a non-instrument runway or a non-precision approach runway. This is provided to enhance the lighting system particularly in marginal weather conditions. This system cannot be used at an aerodrome that does not have air traffic services or similar personnel.

> **Note:** This requirement is for controlling light intensity during the landing phase. This section is not to be confused with lighting systems controlled by a photo-electric cell which can provide Day, Twilight and Night intensity settings based on ambient conditions.

(c) high intensity – a 5 or 6 stage intensity lighting system which is suitable for precision approach runways. This system cannot be used at an aerodrome that does not have air traffic services or similar personnel.

9.10.2 Runway Edge Lights

9.10.2.1 Runway edge lights must be provided for a runway intended for use at night or for a precision approach runway intended for use by day or night.

9.10.2.2 Runway edge lighting must meet the following operational requirements:

(a) for every runway intended for use at night, omnidirectional lights meeting the characteristics requirements of 9.10.6 shall be provided to cater for both visual circling after an instrument approach to circling minima, and circuits in VMC;

(b) for a precision approach runway, in addition to (a) above, unidirectional lights meeting the characteristics requirements of 9.10.7, and 9.10.8, if applicable, shall also be provided.

> **Note**: Successful past practice has been for separate light fittings, one to satisfy the omnidirectional characteristic, and another to satisfy the unidirectional characteristic, to be provided.

9.10.3 Location of Runway Edge Lights

9.10.3.1 Runway edge lights must be placed along both sides of the runway, in two parallel straight rows equidistant from the centreline of the runway, commencing one-light spacing from the threshold and continuing to one-light spacing from the runway end.

9.10.4 Longitudinal Spacing of Runway Edge Lights

9.10.4.1 The longitudinal spacing of runway edge lights must be uniform and be:

(a) for an instrument runway, 60 m +0 / -5 m;

(b) for a non-instrument runway, 90 m ± 10 m, or 60 m +0 / -5 m if there is an intention to upgrade the runway to an instrument runway at some time in the future.

(c) for non-precision instrument runways intended to be used in visibility conditions of 1.5 km or greater, where existing edge lights are spaced at 90 m ±10 m, it is acceptable to retain this spacing until the next replacement or improvement of the edge lighting system. (This situation typically arises from an existing non-instrument runway being upgraded to a non-precision instrument runway, but without re-installing the runway edge lights to the 60 m +0 / -5 m standard.)

Notes: 1. With GPS technology, virtually any runway can become an instrument runway. Accordingly, it is recommended that any new runway edge lights should be spaced in accordance with Paragraph 9.10.4.1(a).

2. Existing lights spaced in accordance with previous standards of 200 ft or 300 ft imperial measurements may exceed 60 m or 100 m respectively. They are deemed to comply with the standards of this Paragraph, until the next replacement or upgrade of the edge lighting system.

9.10.4.2 Where the runway is a non-instrument or a non-precision instrument runway, and it is intersected by other runways or taxiways:

(a) within 600 m of the threshold, lights may be spaced irregularly, but not omitted, and

(b) more than 600 m from the threshold, lights may be spaced irregularly or omitted, but no two consecutive lights may be omitted;

provided that such irregular spacing or omission does not significantly alter the visual guidance available to a pilot using the runway.

9.10.4.3 Runway edge lights must not to be omitted on a precision approach runway.

9.10.4.4 Where a runway edge light cannot be omitted, inset runway edge lights must be provided in place of elevated lights.

9.10.4.5 Unless a light is omitted or displaced in accordance with Paragraph 9.10.4.2, a runway edge light must be aligned with a light on the opposite side of the runway.

9.10.5 Lateral Spacing of Runway Edge Lights

9.10.5.1 Subject to Paragraph 9.10.5.2, runway edge lights must be placed along the edges of the area declared for use as the runway or outside the edges of the area at a distance of not more than 3 m.

> **Note:** Existing edge lights located beyond 3 m from the edge of runway as a result of a reduction in the declared runway width do not need to be relocated until they are being replaced.

9.10.5.2 If the width of a runway is less than 30 m in width, the runway edge lights must be placed as if the runway is 30 m in width, and in accordance with Paragraph 9.10.5.1.

9.10.5.3 If a runway is provided with both low or medium intensity and high intensity runway light units, the row of high intensity light units shall be placed closer to the runway centreline. The two rows of light units are to be parallel, separated by a distance of at least 0.5 m.

9.10.6 Characteristics of Low and Medium Intensity Runway Edge Lights

9.10.6.1 Low intensity and medium intensity runway edge lights must be fixed omnidirectional lights that show variable white. Elevated omnidirectional lights must have light distribution that is uniform for the full 360° horizontal coverage. Where elevated lights are impracticable and inset lights are used, the photometric characteristics of the inset lights are to be as close as practicable to those of the elevated lights.

9.10.6.2 The minimum light intensity for low intensity runway edge lights is to be in accordance with Section 9.11, Figure 9.11-1. The main beam, between 0° and 7° above the horizontal, is to have a minimum average intensity of not less than 100 cd, and a maximum average intensity of not more than 200 cd.

9.10.6.3 Low intensity runway edge lights are to have a single intensity for all lights in the same runway lighting system.

9.10.6.4 The minimum light intensity for medium intensity runway edge lights is to be in accordance with Section 9.11, Figure 9.11-2. The main beam, between 0° and 7° above the horizontal, is to have a minimum average intensity of not less than 200 cd, and a maximum average intensity of not more than 600 cd.

9.10.7 Characteristics of High Intensity Runway Edge Lights

9.10.7.1 High intensity runway edge lights must be fixed unidirectional lights with the main beam directed towards the threshold.

9.10.7.2 High intensity runway edge light beam coverage shall be toed in towards the runway as follows:

(a) 3.5° in the case of a 30-45 m wide runway;

(b) 4.5° in the case of a 60 m wide runway.

9.10.7.3 High intensity runway edge lights must show variable white except for those located within 600 m from the runway end which must show yellow.

9.10.7.4 The minimum light intensity for high intensity runway edge lights that show variable white is to be in accordance with Section 9.11

(a) Figure 9.11-3 for 30 m to 45 m wide runways; and

(b) Figure 9.11-4 for 60 m wide runways.

9.10.7.5 The minimum light intensity for high intensity runway edge lights that show yellow is the standard set out in Figure 9.11-3 or Figure 9.11-4, whichever is applicable, multiplied by 0.4.

9.10.8 Use of Bidirectional or Back-to-back Light Fittings

9.10.8.1 On a runway where high intensity edge lights are intended to be used from either direction, separate high intensity runway edge light fittings may be provided back-to-back, or bidirectional light fittings with the correct toe-in angle built in, may be used.

9.10.9 Runway Threshold Lights

9.10.9.1 Runway threshold lights must be provided on a runway that is equipped with runway edge lights.

9.10.10 Location of Runway Threshold Lights

9.10.10.1 Runway threshold lights must be located in a straight line at right angles to the centreline of the runway and:

(a) when the threshold is at the extremity of a runway – as near to the extremity as possible and not more than 3 m outside, or 1 m inside of the extremity; or

(b) when the threshold is a displaced threshold – at the displaced threshold with a tolerance of ± 1 m.

9.10.11 Pattern of Low Intensity and Medium Intensity Runway Threshold Lights

9.10.11.1 Low and medium intensity runway threshold lights are to consist of:

(a) 2 omnidirectional lights, one at each end of the threshold and in line with the runway edge lights; and

(b) 6 unidirectional lights at equal intervals between the 2 omnidirectional lights.

9.10.11.2 The 6 unidirectional lights are to be inset lights if:

(a) the threshold is a permanently displaced threshold; or

(b) the threshold is also equipped with high intensity threshold lights; or

(c) it is impractical for elevated lights to be installed.

9.10.11.3 Aerodromes used predominantly for training and general aviation, may choose to use an alternative pattern of low intensity or medium intensity runway threshold lights.

9.10.11.4 The alternative pattern is not suitable for aerodromes used predominantly by aircraft having a take-off weight greater than 5,700 kg, nor is it suitable for aerodromes where commercial air transport jet propelled aeroplanes operate.

9.10.11.5 The alternative pattern consists of:

(a) 6 elevated lights arranged in 2 groups of 3 equally spaced lights, with the distance between the 2 groups equal to half the lateral distance between the 2 rows of runway edge lights; and

(b) The outer lights on either side shall be omnidirectional green lights, and the inner 4 lights shall be unidirectional green lights (or bidirectional green/red lights when the same light fittings are used for runway end lights).

9.10.12 Pattern of High Intensity Runway Threshold Lights

9.10.12.1 High intensity runway threshold lights must consist of:

(a) 2 unidirectional lights, one at each end of the threshold and in line with the row of runway edge lights; and

(b) unidirectional lights uniformly spaced between the 2 outer lights, at intervals of not more than 3 m. These lights must be inset lights.

9.10.13 Characteristics of Low Intensity and Medium Intensity Runway Threshold Lights

9.10.13.1 Low intensity and medium intensity runway threshold lights must have the following characteristics:

(a) the outermost light on each side must be a fixed omnidirectional light showing green;

(b) the inner lights must be fixed unidirectional lights showing green in the direction of approach over not less than 38° or more than 180° of azimuth;

(c) the light distribution in the direction of approach must be as close as practicable to that of the runway edge lights;

(d) the intensity of the green lights must be in the range of 1 to 1.5 times the intensity of the runway edge lights.

Note: Older installations with the intensity of green light in the range of 0.5 to 1 times the intensity of the runway edge lights are acceptable, until the next replacement or upgrade of the runway and/or threshold lighting system.

9.10.14 Characteristics of High Intensity Runway Threshold Lights

9.10.14.1 High intensity runway threshold lights must be fixed lights showing green in the direction of approach with a minimum light intensity in accordance with Section 9.11, Figure 9.11-5.

9.10.15 Additional Lighting to Enhance Threshold Location

9.10.15.1 Threshold Wing Bars:

(a) On a precision approach runway, if it is operationally required that an increase in the conspicuity of the threshold at night be provided, the threshold may be provided with threshold wing bars.

(b) Where provided, threshold wing bars must be symmetrically disposed on either side of the threshold:

(i) each wing bar is to consist of 5 lights at 2.5 m apart;

(ii) at right angles to the runway centreline; and

(iii) with the inner most light of each wing bar aligned with the row of runway edge lights on that side of the threshold.

9.10.15.2 Characteristics of Threshold Wing Bars:

(a) Threshold wing bars must have the following characteristics:

(i) be fixed unidirectional lights showing green in the direction of approach; and

(ii) the minimum light intensity is to be in accordance with Section 9.11, Figure 9.11-6.

(b) If it is impracticable to use elevated lights, inset lights may be used, however, inset and elevated lights must not be used in the same threshold wing bar.

9.10.15.3 Runway Threshold Identification Lights:

(a) At an aerodrome where it is difficult to locate a runway threshold from the air during the day such as in the case of a displaced threshold or an aerodrome with complex runway/taxiway layout in the vicinity of the threshold, runway threshold identification lights may be required.

Note: Runway threshold identification lights may also assist pilot acquisition of a threshold during twilight hours and at night. During these periods the lights need to be controlled such that an approaching pilot will not be dazzled by the flashing lights.

(b) Runway threshold identification lights must be provided, during the day, to mark a temporarily displaced threshold of a runway serving international jet propelled aeroplanes conducting air transport operations.

> **Note:** Runway threshold identification lights may also be used to mark the temporarily displaced thresholds of other runways. When used, the need for temporarily displaced threshold V-bar markings is normally waived.

9.10.15.4 **Location of runway threshold identification lights**. Because of their nature and use, runway threshold identification lights can have more flexibility in their installation location than other visual aids. Advantage can be taken of this particularly when they are provided on temporary displaced thresholds, to site them clear of existing facilities, and works areas.

9.10.15.5 Where provided, one light unit shall be on each side of the runway, equidistant from the runway centreline, on a line perpendicular to the runway centreline. The optimum location of the light units shall be 12 to 15 m outside each line of runway edge lights, and in line with the threshold. The light units may be located laterally up to 20 m from the line of runway edge lights and longitudinally up to 12 m prior to the threshold. Each light unit shall be a minimum of 12 m from the edge of taxiways and runways. The elevation of both light units shall be within 1 m of a horizontal plane through the runway centreline, with the maximum height above ground not exceeding 1 m.

9.10.15.6 **Characteristics of runway threshold identification lights.** Runway threshold identification lights must have the following characteristics:

(a) be flashing lights;

(b) the light flashes are synchronised with a normal flash rate of 100-120 per minute;

(c) the colour of the lights is white;

(d) a minimum range in bright sunlight of approximately 7 km; and

(e) the beam axis of each light unit shall be aimed 15° outward from a line parallel to the runway centreline and inclined at an angle of 10° above the horizontal.

> **Note:** L-849 A and E light units specified in FAA AC 150/5345-51 '*Specification for Discharged -Type of Flashing Light Equipment*' are xenon strobe type of lights suitable for use as runway threshold identification lights.

9.10.15.7 **Temporarily displaced threshold lights for use at night.** Temporarily displaced threshold lights must be provided at night to identify the new threshold location when the threshold of a runway is temporarily displaced.

9.10.15.8 **Location of temporarily displaced threshold lights.** Temporarily displaced threshold lights must be provided on each side of the runway:

(a) in line with the displaced threshold:

(b) at right angles to the runway centreline; and

(c) with the innermost light on each side aligned with the row of runway edge lights on that side of the threshold.

9.10.15.9 **Characteristics of temporarily displaced threshold lights.** Temporarily displaced threshold lights must have the following characteristics:

(a) each side must consist of 5 lights except that 3 lights per side is sufficient if the runway width is 30 m or less;

(b) the lights must be spaced at 2.5 m apart;

(c) the innermost light of each side must be a fixed omnidirectional light showing green in all angles of azimuth;

(d) the outer 4 or 2 lights, as appropriate, of each side must be fixed unidirectional lights showing green in the direction of approach, over not less than 38° or more than 180° of azimuth;

(e) the light distribution in the direction of approach must be as close as practicable to that of the runway edge lights;

(f) the light intensity must be as close as practicable to 1.5 times, and not less than, that of the runway edge lights.

Note: Temporary displaced threshold lights are associated only with low intensity or medium intensity runway lighting systems. They are not associated with high intensity runway lighting systems. If a precision approach runway has the threshold temporarily displaced, it renders ILS unavailable for precision approaches, which changes the runway to a non-precision or non-instrument runway.

9.10.15.10 Runway lighting before a displaced threshold

(a) If the part of runway located before a displaced threshold is available for aircraft use, i.e. for take-offs, and landings from the opposite direction, runway edge lights in this part of runway must:

  (i) show red in the direction of approach to the displaced threshold; and

  (ii) show white in the opposite direction, or yellow as appropriate for a precision approach runway.

(b) The intensity of the red runway edge lights required under Paragraph 9.10.15.10(a) must not be less than one-quarter, and not more than one-half, that of the white runway edge lights.

(c) Runway edge lights may be bidirectional light fittings or separate light fittings installed back to back.

(d) If the portion of runway before a displaced threshold is closed to aircraft operations, all the runway lights thereon must be extinguished.

9.10.16 Runway End Lights

9.10.16.1 Runway end lights must be provided on a runway equipped with runway edge lights.

9.10.17 Location of Runway End Lights

9.10.17.1 Runway end lights must be located in a straight line at right angles to the runway centreline, and:

(a) when the runway end is at the extremity of the runway – as near to the extremity as possible and not more than 3 m outside, or 1 m inside the extremity;

(b) when the runway end is not at the extremity of the runway – at the runway end, with a tolerance of ± 1 m.

(c) with respect to taxiways intended for exiting the runway, be located such that an aircraft exiting the runway will not be required to cross the row of red lights comprising the runway end lights.

> **Note:** The universally accepted convention in aerodrome lighting is that a pilot is never required to cross a row of red lights.

9.10.18 Pattern of Runway End Lights

9.10.18.1 The pattern of runway end lights must consist of:

(a) 6 lights spaced at equal intervals between the rows of runway edge lights; or

(b) if the runway is provided with the alternative threshold light pattern, the threshold pattern.

9.10.19 Characteristics of Low and Medium Intensity Runway End Lights

9.10.19.1 Low intensity and medium intensity runway end lights must have the following characteristics:

(a) the lights must be fixed unidirectional showing red in the direction of the runway over not less than 38° or more than 180° of azimuth;

(b) the intensity of the red light must not be less than one-quarter, and not more than one-half, that of the runway edge lights;

(c) the light distribution in the direction of the runway must be as close as practicable to that of the runway edge lights.

9.10.19.2 Low intensity and medium intensity runway end lights must be inset lights if:

(a) the runway is also equipped with high intensity runway end lights; or

(b) it is impracticable for elevated lights to be installed.

9.10.19.3 If the runway end coincides with the runway threshold, bidirectional light fittings may be used or separate light fittings installed back to back.

9.10.20 Characteristics of High Intensity Runway End Lights

9.10.20.1 High intensity runway end lights must have the following characteristics:

(a) the lights must be inset, fixed unidirectional showing red in the direction of the runway; and

(b) the minimum light intensity must be in accordance with Section 9.11, Figure 9.11-7.

9.10.21 Runway Turning Area Edge Lights

9.10.21.1 Where an aircraft turning area is provided on a runway, the edge of the turning area must be provided with blue edge lights if the runway is provided with edge lights.

9.10.21.2 Runway turning area edge lights must be located not less than 0.6 m, and not more than 1.8 m, outside the edge of the turning area.

9.10.21.3 If the beginning of the splay into a runway turning area is more than 10 m from the previous runway edge light, a blue edge light must be located where the turning area commences.

9.10.21.4 Turning area edge lights must be provided to mark any change of direction along the side of the turning area.

9.10.21.5 Where a side of the turning area is longer than 30 m, equally spaced blue edge lights must be provided along that side, with spacing not exceeding 30 m.

9.10.21.6 Runway turning area edge lights must have the same characteristics as taxiway edge lights, in accordance with Paragraph 9.13.15.

9.10.22 Stopway Lights

9.10.22.1 Stopway lights must be provided on a stopway which is longer than 180 m and is intended for night use.

9.10.22.2 Stopway lights must be located along both sides of the stopway in line with the runway edge lights and up to the stopway end.

9.10.22.3 The spacing of stopway lights must be uniform and not more than that of the runway edge lights, with the last pair of lights located at the stopway end.

9.10.22.4 The stopway end must be further indicated by at least 2 stopway lights at equal intervals across the stopway end between the last pair of stopway lights.

9.10.22.5 Stopway lights must have the following characteristics:

(a) the lights must be fixed and unidirectional showing red in the direction of the runway, and not visible to a pilot approaching to land over the stopway;

(b) the light distribution in the direction of the runway must be as close as possible to that of the runway edge lights; and

(c) the intensity of the red light must not be less than one quarter, and not more than one half, that of the white runway edge lights.

9.10.23 Hold Short Lights

9.10.23.1 Hold short lights must be provided on a runway which is intended to accommodate land and hold short operations (LAHSO).

9.10.23.2 Hold short lights must be at least 6 inset lights located across the runway as near to the hold short line as possible, and in any case not beyond, and not more than 3 m before the hold short line, which is at least 75 m from the centreline of the intersecting runway.

9.10.23.3 The hold short lights must be at right angles to the runway, and located symmetrically about the runway centreline, with the closest lights at 1.5 m from the centreline, and subsequent lights 3 m apart.

9.10.23.4 The hold short lights must be unidirectional, showing white in the direction of approach to the hold short position, and have photometric characteristics in accordance with Section 9.11, Figure 9.11-8.

9.10.23.5 The lights must occult, in unison, at between 25 and 35 cycles per minute. The illumination period shall be approximately 2/3, and the light suppression period shall be approximately 1/3, of the total period of each cycle.

> **Note:** The illumination and suppression period will be affected by varying the light intensity. The FAA AC 150/5345-54 specified L-884 Power and Control Unit (PCU) is typically used to power LAHSO systems. The PCU pulses the lights by varying the voltage on the primary side of the series circuit. The light fixtures need to be isolated from the series circuit via 6.6/6.6 ampere isolating transformers. Typically, the PCU continuously switches the output current with an ‘on’ cycle duration of 1.35 ± 0.1 seconds, and an ‘off’ cycle duration of 0.8 ± 0.1 seconds.

9.10.23.6 Each bar of hold short lights must be individually controlled, provided with variable intensity setting, and technically monitored for serviceability, at the operator position of the ATC operator controlling the LAHSO operation.

9.10.23.7 Where secondary power is available, hold short lights must be connected to that power system, with changeover times not greater than for the runway lighting on the same runway.

9.10.24 Runway Centreline Lights

9.10.24.1 Runway centreline lights must be provided on a precision approach runway Category II or III.

> **Note:** Provision of runway centreline lights on a precision approach runway Category I where the width between the runway edge lights is greater than 50 m is recommended.

9.10.24.2 Runway centreline lights must be located from the threshold to the end at longitudinal spacing of approximately:

(a) 15 m on a runway intended for use in runway visual range conditions less than a value of 300 m; and

(b) 30 m on a runway intended for use in runway visual range conditions of 300 m or greater.

9.10.24.3 The runway centreline lights may be offset by not more than 0.6 m from the true runway centreline, for maintenance of runway marking purposes.

9.10.24.4 The offset shall be on the left hand side of the landing aircraft, where practicable. Where the runway is used in both directions, the direction from which the majority of landings will take place shall prevail.

9.10.24.5 Runway centreline lights must be inset, fixed lights showing white from the threshold to a point 900 m from the runway end. From 900 m to 300 m from the runway end, the light pattern is to be two red lights followed by two white lights. For the last 300 m before the runway end, the lights must show red.

Note: The double red and white alternating light arrangement is for interleaving circuitry, to ensure that failure of part of the electrical system does not result in a false indication of the runway distance remaining.

9.10.24.6 The light intensity and distribution of runway centreline lights must be in accordance with:

(a) Section 9.11, Figure 9.11-8 — for 30 m spacing;

(b) Section 9.11, Figure 9.11-9 — for 15 m spacing.

