Part 14
Aerodrome Design and Operations

This part of Jordanian Civil Aviation Regulations is hereby issued under the authority and provisions of article 12-B of the Civil Aviation Law No. (41) dated 2007, as amended.

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المملكة الأردنية الهاشمية
هيئة تنظيم الطيران المدني
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Contents

(a) Abbreviations

ACR	Aircraft classification rating
ADP	Airside Driver permit
ADG	Aeroplane design group
AIP	Aeronautical Information publication
APAPI	Abbreviated precision approach path indicator.
ARFF	Aircraft Rescue and Firefighting.
APRX	Approximately.
ASDA	Accelerate-stop distance available.
ATS	Air traffic services.
AT-VASIS	Abbreviated T visual approach slope indicator system.
C	Degree Celsius.
CARC	Civil Aviation Regulatory Commission.
CBR	California bearing ratio.
Cd	Candela.
CIE	International Commission on Illumination.
Cm	Centimeter.
DME	Distance measuring equipment.
E	Modulus of Elasticity
Ft	Foot.
FOD	Foreign Objects Debris.
GBAS	Ground-based augmentation system
GHSP	Ground handling service provider
GSE	Ground support equipment
ILS	Instrument landing system.
IMC	Instrument meteorological conditions.
JCAR	Jordan Civil Aviation Regulation.
K	Degree Kelvin.
Kg	Kilogram.
Km	Kilometer.
km/h	Kilometer per hour.
kt	Knot.
L	Liter.
LCFZ	Laser-beam critical flight zone
LDA	Landing distance available.
LFFZ	Laser-beam sensitive free zone
LSFZ	Laser-beam sensitive flight zone
M	Meter.
Max	Maximum.
MLS	Microwave landing system.
Mm	Millimeter.
Mnm	Minimum.

MN	Mega newton.
MPa	Mega Pascal.
MSL	Mean sea level.
NFZ	Normal flight zone.
NM	Nautical mile.
NU	Not usable.
OCA/H	Obstacle clearance altitude/height.
OES	Obstacle evaluation surfaces
OFS	Obstacle free surfaces
OFZ	Obstacle free zone.
OLS	Obstacle limitation surface.
OMGWS	Outer main gear wheel span
PAPI	Precision approach path indicator.
PCR	Pavement classification rating.
RDRS	Runway distance remaining sign
RESA	Runway end safety area.
RFF	Rescue and firefighter.
RVR	Runway visual range.
SBAS	Satellite-based augmentation system
TODA	Take-off distance available.
TORA	Take-off run available.
T-VASIS	T visual approach slope indicator system.
ULD	Unit load device
VMC	Visual meteorological conditions.
VOR	Very high frequency omnidirectional radio range.
V_{at}	Indicated airspeed at threshold
V_{so}	Stalling speed or the minimum steady flight speed in the landing configuration
V_{s1g}	Stalling speed or the minimum steady flight speed in a specified configuration
WHMP	Wildlife hazard management program.
WIP	Work in progress.

(b) Symbols.

°	Degree
=	Equals
'	Minute of arc
μ	Friction coefficient
>	Greater than
<	Less than
%	Percentage
±	Plus or minus

Chapter (1)
General

1.1 Definitions

When the following terms are used in this Publication, they have the following meanings:

Aerodrome: A defined area on land or water (including any buildings, installations and equipment) intended to be used either wholly or in part for the arrival, departure and surface movement of aircraft.

Aerodrome beacon: Aeronautical beacon used to indicate the location of an aerodrome from the air.

Aerodrome certificate: A certificate issued by the appropriate authority under applicable regulations for the operation of an aerodrome.

Aerodrome elevation: The elevation of the highest point of the landing area.

Aerodrome identification sign: A sign placed on an aerodrome to aid in identifying the aerodrome from the air.

Aerodrome mapping data (AMD): Data collected for the purpose of compiling aerodrome mapping information for aeronautical uses.

Note: Aerodrome mapping data are collected for purposes that include the improvement of the user's situational awareness, surface navigation operations, training, charting and planning.

Aerodrome mapping database (AMDB): A collection of aerodrome mapping data organized and arranged as a structured data set.

Aerodrome reference point: The designated geographical location of an aerodrome.

Aerodrome traffic density:

(a) ***Light.*** Where the number of movements in the mean busy hour is not greater than 15 per runway or typically less than 20 total aerodrome movements.

(b) ***Medium.*** Where the number of movements in the mean busy hour is of the order of 16 to 25 per runway or typically between 20 to 35 total aerodrome movements.