9.10.25 Runway Touchdown Zone Lights

9.10.25.1 Runway touchdown zone lights must be provided for a runway intended for precision approach Category II or III operations.

9.10.25.2 From paragraphs 9.7.3.8 and 9.7.3.9 above, it is implicit that touchdown zone lights must be provided where Category II and III approach lights are provided.

9.10.25.3 Runway touchdown zone lights must extend from the threshold for a distance of 900 m. The lighting is to consist of a series of transverse rows of lights, or barrettes, symmetrically located on each side of the runway centreline.

9.10.25.4 Each barrette must consist of three light units at 1.5 m apart. The innermost light of each barrette must be at 9 m from the true runway centreline.

9.10.25.5 The first pair of barrettes must be located at 60 m from the threshold. Subsequent barrettes must be spaced longitudinally at 60 m apart.

9.10.25.6 Runway touchdown zone lights must be inset, fixed unidirectional lights showing variable white.

9.10.25.7 Runway touchdown zone lights must be in accordance with Section 9.11, Figure 9.11-10.

9.10.26 Photometric Characteristics of Runway Lights

9.10.26.1 Section 9.11, Figure 9.11-11 shows the method of establishing the grid points for calculating the average intensity of low and medium intensity runway lights for non-instrument and instrument non-precision approach runways.

9.10.26.2 Section 9.11, Figure 9.11-12 shows the method of establishing grid points for calculating the average intensity of high intensity approach and runway lights for precision approach runways.

9.10.26.3 The average light intensity of the main beam of a light is calculated by:

(a) establishing grid points in accordance with the method shown in Section 9.11, Figure 9.11-11 or Figure 9.11-12, whichever is applicable.

(b) measuring the light intensity values at all grid points within and on the perimeter of the rectangle or ellipse representing the main beam;

(c) calculating the arithmetic average of the light intensity values as measured at those grid points.

9.10.26.4 The maximum light intensity value measured on or within the perimeter of the main beam must not to be more than three times the minimum light intensity value so measured.

9.10.27 Installation and Aiming of Light Fittings

9.10.27.1 The following points must be followed in the installation and aiming of light fittings:

(a) the lights are aimed so that there are no deviations in the main beam pattern, to within 1/2° from the applicable standard specified in this Chapter;

(b) horizontal angles are measured with respect to the vertical plane through the runway centreline;

(c) when measuring horizontal angles for lights other than runway centreline lights, the direction towards the runway centreline is to be taken to be positive;

(d) vertical angles specified are to be measured with respect to the horizontal plane.

9.10.28 Illustrations of Runway Lighting

9.10.28.1 Section 9.12 contains illustrations of runway lighting.

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Section 9.11: Isocandela Diagrams of Runway Lighting

9.11.1 Collective Notes

9.11.1.1 The ellipses in each figure are symmetrical about the common vertical and horizontal axes.

9.11.1.2 Figure 9.11-1 to Figure 9.11-10 show the minimum allowable light intensities. The average intensity of the main beam is calculated by establishing the grid points as shown in Figure 9.11-11 or Figure 9.11-12, as appropriate, and using the intensity values measured 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.

9.11.1.3 No deviations are acceptable in the main beam pattern when the lighting fixture is properly aimed.

9.11.1.4 Average intensity ratio. The ratio between the average intensity within the ellipse defining the main beam of a typical new light and average light intensity of the main beam of a new runway edge light is to be as follows:

Figure 9.11-1	Low intensity runway edge lights	1.0 (white light)
Figure 9.11-2	Medium intensity runway edge lights	1.0 (white light)
Figure 9.11-3	High intensity runway edge lights (where the width of runway is 30-45 m)	1.0 (white light)
Figure 9.11-4	High intensity runway edge lights (where the width of runway is 60 m)	1.0 (white light)
Figure 9.11-5	High intensity threshold lights	1.0 to 1.5 (green light)
Figure 9.11-6	High intensity threshold wing bar lights	1.0 to 1.5 (green light)
Figure 9.11-7	High intensity runway end lights	0.25 to 0.5 (red light)
Figure 9.11-8	High intensity runway centreline lights (longitudinal spacing 30 m)	0.5 to 1.0 (white light)
Figure 9.11-9	High intensity runway centreline lights (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 9.11-10	Runway touchdown zone lights	0.5 to 1.0 (white light)

9.11.1.5 The beam coverages in the figures provide the necessary guidance for approaches down to an RVR of the order of 150 m and take-off to an RVR of the order of 100 m.

9.11.1.6 Horizontal angles are measured with respect to the vertical plane through the runway centreline. For lights other than centreline lights, the direction towards the runway centreline is considered positive. Vertical angles are measured with respect to the horizontal plane.

9.11.1.7 The light units are to be installed so that the main beam is aligned within one-half degree of the specified requirement.

9.11.1.8 On the perimeter of and within the ellipse defining the main beam, the maximum light intensity is not to be greater than three times the minimum light intensity value measured.

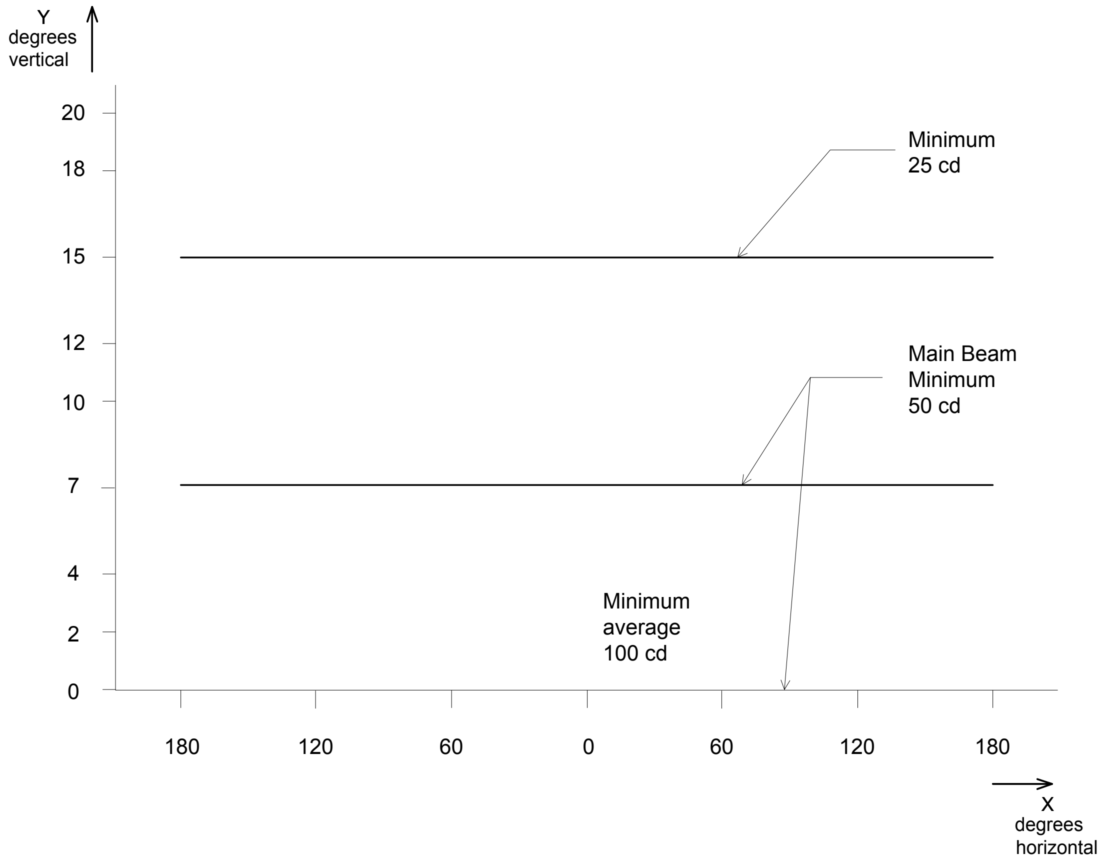


Figure 9.11-1: Isocandela Diagram for Omnidirectional Runway Edge Light - Low Intensity Runway Lighting System

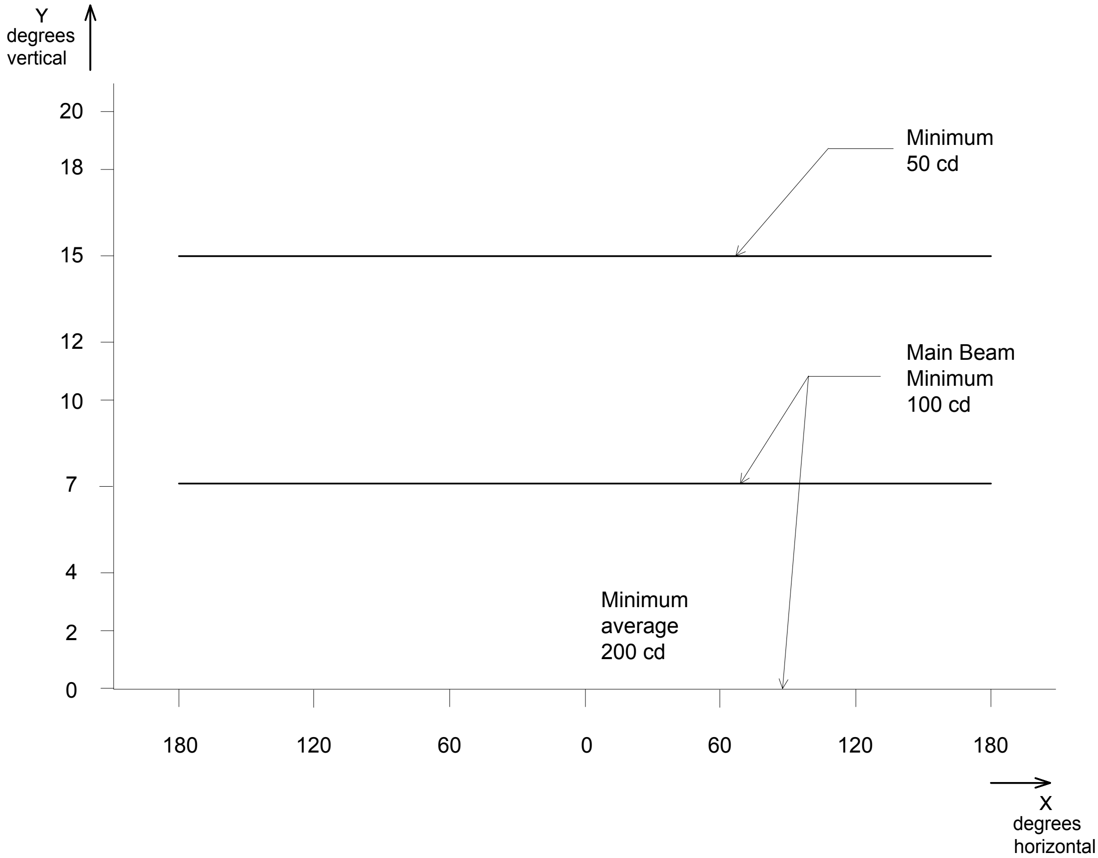


Figure 9.11-2: Isocandela Diagram for Omnidirectional Runway Edge Light - Medium Intensity Runway Lighting System

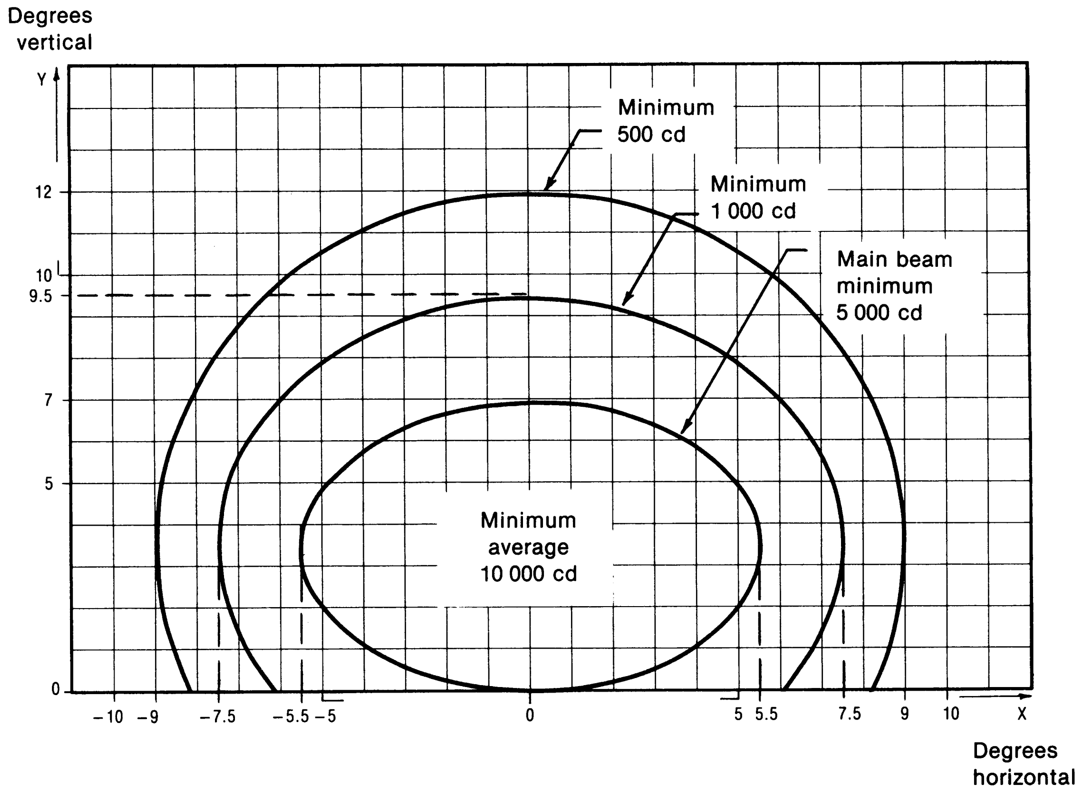


Figure 9.11-3: Isocandela Diagram for High Intensity Runway Edge Lights where the Width of the Runway is 30 to 45 metres (White Light)

Notes: 1. Curves calculated on formula $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$

a	5.5	7.5	9.0
b	3.5	6.0	8.5

2. Toe-in 3.5º
3. For yellow light multiply values by 0.4
4. See collective notes at Paragraph 9.11.1 for Figure 9.11-1 to Figure 9.11-10.

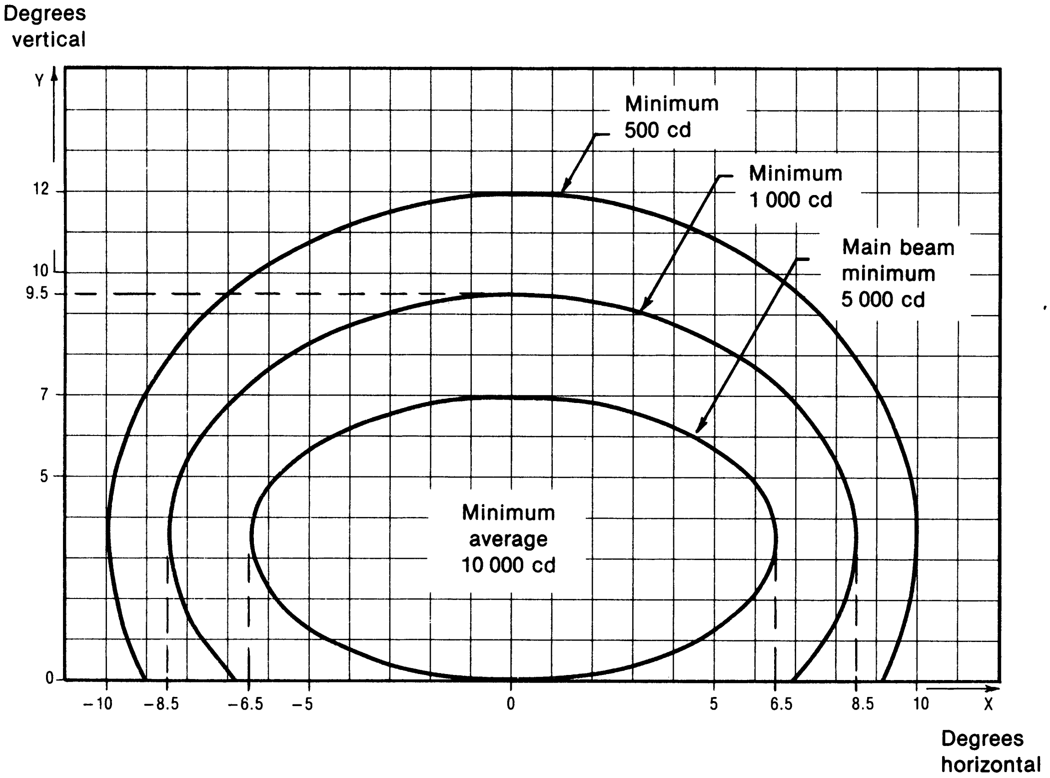


Figure 9.11-4: Isocandela Diagram for High Intensity Runway Edge Lights where the Width of the Runway is 60 m (White Light)

Notes: 1. Curves calculated on formula $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$

a	6.5	8.5	10.0
b	3.5	6.0	8.5

2. Toe-in 4.5°
3. For yellow light multiply values by 0.4
4. See collective notes at Paragraph 9.11.1 for Figure 9.11-1 to Figure 9.11-10.

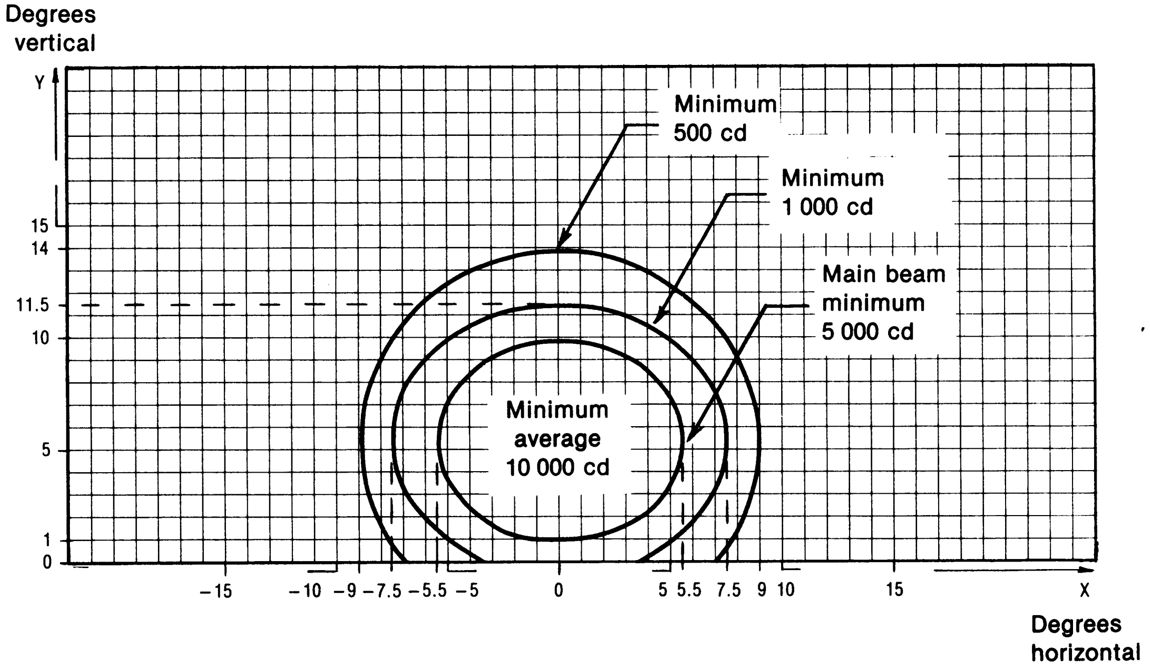


Figure 9.11-5: Isocandela Diagram for High Intensity Threshold Lights (Green Light)

Notes:

1. Curves calculated on formula $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$

a	5.5	7.5	9.0
b	4.5	6.0	8.5

2. Toe-in 3.5º
3. See collective notes at Paragraph 9.11.1 for Figure 9.11-1 to Figure 9.11-10.

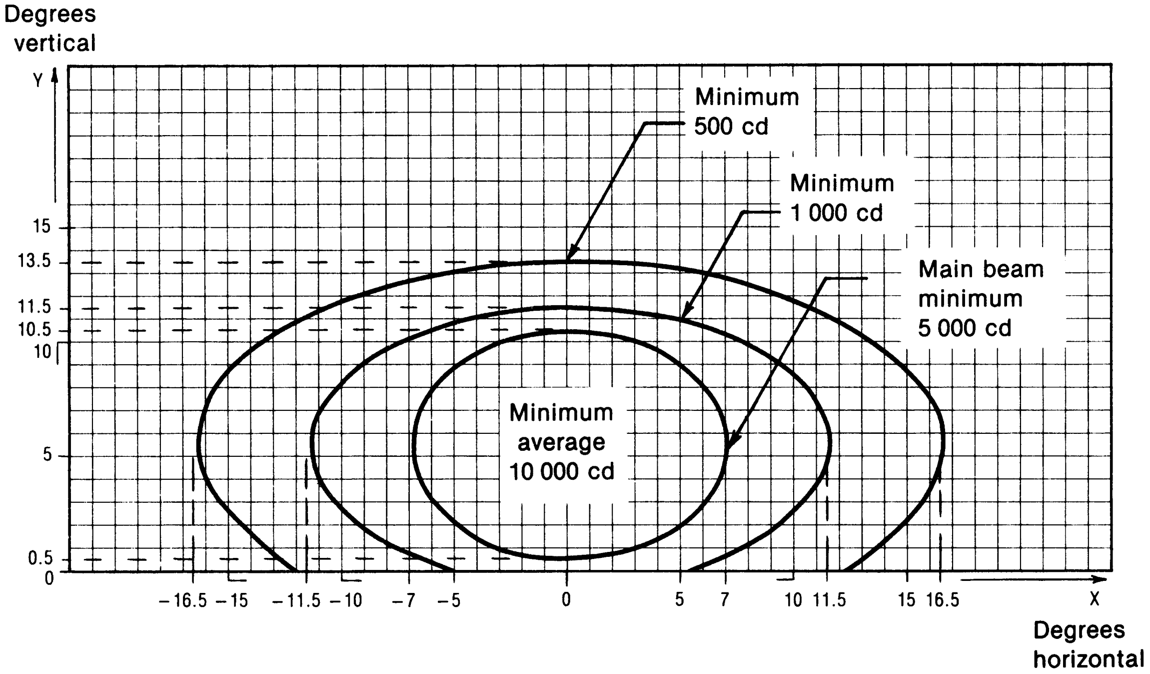


Figure 9.11-6: Isocandela Diagram for High Intensity Threshold Wing Bar Lights (Green Light)

Notes: 1. Curves calculated on formula $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$

a	7.0	11.5	16.5
b	5.0	6.0	8.0

2. Toe-in 2º

3. See collective notes at Paragraph 9.11.1 for Figure 9.11-1 to Figure 9.11-10.

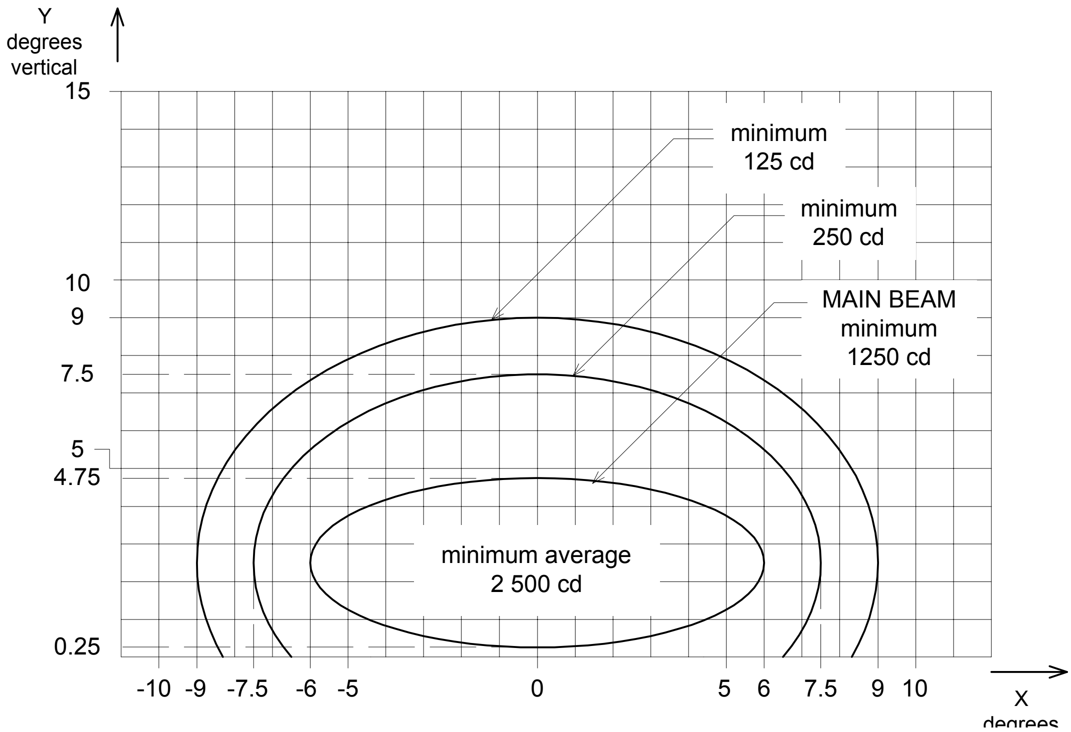


Figure 9.11-7: Isocandela Diagram for High Intensity Runway End Lights (Red Light)

Notes: 1. Curves calculated on formula $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$

a	6.0	7.5	9.0
b	2.25	5.0	6.5

2. See collective notes at Paragraph 9.11.1 for Figure 9.11-1 to Figure 9.11-10.

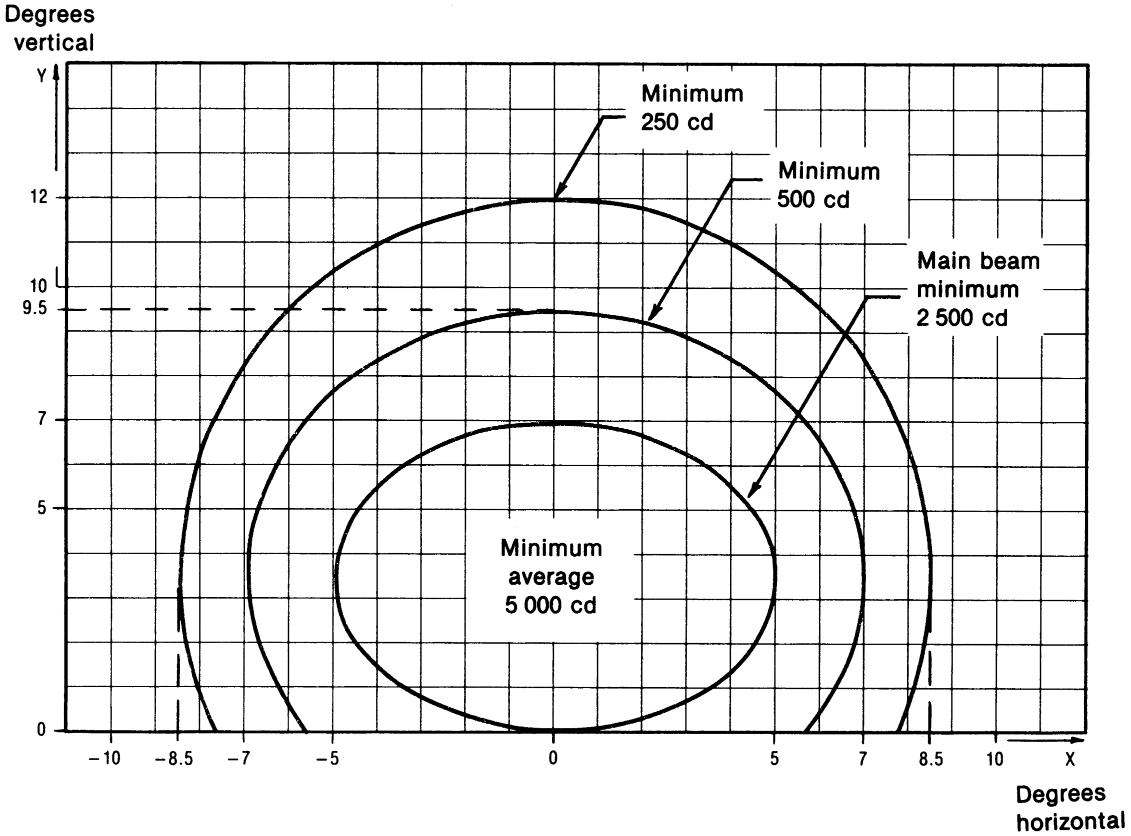


Figure 9.11-8: Isocandela Diagram for High Intensity Runway Centreline Lights with 30 m Longitudinal Spacing (White Light)

Notes: 1. Curves calculated on formula $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$

a	5.5	7.5	9.0
b	3.5	6.0	8.5

2. For red light multiply values by 0.15

3. See collective notes at Paragraph 9.11.1 for Figure 9.11-1 to Figure 9.11-10.

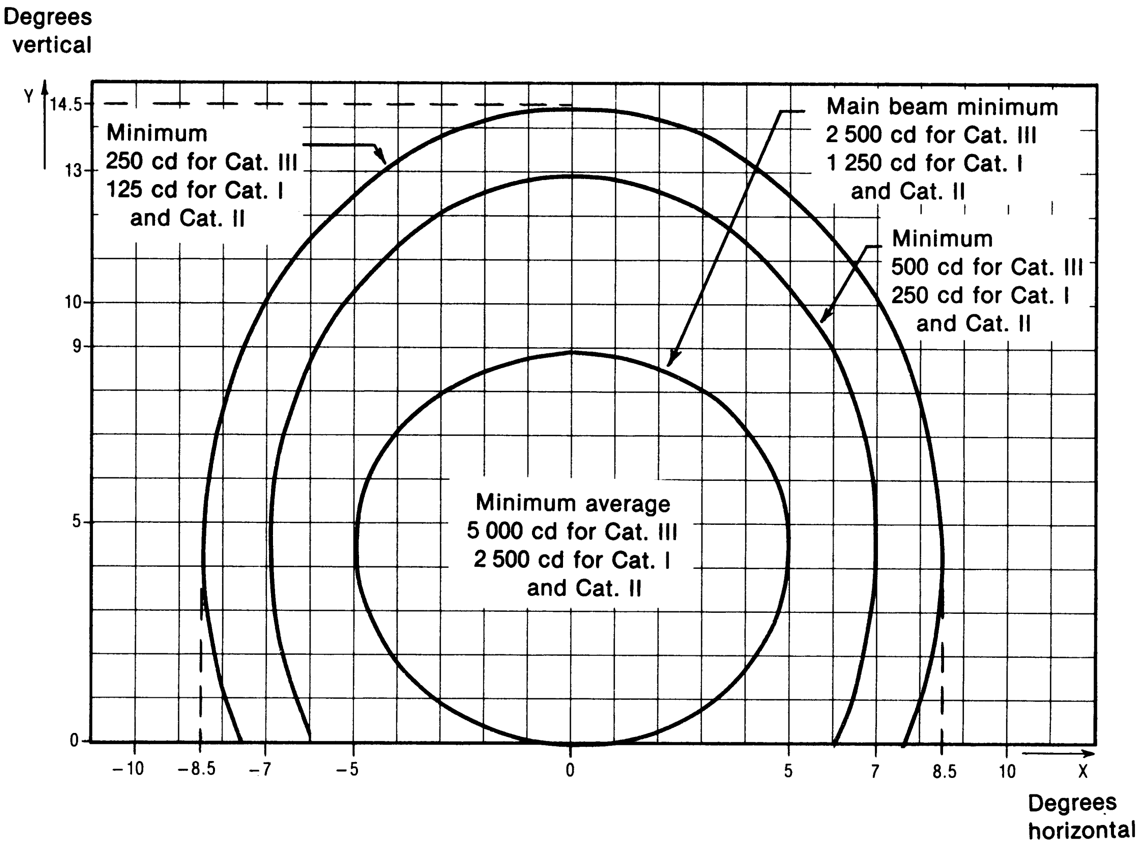


Figure 9.11-9: Isocandela Diagram for High Intensity Runway Centreline Lights with 15 m Longitudinal Spacing (White Light)

Notes: 1. Curves calculated on formula $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$

a	5.0	7.0	8.5
b	4.5	8.5	10

2. For red light multiply values by 0.15

3. See collective notes at Paragraph 9.11.1 for Figure 9.11-1 to Figure 9.11-10.

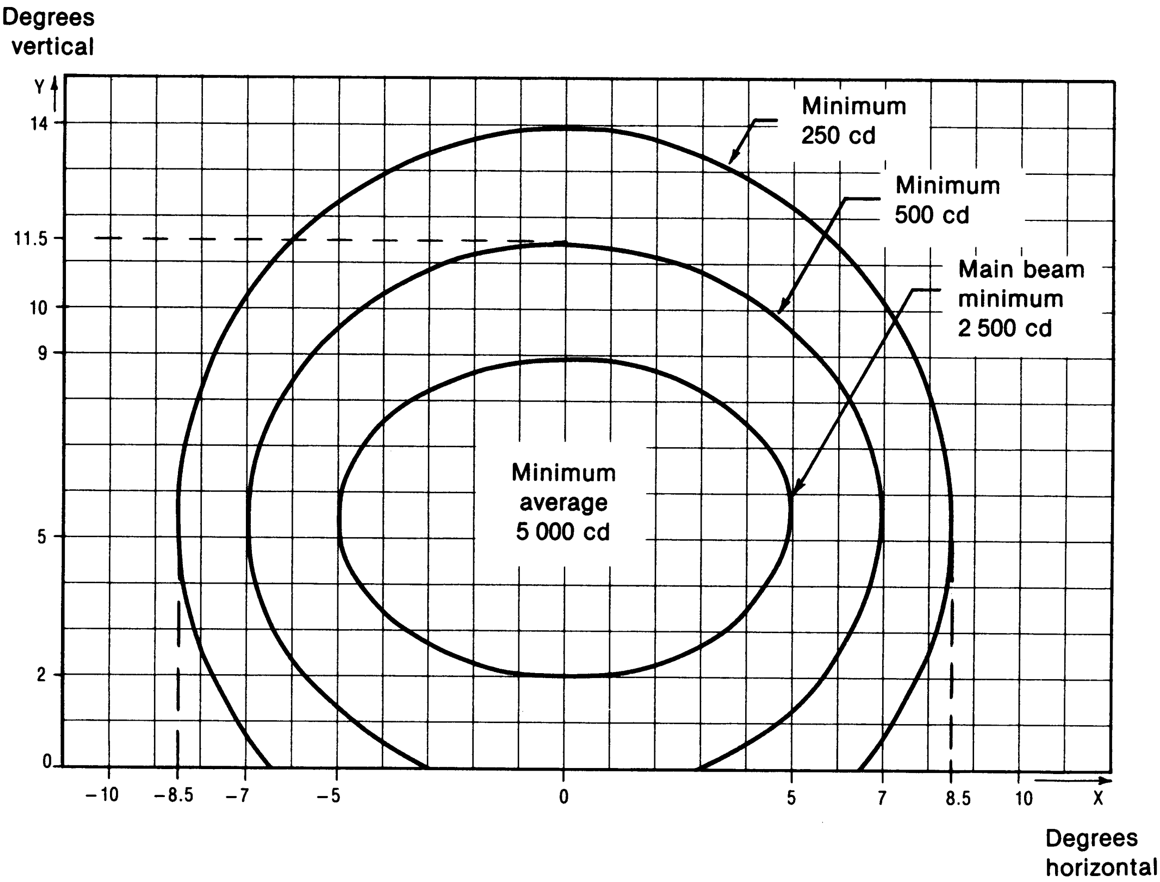


Figure 9.11-10: Isocandela Diagram for Runway Touchdown Zone Lights (White Light)

Notes: 1. Curves calculated on formula $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$

a	5.0	7.0	8.5
b	3.5	6.0	8.5

2. Toe-in 4º

3. See collective notes at Paragraph 9.11.1 for Figure 9.11-1 to Figure 9.11-10.

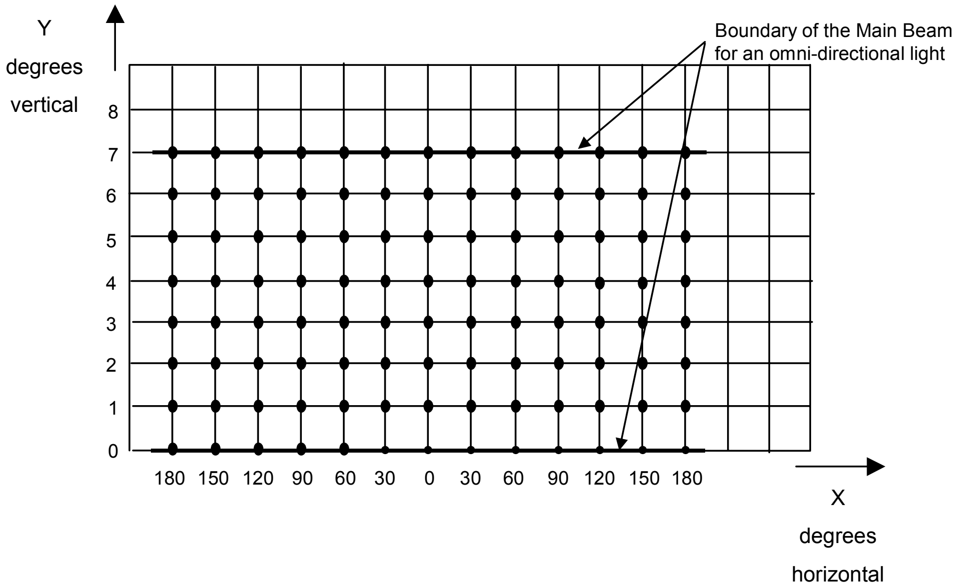


Figure 9.11-11: Method of Establishing Grid Points to be used for the Calculation of Average Intensity of Runway Lights specified by Figure 9.11-1 and Figure 9.11-2

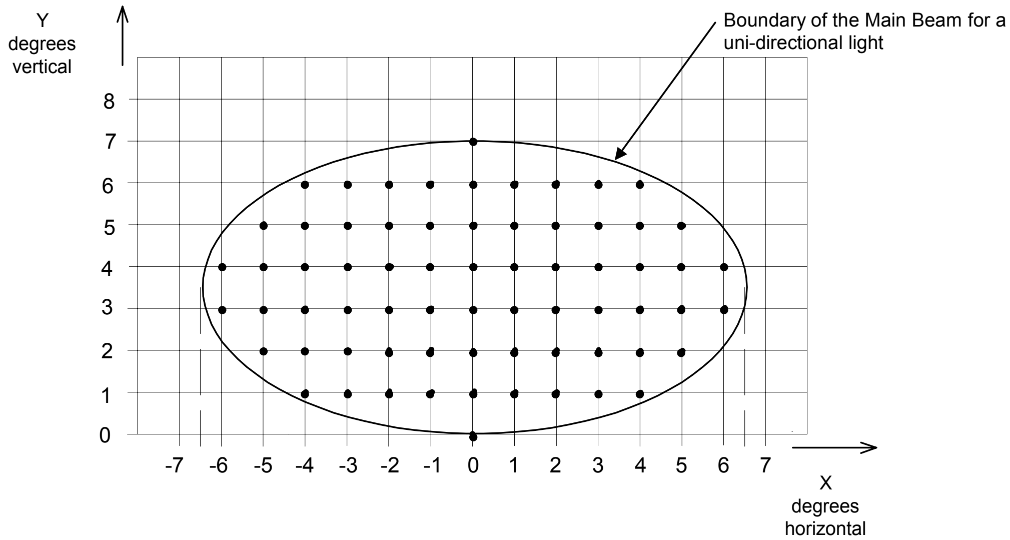


Figure 9.11-12: Method of Establishing Grid Points to be used for the Calculation of Average Intensity of Runway Lights specified by Figure 9.11-3 to Figure 9.11-10

Section 9.12: Illustrations of Runway Lighting

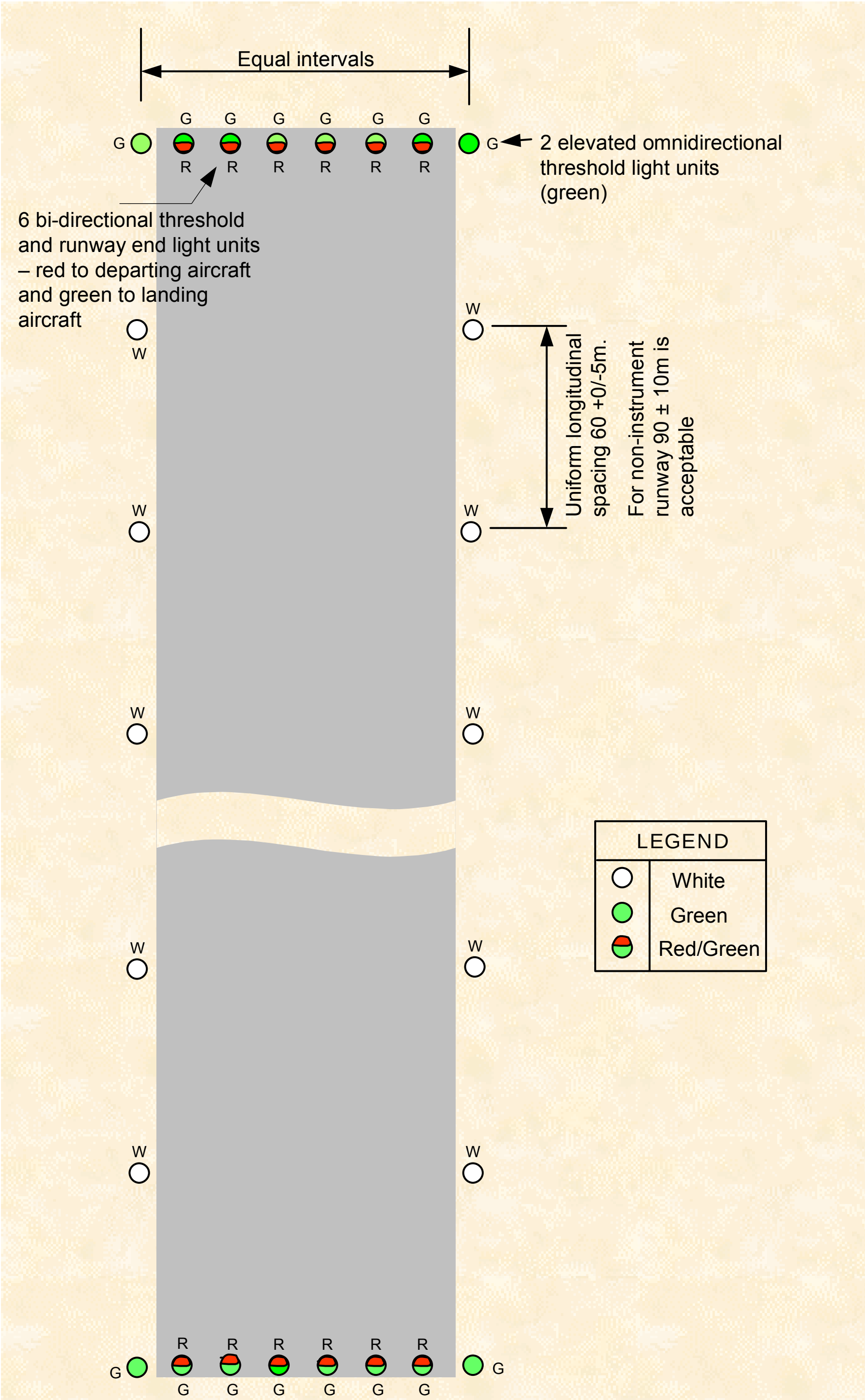


Figure 9.12-1: Runway Edge Lights, Threshold Lights and Runway End Lights Low and Medium Intensity for Non-Instrument and Non-Precision Approach Runways

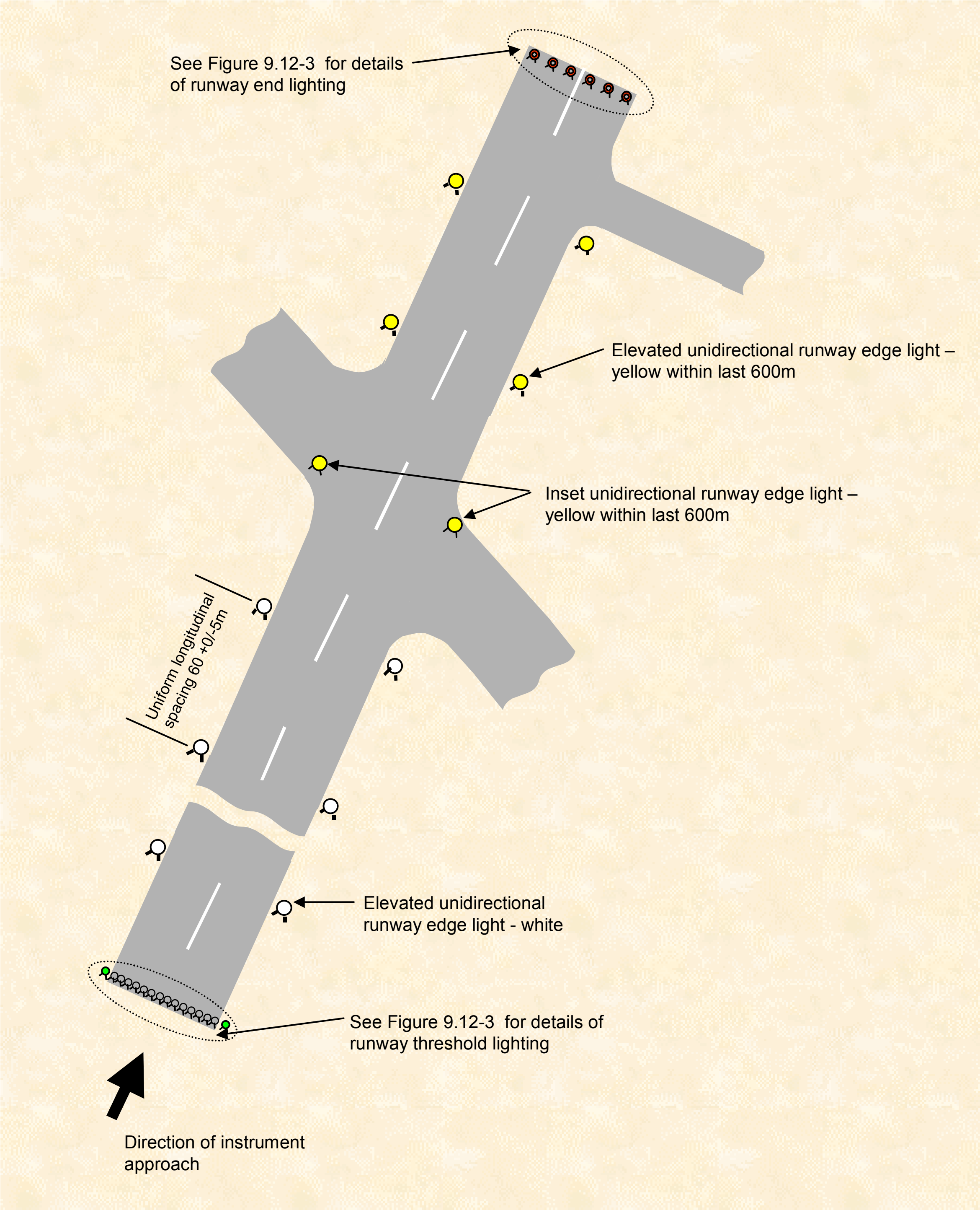


Figure 9.12-2: Runway Edge Lights High Intensity for Precision Approach Runways

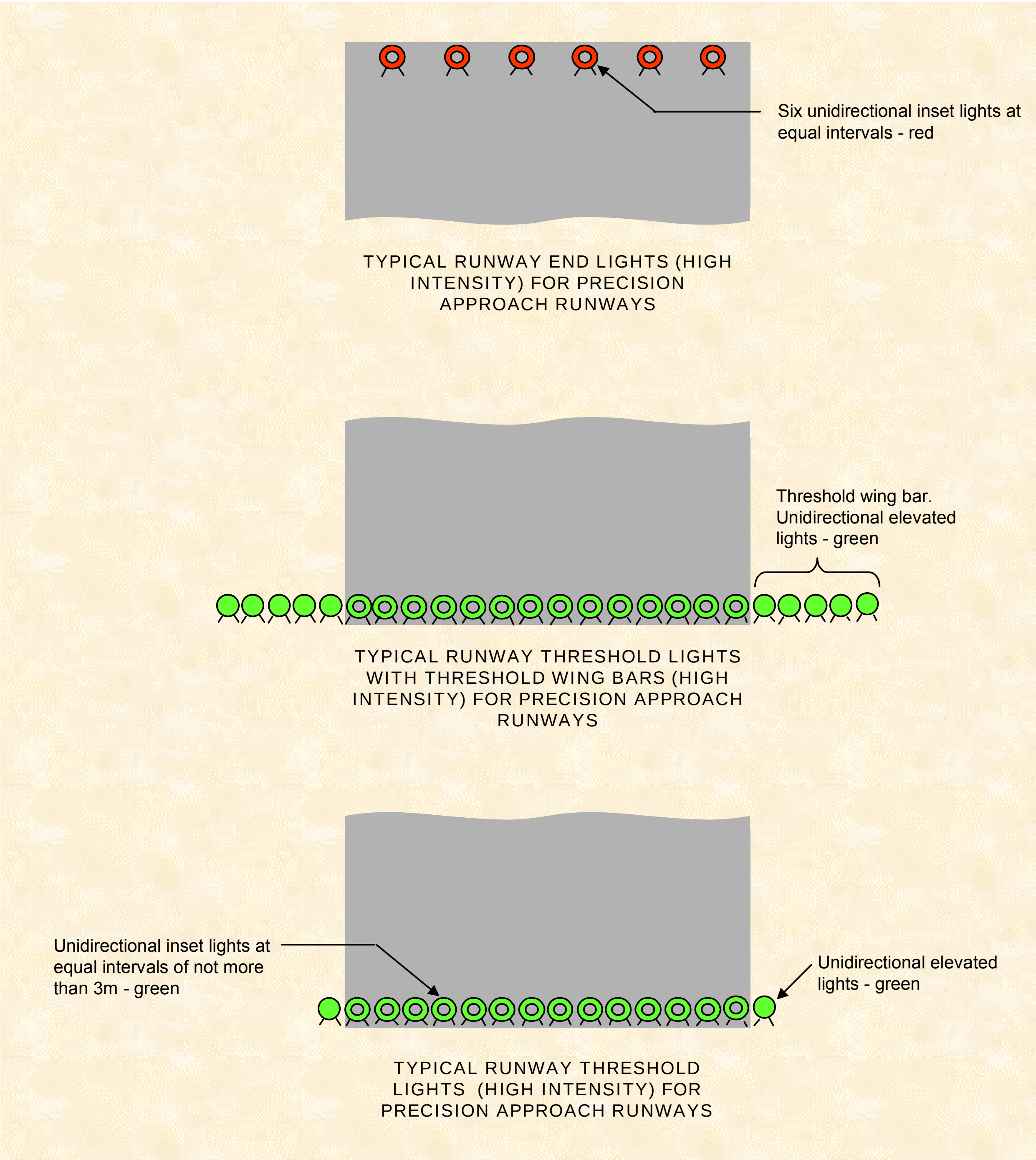


Figure 9.12-3: Typical Runway Threshold and Runway End Lights High Intensity for Precision Approach Runways

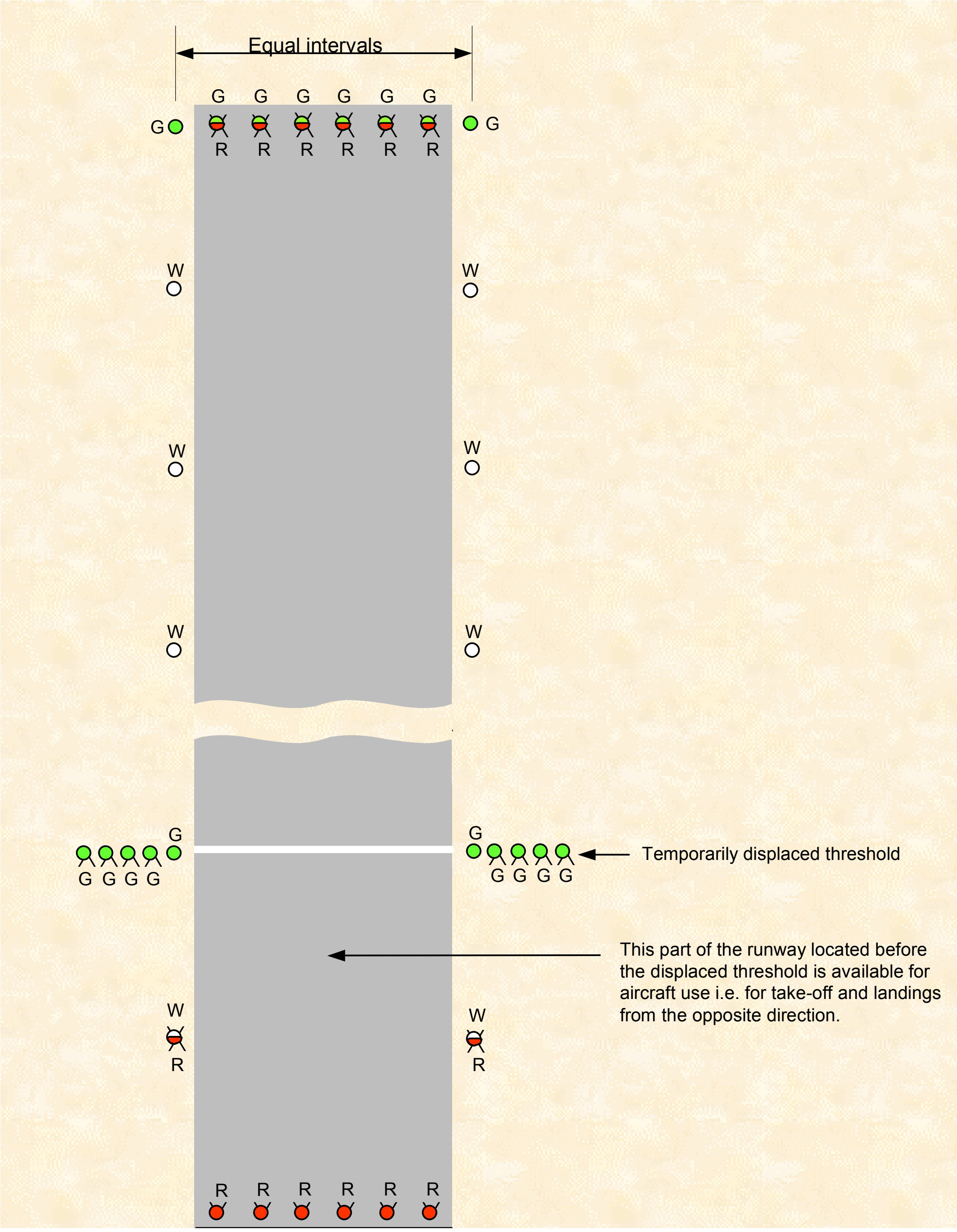


Figure 9.12-4: Typical Temporarily Displaced Threshold

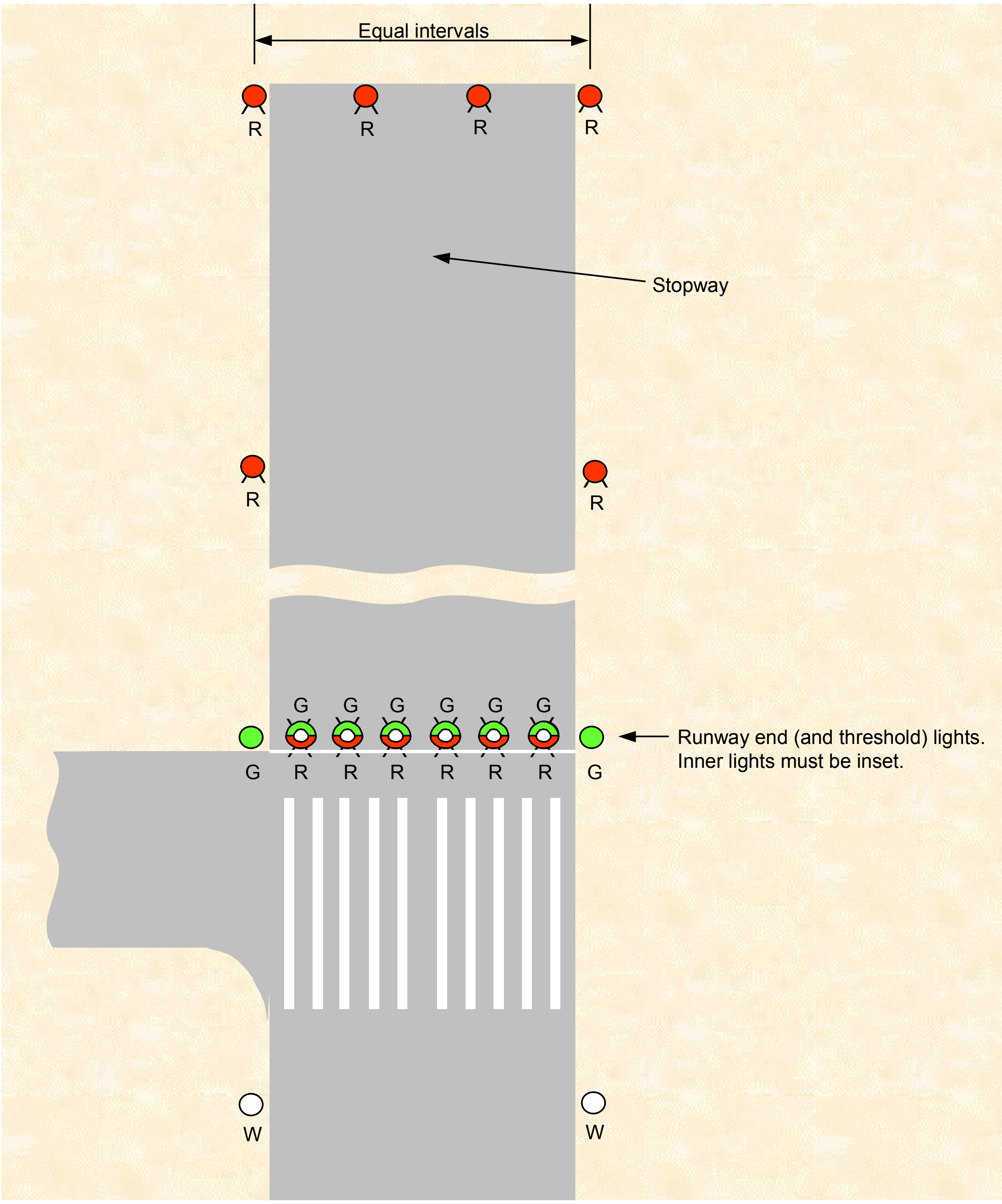
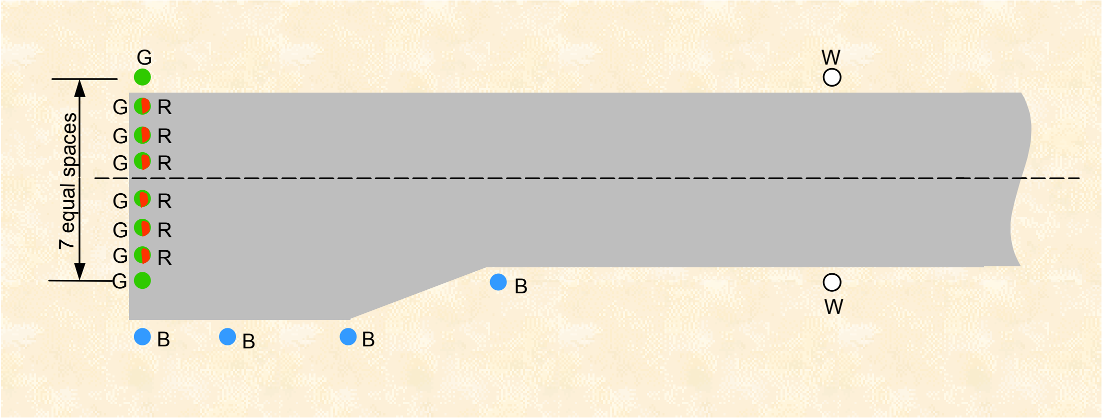
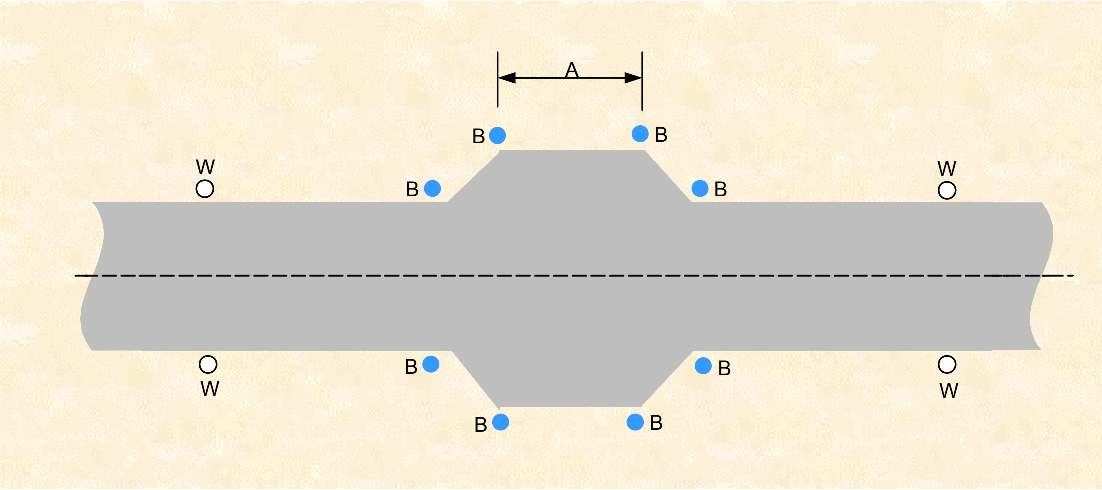


Figure 9.12-5: Typical Stopway Lights





Where distance ‘A’ is longer than 30m, equally spaced lights not exceeding 30m spacing are to be included

Blue edge lights at the start of the splay are to be omitted where runway edge lights are located within 10m of the start of the splay

Figure 9.12-6: Typical Turning Area Edge Lights

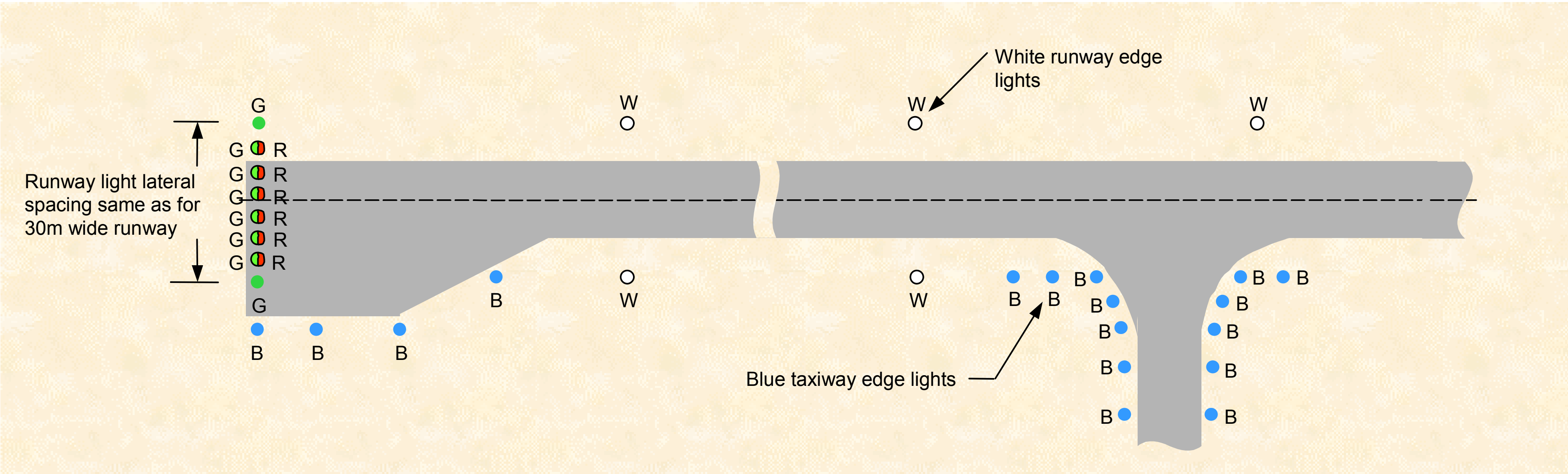


Figure 9.12-7: Typical Light Layout Where Runway Pavement is 23 m or 18 m wide

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Section 9.13: Taxiway Lighting

9.13.1 Provision of Taxiway Centreline Lights

9.13.1.1 Taxiway centreline lights must be provided on a taxiway intended for use in conjunction with an associated runway when the runway is used in precision approach Category II or III conditions, unless the aerodrome traffic density is light.

9.13.1.2 Taxiway centreline lights must be provided on a taxiway intended for use in conjunction with an associated runway when the runway is used in precision approach Category I conditions, unless the aerodrome layout is simple or the aerodrome traffic density is light.

9.13.1.3 Taxiway centreline lights must be used on a rapid exit taxiway.

9.13.1.4 Taxiway centreline lights may be used in other cases, if the aerodrome chooses. At aerodromes where the layout is complex, the use of taxiway centreline lights would be beneficial for surface movement.

9.13.2 Provision of Taxiway Edge Lights

9.13.2.1 Except for Paragraphs 9.13.3.1 and 9.13.4.1, taxiway edge lights must be provided at the edges of a taxiway and holding bays, intended for use at night and not provided with centreline lights.

9.13.2.2 Where additional visual cues are required to delineate apron edges at night, taxiway edge lights may be used. Examples of where this requirement may occur include, but are not limited to:

(a) aprons where taxi guidelines and aircraft parking position marking are not provided;

(b) aprons where apron floodlighting provides inadequate illumination at the edge of the apron; and

(c) where the edge of the apron is difficult to distinguish from the surrounding are at night.

9.13.3 Taxiway Markers

9.13.3.1 For code letter A or B taxiways, reflective taxiway edge markers may be used instead of taxiway centreline or edge lights, or to supplement taxiway lights. However, at least one taxiway from the runway to the apron must be provided with taxiway lighting.

9.13.4 Apron Taxiway Lighting

9.13.4.1 Taxiway lights are not required for an apron taxiway if the apron taxiway is illuminated by apron floodlighting meeting the standards specified in Section 9.16.

9.13.5 Use of Different Types of Taxiway Lights

9.13.5.1 As far as practicable, the provision of taxiway lights shall be such that taxying aircraft do not need to alternate between taxiway centreline and edge lights.

9.13.5.2 Where additional guidance is required to delineate taxiway edges, taxiway edge lights may be used to supplement taxiway centreline lights. When provided, taxiway edge lights must comply with Paragraphs 9.13.13 to 9.13.15. This may occur at, but is not limited to:

(a) rapid exit taxiways;

(b) taxiway curves;

(c) intersections;

(d) a narrower section of taxiway.

9.13.6 Control of Lights on Taxiways

9.13.6.1 At an aerodrome with Air Traffic Service, taxiway lights with an average intensity within the main beam of more than 20 candela must be provided with intensity control in accordance with Paragraph 9.1.14.6, to allow adjustment of the lighting to suit ambient conditions.

9.13.6.2 If it is desired to illuminate only standard taxi routes during certain period of operations, for example during low visibility operations, the taxiway lighting may be designed to allow taxiways in use to be lit and those not in use to be unlit.

9.13.6.3 Where a runway forming part of a standard taxi-route is provided with runway lighting and taxiway lighting, the lighting systems must be interlocked to preclude the possibility of simultaneous operation of both forms of lighting.

9.13.7 Location of Taxiway Centreline Lights

9.13.7.1 Taxiway centreline lights must be located on the centreline of the taxiway or uniformly offset from the taxiway centreline by not more than 0.3 m.

9.13.8 Spacing of Taxiway Centreline Lights

Notes: 1. The longitudinal spacing of centreline lights that will provide satisfactory guidance to pilots on curved sections of taxiway, including exit taxiways and fillets at intersections, is influenced by the width of the light beam from the centreline light fittings.

2. Some taxiway centreline lights were introduced in Australian aerodromes before international standards for them were developed. Since then, international standards have been established, with lights having narrower beam spreads, and higher light intensity. Australia has now adopted the internationally accepted ICAO standards on taxiway centreline lights, recognising that international light manufacturers will be producing lights in compliance with these standards. To provide satisfactory guidance with these light fittings it is necessary to use longitudinal spacing that is less than previously used in Australia, particularly on curved sections.

Notes: (Contd.)

3. There is no need to replace existing lights, or change the spacing of existing lights. The longitudinal spacing and photometric specifications herein are meant for all new taxiway centreline lights, and for replacement of existing light fittings with light fittings in compliance with ICAO standards.

9.13.8.1 Except for Paragraphs 9.13.8.2 and 9.13.9.1, the longitudinal spacing of taxiway centreline lights on a straight section of taxiway must be uniform and be not more than the values specified in Table 9.13-1 below:

Table 9.13-1 Maximum spacing on straight sections of taxiway

Type	General	Last 60 m before a runway or apron
Taxiways used in conjunction with a non-instrument, non-precision, or a precision approach Category I runway	60 m	15 m
Taxiways used in conjunction with a precision approach Category II runway	30 m	15 m
Taxiways used in conjunction with a precision approach Category III runway	15 m	7.5 m

9.13.8.2 For the purpose of taxiway centreline lighting, a straight section of taxiway that is less than 181 metres in length is considered a short straight taxiway. Taxiway centreline lights on a short straight section of taxiway must be spaced at uniform intervals of not more than 30 m.

9.13.8.3 In the case of an entry taxiway, the last light must not be more than 1 m outside the line of runway edge lights.

9.13.8.4 When a taxiway changes from a straight to a curved section, the taxiway centreline lights must continue on from the preceding straight section at a uniform distance from the outside edge of the taxiway.

9.13.8.5 The longitudinal spacing of taxiway centreline lights on a curved section of taxiway must be uniform and be not more than the values specified in Table 9.13-2.

Table 9.13-2: Maximum spacing on curved sections of taxiway

Type	On curve with radius of 400 m or less	On curve with radius greater than 400 m	On straight section before and after the curve
Taxiways used in conjunction with a non-instrument, non-precision, or a precision approach Category I or II runway	15 m See Note	30 m	No special requirement. Use same spacing as on the rest of the straight section.

Type	On curve with radius of 400 m or less	On curve with radius greater than 400 m	On straight section before and after the curve
Taxiways used in conjunction with a precision approach Category III runway	7.5 m	15 m	Same spacing as on the curve is to extend for 60 m before and after the curve
Note: At a busy or complex taxiway intersection where additional taxiing guidance is desirable, closer light spacing down to 7.5 m should be used.			

9.13.9 Location of Taxiway Centreline Lights on Exit Taxiways

9.13.9.1 Taxiway centreline lights on exit taxiways, other than rapid exit taxiways, must:

(a) start at the tangent point on the runway;

(b) have the first light offset 1.2 m from the runway centreline on the taxiway side; and

(c) be spaced at uniform longitudinal intervals of not more than 7.5 m.

9.13.10 Location of Taxiway Centreline Lights on Rapid Exit Taxiways

9.13.10.1 Taxiway centreline lights on a rapid exit taxiway must:

(a) start at least 60 m before the tangent point;

(b) on that part of taxiway parallel to the runway centreline, be offset 1.2 m from the runway centreline on the taxiway side; and

(c) continue at the same spacing to a point on the centreline of the taxiway at which an aeroplane can be expected to have decelerated to normal taxying speed.

9.13.10.2 Taxiway centreline lights on a rapid exit taxiway must be spaced at uniform longitudinal intervals of not more than 15 m.

9.13.11 Characteristics of Taxiway Centreline Lights

9.13.11.1 Taxiway centreline lights are to be inset, fixed lights showing green on:

(a) a taxiway other than an exit taxiway; and

(b) a runway forming part of a standard taxi-route.

9.13.11.2 Taxiway centreline lights on exit taxiways, including rapid exit taxiways, must be inset, fixed lights:

(a) showing green and yellow alternately, from the point where they begin to the perimeter of the ILS or MLS critical area or the lower edge of the inner transitional surface, which ever is further from the runway; and

(b) showing green from that point onwards.

9.13.11.3 When viewed from the runway, the exit taxiway light nearest the perimeter or the lower edge of the inner transitional surface, whichever is further, must show yellow.

9.13.11.4 Where the taxiway centreline lights are used for both runway exit and entry purposes, the colour of the lights viewed by a pilot of an aircraft entering the runway must be green. The colour of the lights viewed by a pilot of an aircraft exiting the runway is to be green and yellow alternately. See Figure 9.15-1.

9.13.12 Beam Dimensions and Light Distribution of Taxiway Centreline Lights

9.13.12.1 The beam dimensions and light distribution of taxiway centreline lights must be such that the lights are visible only to pilots of aircraft on, or in the vicinity of, the taxiway.

9.13.12.2 The light distribution of the green taxiway centreline lights in the vicinity of a threshold must be such as not to cause confusion with the runway threshold lights.

9.13.12.3 On a taxiway intended for use in conjunction with a non-instrument, non-precision or a precision approach Category I or II runway, taxiway centreline lights must comply with the specifications set out in Section 9.14, Figure 9.14-1 or, whichever is applicable.

9.13.12.4 On a taxiway that is intended for use in conjunction with a precision approach Category III runway, the taxiway centreline lights must comply with the specifications set out in Section 9.14, Figure 9.14-3, Figure 9.14-4 or Figure 9.14-5, whichever is applicable.

Notes: 1 Light units meeting the intensity standards of Figure 9.14-3, Figure 9.14-4 and Figure 9.14-5, are specifically designed for use in low visibility conditions. For the normal range of visibilities experienced most of the time in Australia, these lights, if operated on maximum intensity, would cause dazzle to pilots. If these lights are installed, it may be necessary to provide additional intensity control stages, or otherwise limit the maximum intensity at which they can be operated.

2 Very high intensity taxiway light units are also available. These lights can have main beam intensities of the order of 1800 cd. These lights are unsuitable for use in Australian conditions.

9.13.13 Location of Taxiway Edge Lights

9.13.13.1 Taxiway edge lights must be located along both sides of the taxiway, with edge lights along each edge located opposite the corresponding lights along the other edge, except as allowed for in Paragraph 9.13.13.2.

9.13.13.2 A taxiway light may be omitted if it would otherwise have to be located on an intersection with another taxiway or runway.

9.13.13.3 Taxiway edge lights must be located outside the edge of the taxiway, being:

(a) equidistance from the centreline except where asymmetric fillets are provided; and

(b) as close as practicable to 1.2 m from the taxiway edge, but no further than 1.8 m, or nearer than 0.6 m.

9.13.13.4 Where a taxiway intersects with a runway, the last taxiway edge lights should preferably line-up with the line of runway edge lights, and must not encroach beyond the line of runway edge lights into the area outlined by the runway edge lights.

9.13.14 Spacing of Taxiway Edge Lights

9.13.14.1 Spacing of taxiway edge lights must be in accordance with Figure 9.13-1 below:

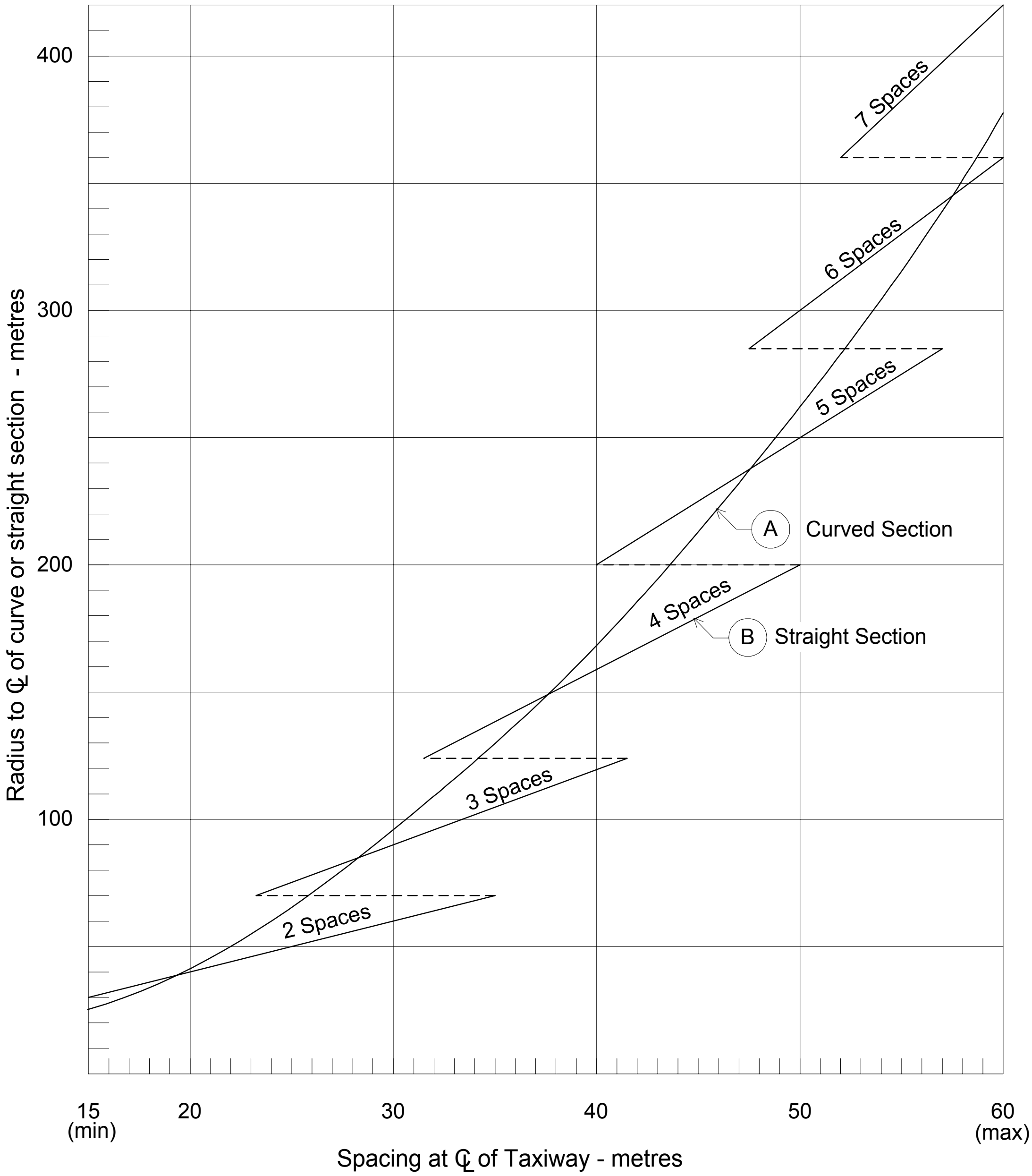

Figure 9.13-1: Longitudinal Spacing for Taxiway Edge Lights

9.13.14.2 On a curved section of taxiway, the edge lights must be spaced at uniform longitudinal intervals in accordance with Curve A in Figure 9.13-1 above.

9.13.14.3 On a straight section of taxiway, the edge lights must be spaced at uniform longitudinal intervals, not exceeding 60 m, in accordance with Curve B in Figure 9.13-1 above.

9.13.14.4 Where a straight section joins a curved section, the longitudinal spacing between taxiway edge lights must be progressively reduced, in accordance with Paragraphs 9.13.14.5 and 9.13.14.6, over not less than 3 spacings before the tangent point.

9.13.14.5 The last spacing between lights on a straight section must be the same as the spacing on the curved section.

9.13.14.6 If the last spacing on the straight section is less than 25 m, the second last spacing on the straight section must be no greater than 25 m.

9.13.14.7 If a straight section of taxiway enters an intersection with another taxiway, a runway or an apron, the longitudinal spacing of the taxiway edge lights must be progressively reduced over not less than 3 spacings, before the tangent point, so that the last and the second last spacings before the tangent point are not more than 15 m and 25 m respectively.

9.13.14.8 The taxiway edge lights must continue around the edge of the curve to the tangent point on the other taxiway, the runway or apron edge.

9.13.14.9 Taxiway edge lights on a holding bay or apron edge are to be spaced at uniform longitudinal intervals not exceeding 60 m, and in accordance with Curve B in Figure 9.13-1.

9.13.15 Characteristics of Taxiway Edge Lights

9.13.15.1 Taxiway edge lights must be fixed omnidirectional lights showing blue. The lights must be visible:

(a) up to at least 30° above the horizontal; and

(b) at all angles in azimuth necessary to provide guidance to the pilot of an aircraft on the taxiway.

9.13.15.2 At an intersection, exit or curve, the lights must be shielded, as far as is practicable, so they cannot be seen where they may be confused with other lights.

9.13.15.3 The peak intensity of the blue edge lights must not be less than 5 candela.

9.13.16 Provision of Runway Guard Lights

Note: Runway guard lights are sometimes colloquially referred to as ‘wig wags’. The effectiveness of this lighting system has been successfully proven in a number of countries and this lighting system has been adopted by ICAO as a standard. Provision of runway guard lights will bring Australian aerodrome lighting in line with international practices. To allow relevant aerodrome operators sufficient time to introduce this lighting system, a deferred effective date for this standard is prescribed. However, provision of runway guard lights at an earlier date is permissible, and indeed, encouraged.

9.13.16.1 Runway guard light standards are applicable from 1 August 2004.

9.13.16.2 Runway guard lights must be provided at the intersection of a taxiway with a precision approach runway if stop bars are not provided at the intersection, and the runway is:

(a) a precision approach Category I runway where the traffic density is heavy; or

(b) a precision approach Category II or III runway.

> **Note:** For (a), consideration for deferment beyond 1 August 2004 may be given to an aerodrome which has a low incidence of Category I visibility conditions, and where the traffic density, though marginally heavy, consists of a large percentage of light aircraft movements. Aerodrome operators seeking such a deferment should submit an application which must be supported by a safety case study.

9.13.16.3 When introduced, runway guard lights must be used at all taxiways which allow access onto the runway. Where possible, they should be introduced at all taxiways at the same time. If they are introduced in stages, adequate provision must be made to ensure that there is no chance of confusion.

> **Note:** Where a taxiway is used for exit only and cannot be used for entry to the runway, runway guard lights are not required.

9.13.17 Pattern and Location of Runway Guard Lights

9.13.17.1 There are two standard configurations of runway guard lights:

(a) Configuration A (or Elevated Runway Guard Lights) has lights on each side of the taxiway, and

(b) Configuration B (or In-pavement Runway Guard Lights) has lights across the taxiway.

9.13.17.2 Configuration A is the configuration to be installed in all cases; except that Configuration B, or both Configuration A and B, must be used where enhanced conspicuity of the taxiway/runway intersection is needed, for example;

(a) on complex taxiway intersections with a runway; or

(b) where holding position markings do not extend straight across the taxiway; or

(c) on a wide-throat taxiway where the Configuration A lights on both sides of the taxiway would not be within the normal field of view of a pilot approaching the runway guard lights.

9.13.17.3 Configuration A runway guard lights must be located on both sides of the taxiway, at the runway holding position closest to the runway, with the lighting on both sides:

(a) equidistant from the taxiway centreline; and

(b) not less than 3 m, and not more than 5 m, outside the edge of the taxiway.

9.13.17.4 Configuration B runway guard lights must be located across the entire taxiway, including fillets, holding bays, etc. at the runway holding position closest to the runway, with the lights spaced at uniform intervals of 3 m.

9.13.18 Characteristics of Runway Guard Lights

9.13.18.1 Configuration A runway guard lights must consist of two pairs of elevated lights showing yellow, one pair on each side of the taxiway.

> **Note:** To enhance visual acquisition:
>
> (a) the centreline of lights in each pair should be separated by a horizontal distance that is not less than 2.5 times, and not more than 4 times, the radius of the individual lantern lens;
>
> (b) each light should be provided with a visor to minimise extraneous reflection from the optical surfaces of the lanterns;
>
> (c) the visors and the face of the light fitting surrounding the lantern lens should be black to minimise reflection and provide enhanced contrast;
>
> (d) where additional isolation of the signal is required from the background, a black target board may be provided around the sides and top of the face of the light fitting.

9.13.18.2 Configuration B runway guard lights must consist of inset lights showing yellow.

9.13.18.3 The performance of Configuration A runway guard lights must comply with the following:

(a) the lights in each pair are to be illuminated alternately at between 30 and 60 cycles per minute;

(b) the light suppression and illumination periods of each light in a pair are to be of equal and opposite duration;

(c) the light beams are to be unidirectional and aimed so that the beam centres cross the taxiway centreline at a point 60 m prior to the runway holding position;

(d) the effective intensity of the yellow light and beam spread are to be in accordance with the specifications in Section 9.14, Figure 9.14-6.

9.13.18.4 The performance of Configuration B runway guard lights must comply with the following:

(a) adjacent lights are to be alternately illuminated and alternate lights are to illuminate in unison;

(b) the lights are to be illuminated between 30 and 60 cycles per minute and the light suppression and illumination periods are to be equal and opposite in each light;

(c) the light beam is to be unidirectional and aligned so as to be visible to the pilot of an aeroplane taxying to the holding position.

(d) the effective intensity of the yellow beam and beam spread are to be in accordance with the specifications in Section 9.14, Figure 9.14-3.

9.13.19 Control of Runway Guard Lights

9.13.19.1 Runway guard lights are to be electrically connected such that all runway guard lights protecting a runway can be turned on when the runway is active, day or night.

9.13.20 Provision of Intermediate Holding Position Lights

9.13.20.1 Intermediate holding position lights must be provided at the following locations:

(a) the runway holding position on a taxiway serving a runway equipped for night use when runway guard lights and/or stop bars are not provided;

(b) the holding position of a holding bay, where the holding bay is intended to be used at night;

(c) at taxiway/taxiway intersections where it is necessary to identify the aircraft holding position; and

(d) a designated intermediate holding position on a taxiway intended to be used at night.

Note: Provision of intermediate holding position lights for (c) and (d) is based on local air traffic control procedures requirements.

9.13.21 Pattern and Location of Intermediate Holding Position Lights

9.13.21.1 On a taxiway equipped with centreline lights, the intermediate holding position lights must consist of at least 3 inset lights, spaced 1.5 m apart, disposed symmetrically about, and at right angles to, the taxiway centreline, located not more than 0.3 m before the intermediate holding position marking or the taxiway intersection marking, as appropriate.

9.13.21.2 On a taxiway equipped with edge lights, the intermediate holding position lights must consist of 1 elevated light on each side of the taxiway, located in line with the taxiway edge lights and the runway holding position marking, intermediate holding position marking or taxiway intersection marking, as appropriate.

9.13.22 Characteristics of Intermediate Holding Position Lights

9.13.22.1 Inset intermediate holding position lights must:

(a) be fixed, unidirectional lights showing yellow;

(b) be aligned so as to be visible to the pilot of an aircraft approaching the holding position;

(c) have light distribution as close as practicable to that of the taxiway centreline lights.

9.13.22.2 Elevated intermediate holding position lights must:

(a) be fixed, omnidirectional lights showing yellow;

(b) have light distribution as close as practicable to that of the taxiway edge lights.

9.13.23 Stop Bars

9.13.23.1 A stop bar must be provided at every runway holding position serving a runway when it is intended that the runway will be used in Cat II or III conditions, if operational procedures at the aerodrome do not restrict the number of aircraft on the manoeuvring area to one at a time during Cat II or III conditions.

> **Note**: As stop bars require direct ATC control, an aerodrome operator needs to consult with ATC before planning for their introduction.

9.13.23.2 Where provided, the control mechanism for stop bars must meet the operational requirements of the Air Traffic Service at that aerodrome.

9.13.24 Location of Stop Bars

9.13.24.1 A stop bar must:

(a) be located across the taxiway on, or not more than 0.3 m before, the point at which it is intended that traffic approaching the runway stop;

(b) consist of inset lights spaced 3 m apart across the taxiway;

(c) be disposed symmetrically about, and at right angles to, the taxiway centreline.

9.13.24.2 Where a pilot may be required to stop the aircraft in a position so close to the lights that they are blocked from view by the structure of the aircraft, a pair of elevated lights, with the same characteristics as the stop bar lights, must be provided abeam the stop bar, located at a distance of at least 3 m from the taxiway edge sufficient to overcome the visibility problem.

9.13.25 Characteristics of Stop Bars

9.13.25.1 A stop bar must be unidirectional and show red in the direction of approach to the stop bar.

9.13.25.2 The intensity and beam spread of the stop bar lights must be in accordance with the applicable specifications in Section 9.14, Figure 9.14-1 to Figure 9.14-5.

9.13.25.3 Selectively switchable stop bars must be installed in conjunction with at least three taxiway centreline lights (extending for a distance of at least 90 m from the stop bar) in the direction that it is intended for an aircraft to proceed from the stop bar.

9.13.25.4 The lighting circuit must be designed so that:

(a) stop bars located across entrance taxiways are selectively switchable;

(b) stop bars located across taxiways used as exit taxiways only are switchable selectively or in groups;

(c) when a stop bar is illuminated, any taxiway centreline lights immediately beyond the stop bar are to be extinguished for a distance of at least 90 m; and

(d) with control interlock and not manual control, when the centreline lights beyond the stop bar are illuminated the stop bar is extinguished and vice versa.

9.13.26 Taxiway Edge Markers

9.13.26.1 Where used in lieu of taxiway edge lights on a taxiway with code letter A or B, taxiway edge markers must be provided at least at the locations where taxiway edge lights would otherwise have been provided.

9.13.27 Characteristics of Taxiway Edge Markers

9.13.27.1 Taxiway edge markers must be retro-reflective blue.

9.13.27.2 The surface of a taxiway edge marker as viewed by the pilot must be a rectangle with a height to width ratio of approximately 3:1 and a minimum viewing area of 150 cm^2.

9.13.27.3 Taxiway edge markers must be lightweight, frangible and low enough to preserve adequate clearance for propellers and for the engine pods of jet aircraft.

9.13.28 Taxiway Centreline Markers

9.13.28.1 Taxiway centreline markers may be used on sections of the taxiway as a supplement to taxiway edge markers or taxiway edge lights, e.g. on curves or intersections. When used, taxiway centreline markers must not be spaced greater than the spacing for centreline lights.

9.13.29 Characteristics of Taxiway Centreline Markers

9.13.29.1 Taxiway centreline markers must be retro-reflective green.

9.13.29.2 The marker surface as viewed by the pilot must be a rectangle and must have a minimum viewing surface of 20 cm^2.

9.13.29.3 Taxiway centreline markers must be able to withstand being run over by the wheels of an aircraft without damage either to the aircraft or to the markers themselves.

9.13.30 Photometric Characteristics of Taxiway Lights

9.13.30.1 The average intensity of the main beam of a taxiway light is calculated by:

(a) establishing the grid points in accordance with the method shown in Section 9.14, Figure 9.14-7;

(b) measuring the light intensity values at all grid points located within and on the perimeter of the rectangle representing the main beam;

(c) calculating the arithmetic average of the light intensity values as measured at those grid points.

9.13.30.2 The maximum light intensity value measured on or within the perimeter of the main beam must not be more than three times the minimum light intensity values so measured.

9.13.31 Installation and Aiming of Light Fittings

9.13.31.1 The following points must be followed in the installation and aiming of light fittings:

(a) the lights are aimed so that there are no deviations in the main beam pattern, to within ½° from the applicable standard specified in this Chapter;

(b) horizontal angles are measured with respect to the vertical plane through the taxiway centreline;

(c) when measuring horizontal angles for lights other than taxiway centreline lights, the direction towards the taxiway centreline is to be taken to be positive;

(d) vertical angles specified are to be measured with respect to the horizontal plane.

(e) Illustrations of Taxiway Lighting

9.13.31.2 Section 9.15: contains illustrations of taxiway lighting.

Section 9.14: Isocandela Diagrams for Taxiway Lights

9.14.1 Collective Notes to Figures

9.14.1.1 Figure 9.14-1 to Figure 9.14-5 show candela values in green and yellow for taxiway centreline lights and red for stop bar lights.

9.14.1.2 Figure 9.14-1 to Figure 9.14-5 show the minimum allowable light intensities. The average intensity of the main beam is calculated by establishing grid points as shown in Figure 9.14-7, 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.

9.14.1.3 No deviations are acceptable in the main beam when the lighting fixture is properly aimed.

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

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

9.14.1.6 The light unit is to be installed so that the main beam is aligned within one-half degree of the specified requirement.

9.14.1.7 On the perimeter of and within the rectangle defining the main beam, the maximum light intensity value is not to be greater than three times the minimum light intensity measured.

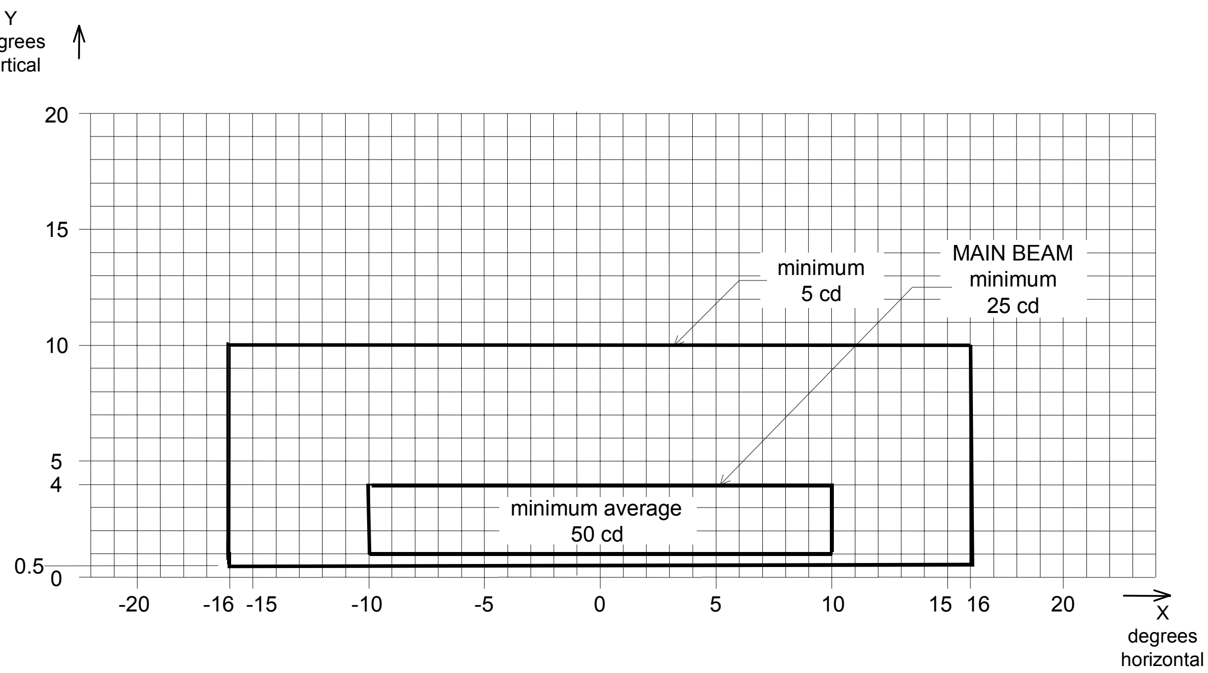

Figure 9.14-1: Isocandela diagram for Taxiway Centreline Lights, and Stop Bar Lights on Straight Sections of Taxiways intended for use in conjunction with a Non-Precision or Precision Approach Category I or II Runway

Notes:

1. The intensity values have taken into account high background luminance, and possibility of deterioration of light output resulting from dust and local contamination.
2. Where omnidirectional lights are used they must comply with the vertical beam spread.
3. See the collective notes at Paragraph 9.14.1 for these isocandella diagrams.

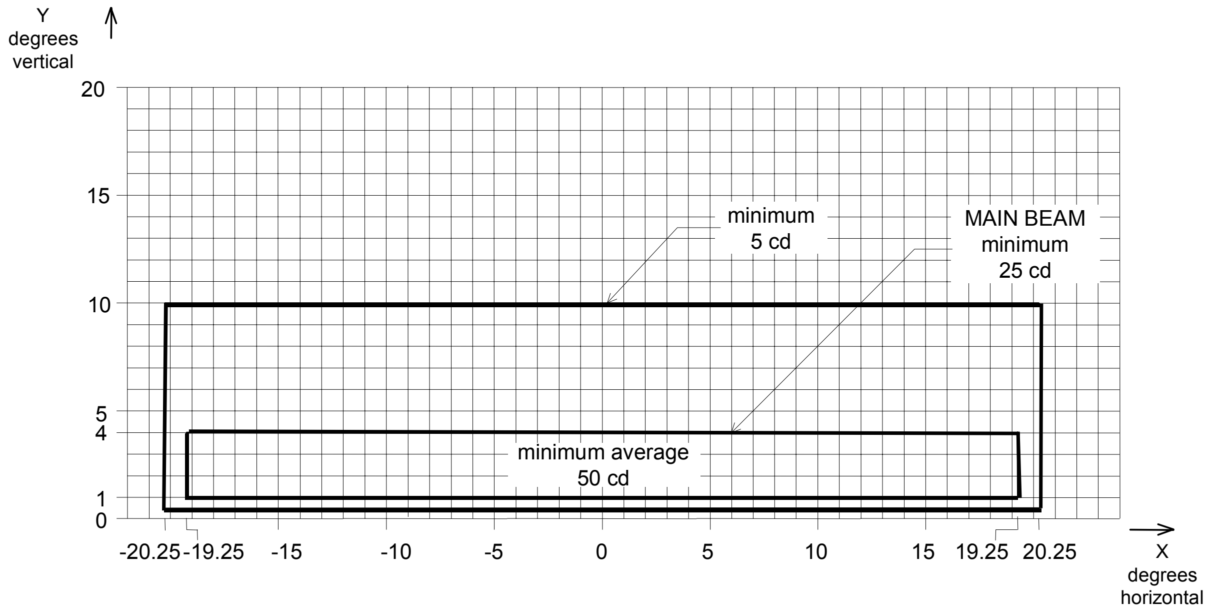

Figure 9.14-2: Isocandela Diagram for Taxiway Centreline Lights, and Stop Bar Lights on Curved Sections of Taxiways intended for use in conjunction with a Non-Precision or Precision Approach Category I or II Runway

Notes:
1. The intensity values have taken into account high background luminance, and possibility of deterioration of light output resulting from dust and local contamination.
2. Lights on curves to have light beam toed-in 15.75º with respect to the tangent of the curve.
3. These beam coverages allow for displacement of the cockpit from the centreline up to distance of the order of 12 m as could occur at the end of curves.
4. See collective notes at Paragraph 9.14.1 for these isocandela diagrams.

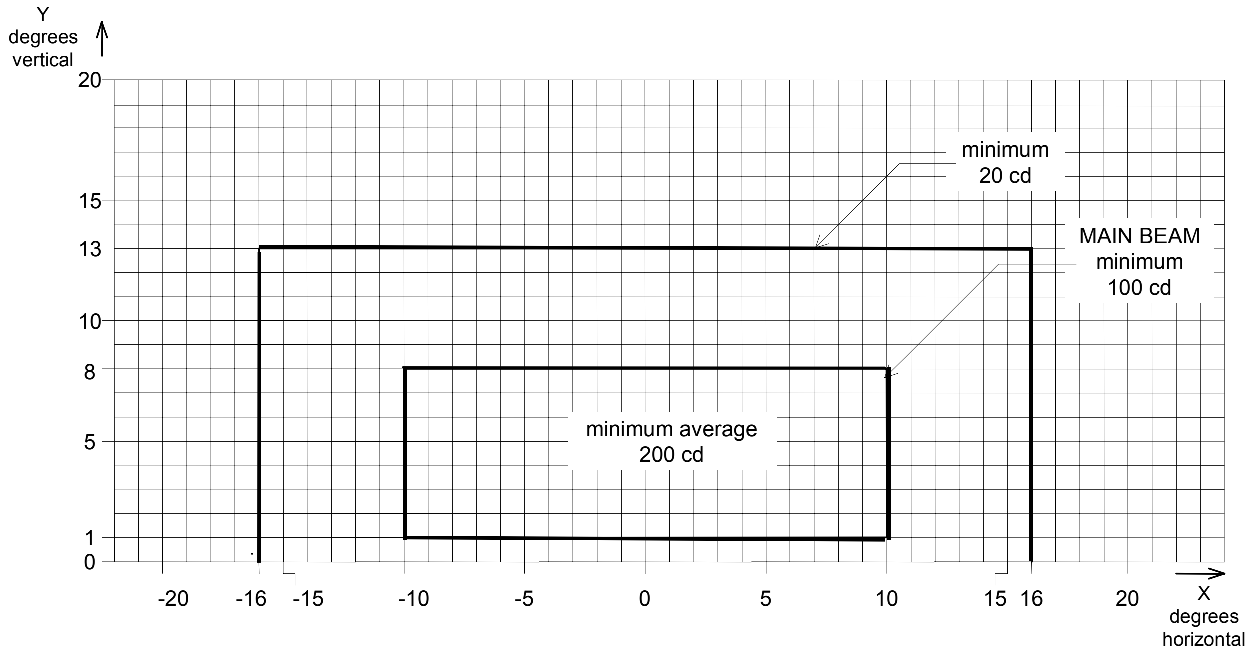

Figure 9.14-3: Isocandela Diagram for Taxiway Centreline Lights, and Stop Bar Lights, on Taxiway intended for use in conjunction with a Precision Approach Category III Runway — for use on straight sections of taxiway where large offsets can occur. Also for Runway Guard Lights Configuration B.

Notes: 1. These beam coverages are suitable for a normal displacement of the cockpit from the centreline of up to 3 m.

2. See collective notes at Paragraph 9.14.1 for these isocandela diagrams.

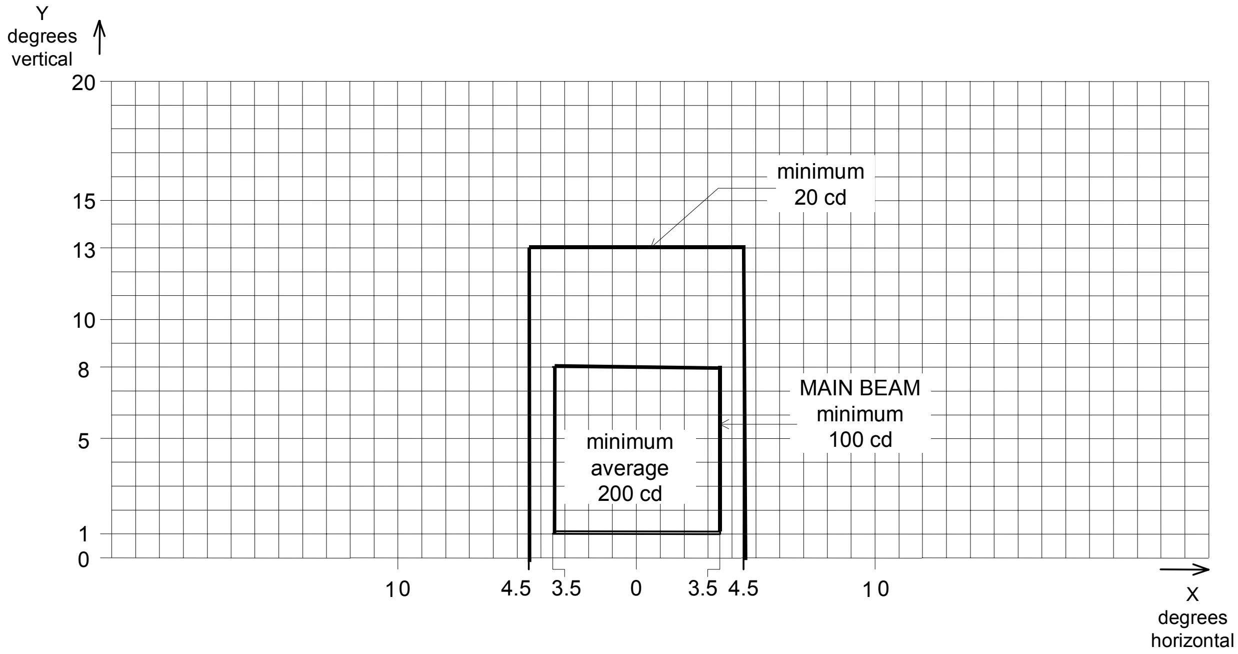

Figure 9.14-4: Isocandela Diagram for Taxiway Centreline Lights, and Stop Bar Lights, for Taxiways intended for use in conjunction with a Precision Approach Category III Runway – for use on straight sections of taxiway where large offsets do not occur

Notes: 1. These beam coverages are suitable for a normal displacement of the cockpit from the centreline of up to 3 m.

2. See collective notes at Paragraph 9.14.1 for these isocandella diagrams.

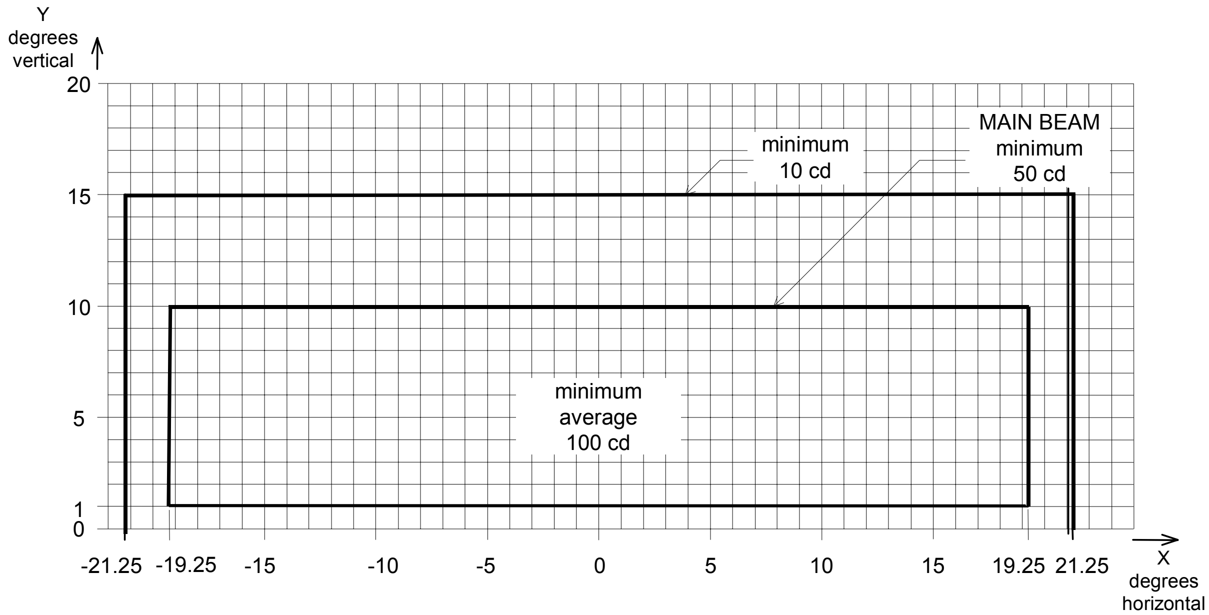

Figure 9.14-5: Isocandela Diagram for Taxiway Centreline Lights, and Stop Bar Lights, for Taxiways intended for use in conjunction with a Precision Approach Category III Runway — for use on curved sections of taxiway

Notes:
1. Lights on curves to have light beam toed-in 15.75º with respect to the tangent of the curve.
2. See collective notes at Paragraph 9.14.1 for these isocandella diagrams.

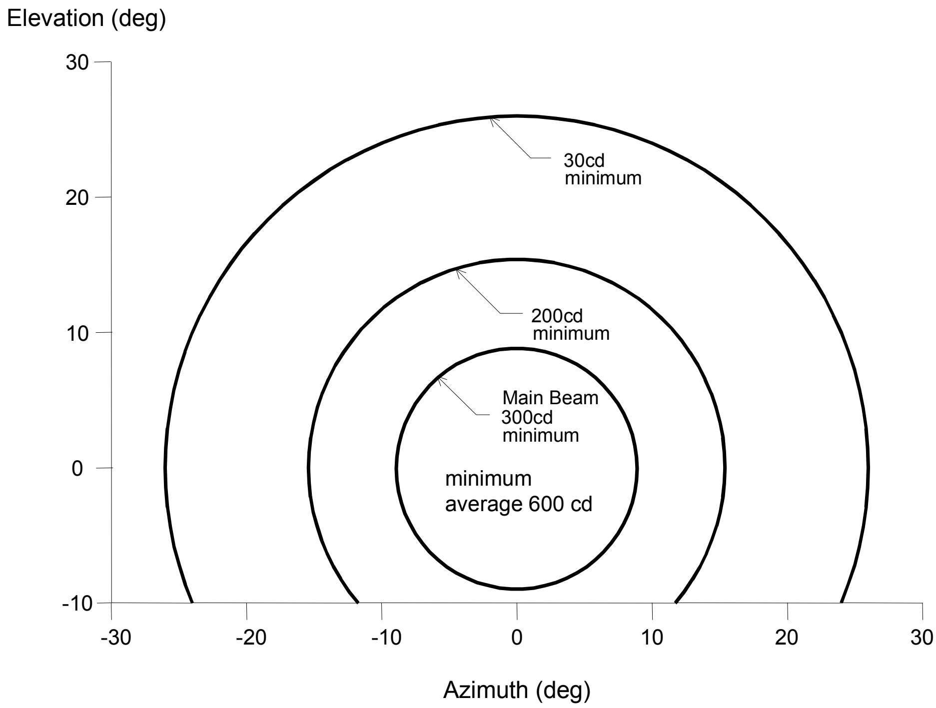

Figure 9.14-6: Isocandela Diagram for Each Light in Runway Guard Lights. Configuration A.

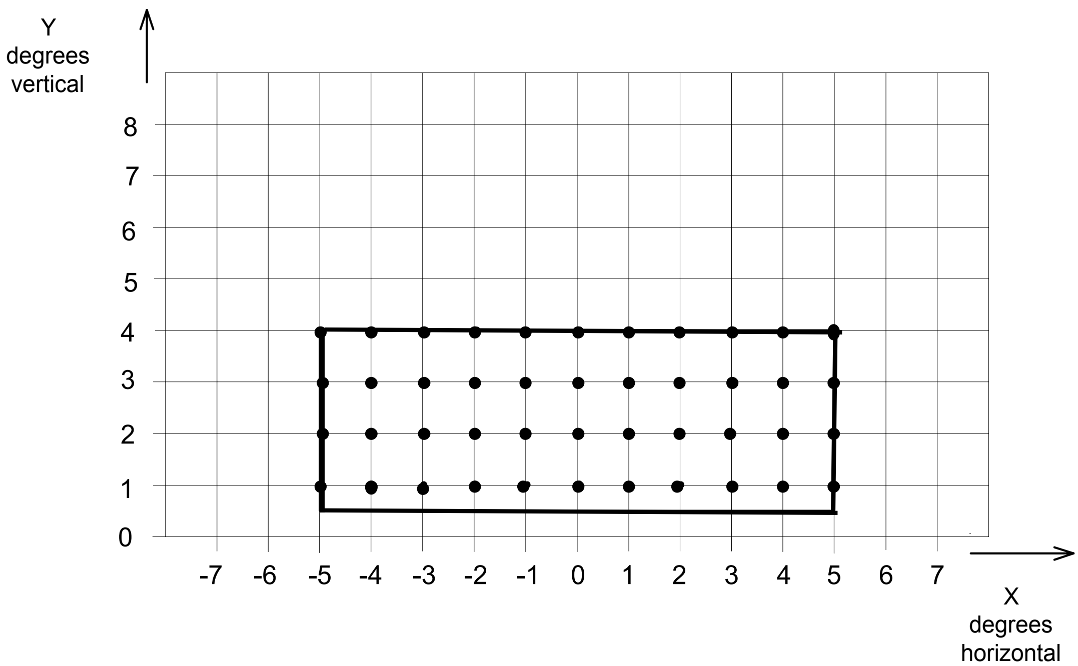

Figure 9.14-7: Method of Establishing Grid Points to be used for Calculation of Average Intensity of Taxiway Centreline Lights and Stop Bar Lights

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Section 9.15: Illustrations of Taxiway Lighting

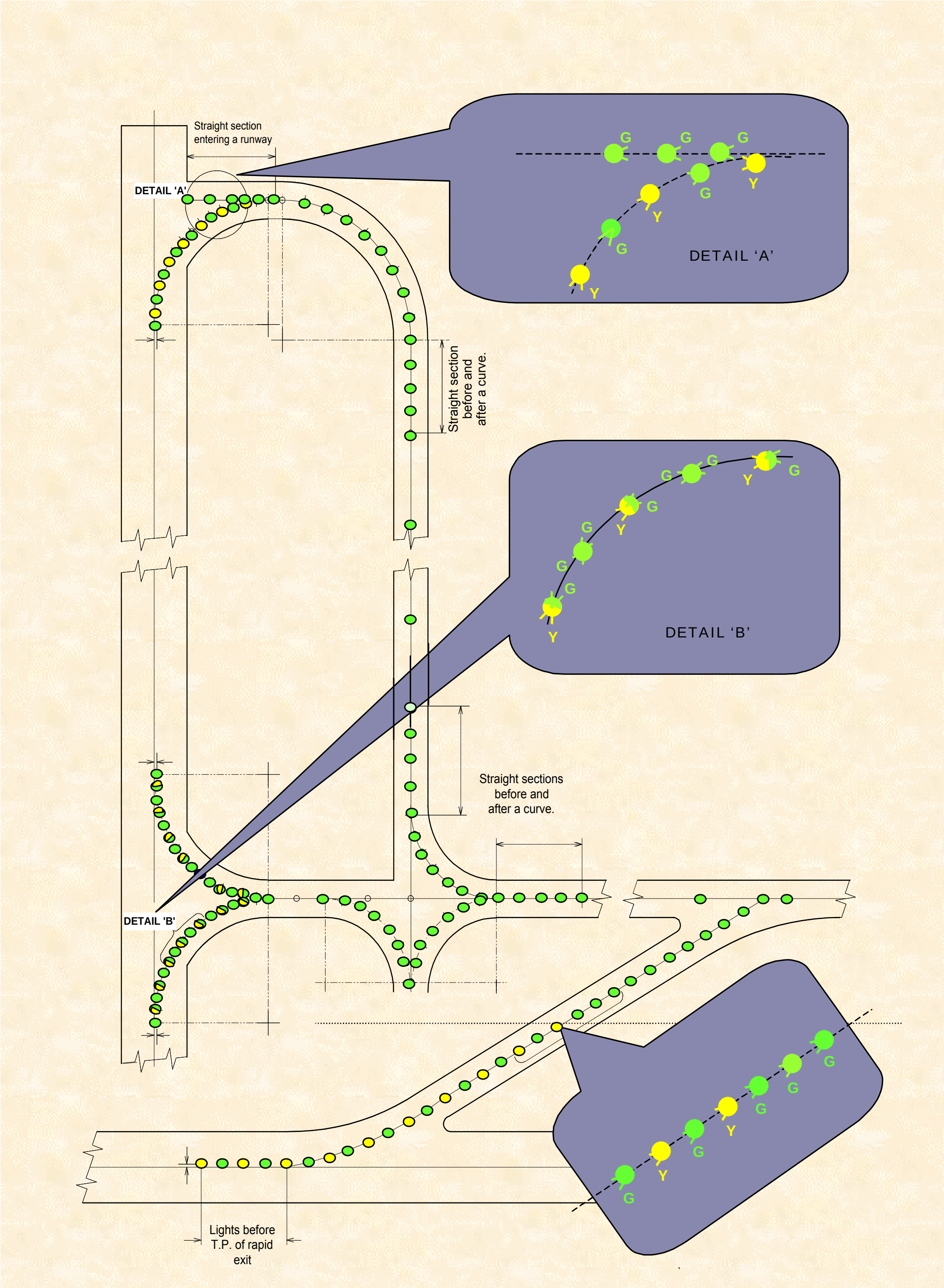

Figure 9.15-1: Typical Taxiway Centreline Lights Layout

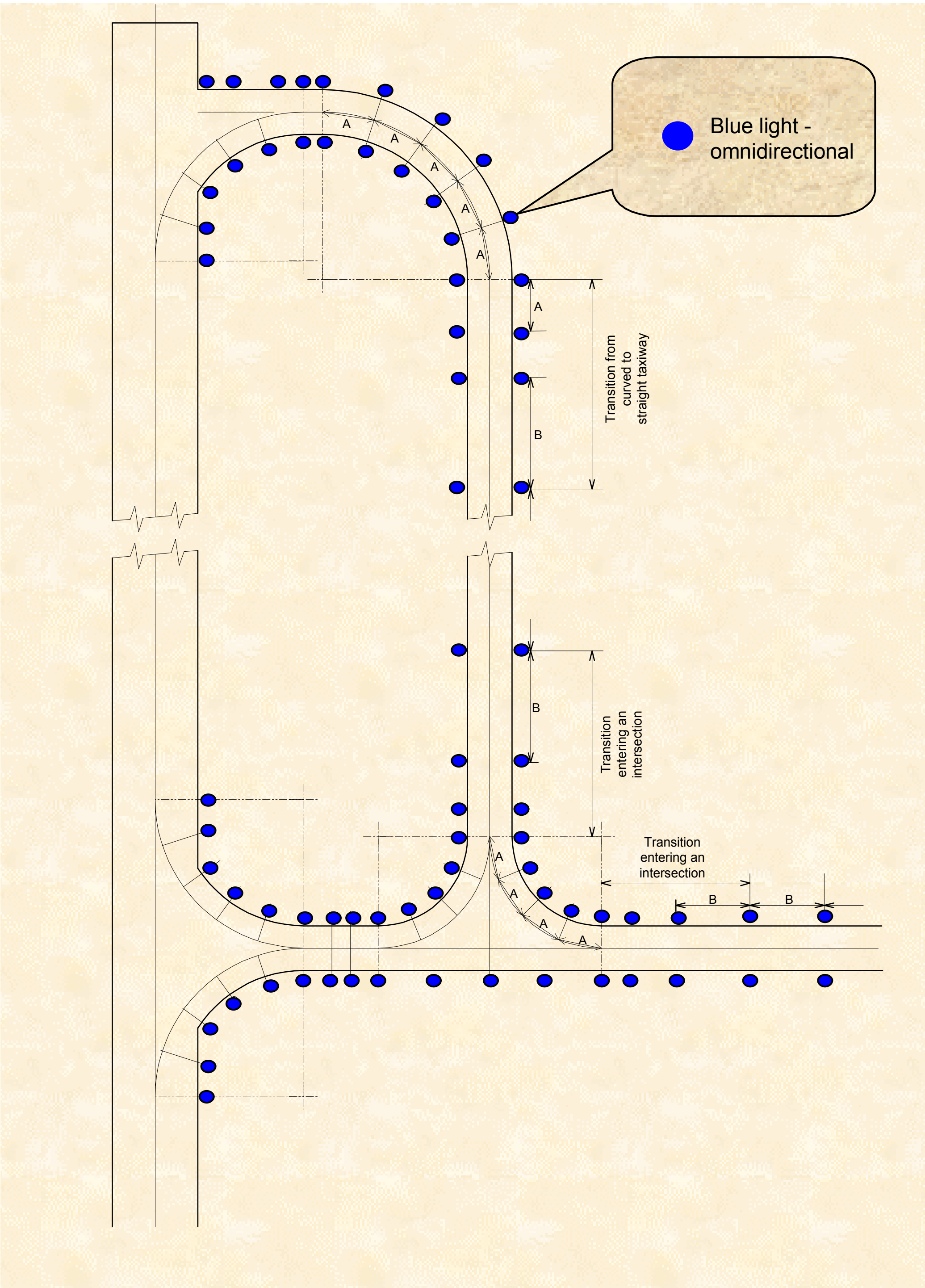

Figure 9.15-2: Typical Taxiway Edge Lights Layout

Section 9.16: Apron Floodlighting

9.16.1 Introduction

Note: Previous apron floodlighting standards called for different illuminance specifications for international and domestic aprons, with higher illuminance specifications for the international aprons. With airlines now conducting both domestic and international operations, setting apron floodlighting requirements based on the international or domestic usage is no longer appropriate and can inhibit flexibility of apron usage. This Section will use aeroplane size as the criterion for illuminance specification.

9.16.1.1 ICAO establishes only one apron floodlighting standard. However, Australia will retain the two tier system, viz. a higher illuminance standard for aprons intended to serve larger aeroplanes, and a lower illuminance standard for aprons intended to serve only smaller aeroplanes. For the purpose of this Section, aeroplanes bigger than code 3C are treated as larger aeroplanes. Code 3C aeroplanes and aeroplanes smaller than code 3C are treated as smaller aeroplanes.

9.16.1.2 An existing floodlighting system on an apron currently used by larger aeroplanes which does not meet the specifications of this Section does not need to be replaced until the system is due for replacement, or there is a significant change in the usage of the apron by larger aeroplanes.

9.16.2 Provision of Apron Floodlighting

9.16.2.1 Apron floodlighting, in accordance with this Section, must be provided on an apron, or the part of an apron, and on a designated isolated aircraft parking position, intended for use at night.

9.16.3 Location of Apron Floodlighting

9.16.3.1 Apron floodlighting must be located so as to provide adequate illumination on all the apron service areas that are intended for use at night.

9.16.3.2 If an apron taxiway is not provided with taxiway lighting, then it must be illuminated by the apron floodlighting in accordance with either 9.16.4.3(b) or 9.16.4.4(b).

9.16.3.3 Apron floodlights must be located and shielded so that there is a minimum of direct or reflected glare to pilots of aircraft in flight and on the ground, air traffic controllers, and personnel on the apron.

Note: See also Section 9.21 in regard to upward component of light.

9.16.3.4 An aircraft parking position must receive, as far as practicable, apron floodlighting from two or more directions to minimise shadows.

> **Note:** For apron floodlighting purpose, an aircraft parking position means a rectangular area subtended by the wing span and overall length of the largest aircraft that is intended to occupy that position.

9.16.3.5 Apron floodlighting poles or pylons must not penetrate the obstacle limitation surfaces.

9.16.4 Characteristics of Apron Floodlighting

9.16.4.1 To minimise the chance of an illuminated rotating object such as a propeller appearing stationary, at major aerodromes, the apron floodlighting is to be distributed across the phases of a three-phase power supply system to avoid a stroboscopic effect.

> **Note:** Aerodrome operators are strongly encouraged to apply Paragraph 9.16.4.1 to aprons at ALL aerodromes.

9.16.4.2 The spectral distribution of apron floodlights must be such that the colours used for aircraft marking connected with routine servicing, and for surface and obstacle marking, can be correctly identified. Monochromatic lights must not to be used.

9.16.4.3 The average illuminance of an apron intended for larger aeroplanes must be at least as follows:

(a) at an aircraft parking position:

(i) for horizontal illuminance – 20 lux with a uniformity ratio (average to minimum) of not more than 4 to 1; and

(ii) for vertical illuminance – 20 lux at a height of 2 m above the apron in the relevant parking direction, parallel to the aeroplane centreline;

(b) at other apron areas, horizontal illuminance at 50 per cent of the average illuminance on the aircraft parking position with a uniformity ratio (average to minimum) of not more than 4 to 1.

> **Note:** The uniformity ratio between the average of all values of illuminance, measured over a grid covering the relevant area, and the minimum illuminance within the area. A 4:1 ratio does not necessarily mean a minimum of 5 lux. If an average illuminance of say 24 lux is achieved, then the minimum should be not less than 24/4 = 6 lux.

9.16.4.4 The average illuminance of an apron intended to be used only by smaller aeroplanes must be at least as follows:

(a) at an aircraft parking position:

(i) for horizontal illuminance – 5 lux with a uniformity ratio (average to minimum) of not more than 4 to 1; and

(ii) for vertical illuminance – 5 lux at a height of 2 m above the apron in the relevant parking direction, parallel to the aeroplane centreline;

(b) at other apron areas, horizontal illuminance graded to a minimum of 1 lux at the apron extremities or 2 lux for apron edge taxiways which do not have taxiway lights.

9.16.4.5 A dimming control may be provided to allow the illuminance of an aircraft parking position on an active apron that is not required for aircraft use to be reduced to not less than 50 per cent of its normal values.

9.16.4.6 At an aerodrome where PAL activates the apron floodlighting, the apron floodlighting must achieve normal illuminance within 2 minutes of activation.

9.16.4.7 For aprons used by larger aeroplanes, the apron floodlighting must:

(a) be included in the aerodrome secondary power supply system; and

(b) be capable, following a power interruption of up to 30 seconds, of being re-lit and achieving not less than 50 per cent of normal illuminance within 60 seconds.

9.16.4.8 If existing floodlights cannot meet the requirement of Paragraph 9.16.4.7, auxiliary floodlighting must be provided that can immediately provide at least 2 lux of horizontal illuminance of aircraft parking positions. This auxiliary floodlighting must remain on until the main lighting has achieved 80 per cent of normal illuminance.

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Section 9.17: Visual Docking Guidance Systems

9.17.1 Provision of Visual Docking Guidance Systems

9.17.1.1 A visual docking guidance system must be provided at an apron aircraft parking position equipped with a passenger loading bridge, where the characteristics of the passenger loading bridge require precise positioning of an aircraft.

9.17.1.2 The provisions of this Section do not, of themselves, require the replacement of existing installations. When existing installations are to be replaced due to obsolescence, facility upgrade, change of apron layout, change of passenger loading bridge, change of aircraft category, change of operational requirements, or similar reasons, all new and/or replacement visual docking guidance systems must comply with this Section.

9.17.2 Characteristics of Visual Docking Guidance Systems

9.17.2.1 The system must provide both azimuth and stopping guidance.

9.17.2.2 The azimuth guidance unit and the stopping position indicator must be adequate for use in all weather, visibility, background lighting, and pavement conditions for which the system is intended, both by day and night, but must not dazzle the pilot.

> **Note:** Care is required in both the design and on-site installation of the system to ensure that reflection of sunlight, or other light in the vicinity, does not degrade the clarity and conspicuity of the visual cues provided by the system.

9.17.2.3 The azimuth guidance unit and the stopping position indicator must be of a design such that:

(a) a clear indication of malfunction of either or both is available to the pilot; and

(b) they can be turned off.

9.17.2.4 The azimuth guidance unit and the stopping position indicator must be located in such a way that there is continuity of guidance between the aircraft parking position markings, the aircraft stand manoeuvring guidance lights, if present, and the visual docking guidance system.

9.17.2.5 The accuracy of the system must be adequate for the type of loading bridge and fixed aircraft servicing installations with which it is to be used.

9.17.2.6 The system must be usable by all types of aircraft for which the aircraft parking position is intended, preferably without selective operation.

9.17.2.7 If selective operation is required to prepare the system for use by a particular type of aircraft, then the system must provide an identification of the selected aircraft type to both the pilot and the system operator as a means of ensuring that the system has been set properly.

9.17.3 Azimuth Guidance Unit - Location

9.17.3.1 The azimuth guidance unit must be located on or close to the extension of the parking position centreline ahead of the aircraft so that its signals are visible from the cockpit of an aircraft throughout the docking manoeuvre and aligned for use at least by the pilot occupying the left seat.

9.17.3.2 Systems with azimuth guidance aligned for use by the pilots occupying both the left and right seats are acceptable.

9.17.4 Azimuth Guidance Unit - Characteristics

9.17.4.1 The azimuth guidance unit must provide unambiguous left/right guidance which enables the pilot to acquire and maintain the lead-in line without over controlling.

9.17.4.2 When azimuth guidance is indicated by colour change, green must be used to identify the centreline and red for deviations from the centreline.

9.17.5 Stopping Position Indicator - Location

9.17.5.1 The stopping position indicator must be located in conjunction with, or sufficiently close to, the azimuth guidance unit so that a pilot can observe both the azimuth and stop signals without turning the head.

> **Note:** Some existing systems at Australian aerodromes require the pilot to turn the head to see the stopping position indicator. These systems may remain in service, in accordance with Paragraph 9.17.1.2 above.

9.17.5.2 The stopping position indicator must be usable at least by the pilot occupying the left seat.

9.17.5.3 Systems with stopping position indicator usable by the pilots occupying both the left and right seats are acceptable.

9.17.6 Stopping Position Indicator - Characteristics

9.17.6.1 The stopping position information provided by the indicator for a particular aircraft type must account for the anticipated range of variations in pilot eye height and/or viewing angle.

9.17.6.2 The stopping position indicator must show the stopping position of the aircraft for which the guidance is being provided, and must provide closing rate information to enable the pilot to gradually decelerate the aircraft to a full stop at the intended stopping position.

9.17.6.3 The stopping position indicator must provide closing rate information over a distance of at least 10 m.

9.17.6.4 When stopping guidance is indicated by colour change, green must be used to show that the aircraft can proceed and red to show that the stop point has been reached except that for a short distance prior to the stopping point a third colour may be used to warn that the stopping point is close.

9.17.7 Parking Position Identification Sign

9.17.7.1 A parking position identification sign must be provided at an aircraft parking position equipped with a visual docking guidance system.

9.17.7.2 A parking position identification sign must be located so as to be clearly visible from the cockpit of an aircraft prior to entering the parking position.

9.17.7.3 A parking position identification sign is to consist of a numeric or alphanumeric inscription, in white on a black background. The inscription is to be outlined in neon tubing for illumination at night. Experience has shown that green neon tubing illumination has proved satisfactory.

9.17.8 Notification of Type of Aircraft Docking Guidance Systems

9.17.8.1 Due to the large variety of different type of visual docking guidance systems to be found in operation at aerodromes, information on particular types installed is published in aeronautical information publications, for use by pilots.

9.17.8.2 Aerodrome operators must notify the Procedure Design Section of Airservices Australia, the details of their aircraft docking guidance system intended for use for International operations.

9.17.8.3 The information to be provided is to include:

(a) type of visual docking guidance system;

(b) descriptive information, including illustrations where appropriate, for any type of system not currently described in *AIP Australia;* and

(c) parking positions at which the system is installed.

9.17.8.4 Initial and subsequent notification must be in accordance with Chapter 5, Aerodrome Information for AIP and Chapter 10, Operating Standards for Certified Aerodromes. The visual docking guidance system information must also be recorded in the Aerodrome Manual.

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Section 9.18: Lighting Associated with Closed and Unserviceable Areas

9.18.1 Closed Runway or Taxiway

9.18.1.1 When a runway or taxiway, or portion thereof is closed, all aerodrome lighting thereon is to be extinguished. The lighting is to be electrically isolated or disabled, to prevent inadvertent activation of the lights.

> **Note:** 1. Restricted operation of the lights is permissible for maintenance or related purposes.
>
> 2. It is acceptable for short time periods, to cover lights with an opaque cover provided that:
>
> (a) the cover is firmly attached to the ground, so that it cannot be unintentionally dislodged, and
>
> (b) the cover, and its means of attachment to the ground, do not pose a hazard to aircraft, and do not constitute an object that is not lightweight and frangible.

9.18.1.2 Where a closed runway, taxiway, or portion thereof, is intercepted by a useable runway or taxiway which is used at night, unserviceability lights are to be placed across the entrance to the closed area at intervals not exceeding 3 m.

9.18.2 Unserviceable Areas

9.18.2.1 When any portion of a taxiway, apron, or holding bay is unfit for movement of aircraft, but it is still possible for aircraft to bypass the area safely, and the movement area is used at night, unserviceability lights are to be used.

9.18.2.2 The lights are to be placed at intervals sufficiently close so as to delineate the unserviceable area and, in any case, must not be more than 7.5 m apart.

9.18.3 Characteristics of Unserviceability Lights

9.18.3.1 Unserviceability lights are to be steady red lights.

9.18.3.2 The lights are to have an intensity sufficient to ensure conspicuity considering the intensity of the adjacent lights and the general level of illumination against which they would normally be viewed. In no case is the intensity to be less than 10 cd of red light.

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Section 9.19: Other Lights on an Aerodrome

9.19.1 Vehicle Warning Lights

9.19.1.1 Vehicle warning lights, as required by subsection 10.9.2, are provided to indicate to pilots and others the presence of vehicles or mobile plant on the movement area.

9.19.1.2 A vehicle warning light or lights must be mounted on the top of the vehicle, so as to provide 360° visibility.

9.19.1.3 The lights must be amber/yellow/orange, and be flashing or rotating of a standard type commercially available as an automobile accessory.

> **Note:** International experience has shown the following specification to be particularly suitable. Yellow light, with a flash rate of between 60 and 90 flashes per minute, with a peak intensity of between 40 cd and 400 cd, a vertical beam spread of 12°, and with the peak intensity located at approximately 2.5° vertical.

9.19.1.4 For lighting of rescue and fire fighting vehicles, see MOS 139 Subpart H, Chapter 4.

9.19.1.5 For emergency or security vehicles not dedicated to aerodrome use, vehicle warning lights complying with the local traffic code are acceptable for on-aerodrome operation.

9.19.2 Works Limit Lights

9.19.2.1 Works limit lights are provided to indicate to persons associated with the works organisation the limit of the works area.

9.19.2.2 Works limit lights must be portable, amber/yellow/orange lights of a standard type commercially available as works warning lights. Alternatively they may be liquid fuel lanterns with amber/yellow/orange lenses.

9.19.3 Road and Car Park Lighting

9.19.3.1 CASA does not regulate the lighting of roads and car parks, other than ensuring compliance with Paragraph 9.1.3.

9.19.3.2 Where road and car park lighting is required on an aerodrome, the aerodrome operator is advised to consult with the relevant local road authority or *Australian Standards AS 1158 – Code of Practice for Public Lighting*.

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Section 9.20: Monitoring, Maintenance and Serviceability of Aerodrome Lighting

9.20.1 General

9.20.1.1 The aerodrome operator must monitor and maintain all lights and lighting systems associated with the aerodrome visual ground aids, both day and night, on a continuing basis for correctness and so that they are easily seen. Monitoring of lighting systems such as T-VASIS, PAPI and approach lighting must be carried out in accordance with the frequencies and procedures set out in the Aerodrome Manual. Other aerodrome lights must be monitored during the daily serviceability inspections and they must be switched on for this purpose.

9.20.1.2 Grass areas around lights must be maintained such that the lights are not in any way obscured. Lights must be kept free from dirt so as not to degrade their colour and conspicuousness. Damage to lights, including loss or degradation of light must be made good.

9.20.2 Reporting of Aerodrome Lighting Outage

9.20.2.1 Any aerodrome light outage detected must be fixed as soon as is practicable. The specifications listed below are intended to define the maintenance performance level objectives. They are not intended to define whether the lighting system is operationally out of service. Nor are they meant to condone outage, but are intended to indicate when lighting outage must be notified to the NOTAM office. The specifications must be used as triggers for NOTAM action, to advise pilots of actual outage, unless the outage can be rectified before the next period of use.

9.20.2.2 For details of the raising of NOTAMs refer to Section 10.3.

9.20.2.3 A light is deemed to be on outage when the main beam is out of its specified alignment or when the main beam average intensity is less than 50 per cent of the specified value. For light units where the designed main beam average intensity is above the specified value, the 50 per cent value shall be related to that design value.

> **Note:** For installations that were in existence prior to 2 May 2003, and where the design main beam average intensity values are unknown and/or unobtainable, the 50 per cent value shall be related to the specified value.

9.20.2.4 A flashing or occulting light is deemed to be on outage when:

(a) the light ceases to flash or occult; or

(b) the frequency and/or duration of flash is outside the specified range by a factor of 2 to 1 or greater; or

(c) within a 10 minute period, more than 20% of flashes fail to occur.

9.20.2.5 A lighting system is deemed to be on outage when:

(a) in the case of a lighting system comprising less than 4 lights (e.g. intermediate holding position lights or runway threshold identification lights), any of the lights are on outage;

(b) in the case of a lighting system comprising 4 or 5 lights (e.g. wind direction indicator lights or runway guard lights), more than 1 light is on outage;

(c) in the case of a lighting system comprising 6 to 13 lights (e.g. threshold lights or LAHSO lights), more than 2 lights are on outage, or 2 adjacent lights are on outage;

(d) in the case of a lighting system comprising more than 13 lights, more than 15% of the lights are on outage, or two adjacent lights are on outage.

> **Note:** A lighting system here means lights used to illuminate a particular facility e.g. all the lights used to mark a threshold or runway end, runway edge lights on a runway, taxiway lights on a length of taxiway between intersections a T–VASIS or a PAPI system.

9.20.2.6 For a T-VASIS, the outage standards take into account both the number of outage lamps within a light unit, and also the number of light units within the T-VASIS system. The standards are:

(a) A T-VASIS light unit is deemed on outage when 3 or more lamps in the electrical (day) circuit are on outage, or when any of the lamps in the electrical (night) circuit is on outage.

(b) A T-VASIS system is deemed on outage when:

(i) bar units — more than 2 light units or two adjacent light units are on outage;

(ii) fly-up units — more than 1 light unit are on outage;

(iii) fly-down units — more than 1 light unit are on outage.

(c) An AT-VASIS system is deemed on outage when:

(i) bar units — more than 1 light unit is on outage,or

(ii) fly-up units — any light unit is on outage,or

(iii) fly-down units — any light unit is on outage.

(d) Whenever a red filter has deteriorated such that it does not produce the correct colour light beam, is missing, or is damaged, all the lamps within the affected light unit must be extinguished until the red filter is rectified. The affected light unit is included as an outage light unit when applying (b) or (c) above.

9.20.2.7 For a PAPI, the outage standards take into account both the number of lamps on outage within a light unit and also the number of light units within the PAPI system. The standards are:

(a) a PAPI light unit is deemed on outage when more than one lamp in a 3 or more lamp light unit is on outage, or any lamp in a less-than-3-lamp light unit is on outage;

(b) whenever a red filter has deteriorated such that it does not produce the correct colour light beam, is missing, or is damaged, all the lamps associated with that filter must be extinguished until the red filter is rectified. The affected lamp/s are included as outage lamps when determining (a) above.

(c) a double-sided PAPI system (i.e. 8 light units) is:

(i) deemed to be on outage but useable when all light units in one wing bar are fully functioning, and any light units in the other wing bar are on outage. The system may remain in use but a NOTAM must be issued detailing the number of light units on outage, and on which side of the runway they are; and

(ii) deemed on outage when one or more light units in each wing bar is on outage. The double-sided PAPI system must be extinguished until the system is rectified;

(d) a single-sided PAPI system (i.e. 4 light units) is deemed to be on outage when any light unit is on outage. The PAPI system must be extinguished until the system is rectified.

9.20.2.8 At an aerodrome where the lighting system is provided with interleaf circuitry, the lighting system is deemed to be on outage when any one of the circuits fails.

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Section 9.21: Lighting in the Vicinity of Aerodromes

9.21.1 Advice to Lighting Designers

9.21.1.1 This Section supersedes a paper of the same name dated July 1988 and issued by the Civil Aviation Authority.

9.21.2 Introduction

9.21.2.1 The Civil Aviation Safety Authority (CASA) has the power through regulation 94 of the Civil Aviation Regulations 1988 (CAR 1988), to require lights which may cause confusion, distraction or glare to pilots in the air, to be extinguished or modified. Ground lights may cause confusion or distraction by reason of their colour, position, pattern or intensity of light emission above the horizontal plane. The text of regulation 94 is reproduced below for reference:

> "*Dangerous Lights*
>
> *94. (1) Whenever any light is exhibited at or in the neighbourhood of an aerodrome, or in the neighbourhood of an air route or airway facility on an air route or airway, and the light is likely to endanger the safety of aircraft, whether by reason of glare, or by causing confusion with, or preventing clear reception of, the lights or signals prescribed in Part XII or of air route or airway facilities provided under the Air Services Act 1995, CASA may authorise a notice to be served upon the owner of the place where the light is exhibited or upon the person having charge of the light directing that owner or person, within a reasonable time to be specified in the notice, to extinguish or to screen effectually the light and to refrain from exhibiting any similar light in the future.*
>
> *"(2) If any owner or person on whom a notice is served under this regulation fails, without reasonable cause, to comply with the directions contained in the notice, the owner or person shall be guilty of an offence punishable, on conviction, by a fine not exceeding 25 penalty units.*
>
> *"(3) If any owner or person on whom a notice under this regulation is served fails, within the time specified in the notice, to extinguish or to screen effectually the light mentioned in the notice, CASA may authorise an officer, with such assistance as is necessary and reasonable, to enter the place where the light is and extinguish or screen the light, and may recover the expenses incurred by CASA in so doing from the owner or person on whom the notice has been served."*

9.21.3 General Requirement

9.21.3.1 Advice for the guidance of designers and installation contractors is provided for situations where lights are to be installed within a 6 km radius of a known aerodrome. Lights within this area fall into a category most likely to be subjected to the provisions of the regulation 94 of CAR 1988. Within this large area there exists a primary area which is divided into four light control zones: A, B, C and D. These zones reflect the degree of interference ground lights can cause as a pilot approaches to land.

9.21.3.2 The primary area is shown in Figure 9.21-1. This drawing also nominates the intensity of light emission above which interference is likely. Lighting projects within this area should be closely examined to see they do not infringe the provision of regulation 94 of CAR 1988.

9.21.3.3 The fact that a certain type of light fitting already exists in an area is not necessarily an indication that more lights of the same type can be added to the same area.

9.21.3.4 Even though a proposed installation is designed to comply with the zone intensities shown in Figure 9.21-1, designers are advised to consult with CASA as there may be overriding factors which require more restrictive controls to avoid conflict.

9.21.4 Light Fittings

9.21.4.1 Light fittings chosen for an installation should have their isocandela diagram examined to ensure the fitting will satisfy the zone requirements. In many cases the polar diagrams published by manufacturers do not show sufficient detail in the sector near the horizontal, and therefore careful reference should be made to the isocandela diagram.

9.21.4.2 For installations where the light fittings are selected because their graded light emission above horizontal conform with the zone requirement, no further modification is required.

9.21.4.3 For installations where the light fitting does not meet the zone requirements, then a screen should be fitted to limit the light emission to zero above the horizontal. The use of a screen to limit the light to zero above the horizontal is necessary to overcome problems associated with movement of the fitting in the wind or misalignment during maintenance.

9.21.5 Coloured Lights

9.21.5.1 Coloured lights are likely to cause conflict irrespective of their intensity as coloured lights are used to identify different aerodrome facilities. Proposals for coloured lights should be referred to the Authority for detailed guidance.

9.21.6 Information and Correspondence

9.21.6.1 Check with the nearest CASA office for likely effect on aircraft operations of proposed lighting in the vicinity of an aerodrome.

MAXIMUM INTENSITY OF LIGHT
SOURCES MEASURED AT 3°
ABOVE THE HORIZONTAL

ZONE A	0 cd
ZONE B	50 cd
ZONE C	150 cd
ZONE D	450 cd

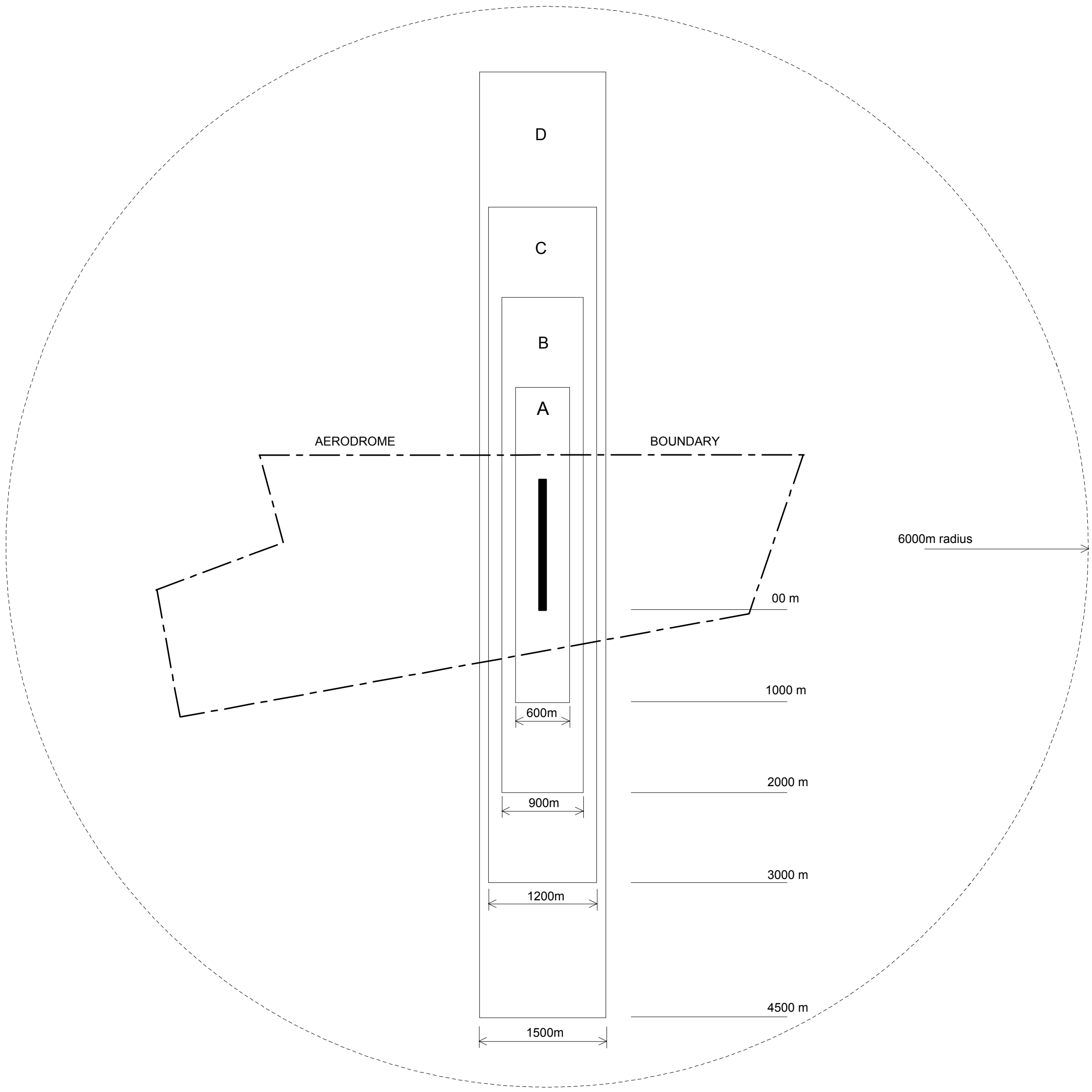

Figure 9.21-1: Maximum lighting intensities

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Section 9.22: Use of Unarmoured Cables for Aerodrome Lighting

9.22.1 Introduction

9.22.1.1 The type of cable usually used in Australia for the series current electrical supply to aerodrome lighting fittings is a single core 6 mm² (7/1.04 mm) plain annealed copper conductor covered with a polyethylene insulation and an overall nylon sheath. It may be safely operated at 3000 volt. The nylon sheath provides additional protection against rough handling during installation, and also prevents damage by termites. The cable is suitable for direct burial in the ground.

9.22.1.2 As the series current system, and the cable used, was significantly different from normal electrical practice, the Department of Civil Aviation (DCA) referred the matter to the Standards Association of Australia in 1958.

9.22.1.3 Committee EL/1, the committee responsible for the SAA Wiring Rules, advised DCA in 1959 that it recommended to all Statutory Authorities that such installations be treated as 'unusual installations' that did not have to strictly comply with certain parts of the Wiring Rules, provided certain precautions were observed.

9.22.2 Significant Areas of the Dispensation

9.22.2.1 Firstly it allowed unarmoured cable to be used for high voltage, and that the cable could be installed at a depth of 450 mm instead of the 750 mm required for high voltage in the Wiring Rules.

9.22.2.2 Secondly, it allowed the cable to be buried directly in the ground without mechanical protection against digging.

9.22.2.3 The dispensation was reaffirmed to the Department of Aviation in 1983, and again to the Civil Aviation Authority in 1993.

9.22.3 Conditions Governing the Dispensation

9.22.3.1 The conditions under which the dispensation was sanctioned by the SAA are:

(a) the series lighting circuit which they serve are normally isolated from the supply mains;

(b) the location of the cables is carefully and permanently marked;

(c) earthworks and excavations on an aerodrome are very strictly controlled; and

(d) the lighting circuits are not normally energised during daylight hours when earthworks could be in progress.

9.22.4 Aspects to Note

9.22.4.1 The dispensation only applies to the Movement Area. In other areas of the aerodrome, such as within the building area, the dispensation does not apply.

9.22.4.2 To satisfy Paragraph 9.22.3.1(b), cables should as far as practicable, be laid in straight lines. Suitably engraved permanent cable markers should be installed above all buried cable. The markers should be flush with the finished ground surface and should be located at changes of direction, duct ends, at no more than 100 metre intervals on long straight runs, and at points of entry into buildings.

9.22.4.3 Accurate and up to date plans of the aerodrome should be maintained which record actual locations of all cables installed on the aerodrome.

9.22.4.4 To satisfy condition (d), at aerodromes where lighting systems may be used by day, including visual approach slope guidance systems, or where pilot activation of aerodrome lighting is possible, local procedures should be established that ensure that aerodrome lighting systems are electrically isolated when any works are in progress that could endanger such cable on an aerodrome.

9.22.4.5 A copy of the most recent Standards Australia letter dated 7 September 1993, is attached for reference in Figure 9.22-1 and Figure 9.22-2.

9.22.5 Acceptability of an Installation to the Supply Authority

9.22.5.1 Not withstanding anything in this Section, it is the aerodrome operators' responsibility to ensure that any proposed installation on their aerodrome meets the requirements of the relevant Supply Authority.

STANDARDS AUSTRALIA

Ref: EL/1
GB:se

STANDARDS ASSOCIATION
OF AUSTRALIA
1 THE CRESCENT
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MAIL
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TELEPHONE (02) 746 4700
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7 September 1993

Civil Aviation Authority
Technical Services Division
GPO Box 367
CANBERRA ACT 2601

Attention: Mr B Sullivan

Dear Mr Sullivan

AS 3000 - 1991: SAA WIRING RULES
USE OF UNARMOURED CABLES FOR AIRFIELD LIGHTING

I would advise you that the use of unarmoured cables for airfield lighting was discussed at the 44th meeting of Committee EL/1, the committee responsible for the SAA Wiring Rules.

The committee noted that, in respect of airfield lighting, an exemption was granted in 1959 and reaffirmed in 1983 which allowed unarmoured cables to be used for airfield lighting in aerodrome movement areas under certain conditions.

The committee agreed that the exemption be reaffirmed again. This allows single core polythene insulated cables operating at 3.3kV and used for lighting series circuits to be installed buried direct at a depth of 450 mm within the aerodrome movement area only if the following four conditions are met:

(i) The series lighting circuits which they serve are normally isolated from the supply mains;

(ii) The location of the cables is carefully and permanently marked;

(iii) Earthworks and excavations on an aerodrome are very strictly controlled; and

(iv) The lighting circuits are not normally energised during daylight hours when earth works could be in progress.

This exemption may be applied to both Licensed Aerodromes and Authorised Landing Areas.

Figure 9.22-1: SAA Letter Regarding Use of Unarmoured Cables

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The committee further noted that CAA information publications titled "Airport Lighting for Licensed Aerodromes - Specification of Requirements" and "Airfield Lighting for Authorized Landing Areas - Advice to Owners" include details of this practice. The committee has asked that if these publications do not already contain details of the conditions under which the exemption is valid that they be amended to state these conditions.

If you require any further information please contact me.

Yours faithfully

Gerry Boardman
Projects Manager
Committee EL/1

Figure 9.22-2: SAA Letter Regarding Use of Unarmoured Cables - Page 2