(c) ***Heavy.*** Where the number of movements in the mean busy hour is of the order of 26 or more per runway or typically more than 35 total 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.

Note (2): Either a take-off or a landing constitutes a movement.

Aeronautical beacon: An aeronautical ground light visible at all azimuths, either continuously or intermittently, to designate a particular point on the surface of the earth.

Aeronautical ground light: Any light specially provided as an aid to air navigation, other than a light displayed on an aircraft.

Aeroplane reference field length: The minimum field length required for take-off at maximum certificated take-off mass, sea level, standard atmospheric conditions, still air and zero runway slope, as shown in the appropriate aeroplane flight manual prescribed by the certificating authority or equivalent data from the aeroplane manufacturer. Field length means balanced field length for aeroplanes, if applicable, or take-off distance in other cases.

Aircraft classification rating (ACR): A number expressing the relative effect of an aircraft on a pavement for a specified standard subgrade category.

Note: The aircraft classification rating is calculated with respect to the center of gravity (CG) position which yields the critical loading on the critical gear. Normally the aftmost CG position appropriate to the maximum gross apron (ramp) mass is used to calculate the ACR. In exceptional cases the forward most CG position may result in the nose gear loading being more critical.

Aircraft stand: A designated area on an apron intended to be used for parking an aircraft.

Apron: A defined area, on a land aerodrome, intended to accommodate aircraft for purposes of loading or unloading passengers, mail or cargo, fuelling, parking or maintenance.

Apron management service: A service provided to regulate the activities and the movement of aircraft and vehicles on an apron.

Arresting system: A system designed to decelerate an aeroplane overrunning the runway.

Autonomous runway incursion warning system (ARIWS): A system which provides autonomous detection of a potential incursion or of the occupancy of an active runway and a direct warning to a flight crew or a vehicle operator.

Balked landing: A landing manoeuvre that is unexpectedly discontinued at any point below the obstacle clearance altitude/height (OCA/H).

Barrette: Three or more aeronautical ground lights closely spaced in a transverse line so that from a distance they appear as a short bar of light.

Calendar: Discrete temporal reference system that provides the basis for defining temporal position to a resolution of one day (ISO 19108).

Certified aerodrome: An aerodrome whose operator has been granted an aerodrome certificate.

Clearway: A defined rectangular area on the ground or water under the control of the appropriate authority, selected or prepared as a suitable area over which an aeroplane may make a portion of its initial climb to a specified height.

Cyclic Redundancy Check (CRC): A mathematical algorithm applied to the digital expression of data that provides a level of assurance against loss or alteration of data.

Data accuracy: A degree of conformance between the estimated or measured value and the true value.

Data integrity (assurance level): A degree of assurance that an aeronautical data and its value has not been lost or altered since the origination or authorized amendment.

Data quality: A degree or level of confidence that the data provided meet the requirements of the data user in terms of accuracy, resolution and integrity (or equivalent assurance level), traceability, timeliness, completeness and format.

Datum: Any quantity or set of quantities that may serve as a reference or basis for the calculation of other quantities (ISO 19104).

De-icing/anti-icing facility: A facility where frost, ice or snow is removed (de-icing) from the aeroplane to provide clean surfaces, and/or where clean surfaces of the aeroplane receive protection (anti-icing) against the formation of frost or ice and accumulation of snow or slush for a limited period of time.

De-icing/anti-icing pad: An area comprising an inner area for the parking of an aeroplane to receive de-icing/anti-icing treatment and an outer area for the manoeuvring of two or more mobile de-icing/anti-icing equipment.

Declared distances:

(a) ***Take-off run available (TORA).*** The length of runway declared available and suitable for the ground run of an aeroplane taking off.

(b) ***Take-off distance available (TODA).*** The length of the take-off run available plus the length of the clearway, if provided.

(c) ***Accelerate-stop distance available (ASDA).*** The length of the take-off run available plus the length of the stopway, if provided.

(d) ***Landing distance available (LDA)***. The length of runway which is declared available and suitable for the ground run of an aeroplane landing.

Dependent parallel approaches: Simultaneous approaches to parallel or near-parallel instrument runways where radar separation minima between aircraft on adjacent extended runway centre lines are prescribed.

Displaced threshold: A threshold not located at the extremity of a runway.

Effective intensity: The effective intensity of a flashing light is equal to the intensity of a fixed light of the same colour which will produce the same visual range under identical conditions of observation.

Ellipsoid height (Geodetic height): The height related to the reference ellipsoid, measured along the ellipsoidal outer normal through the point in question.

Fixed light: A light having constant luminous intensity when observed from a fixed point.

Foreign object debris (FOD): An inanimate object within the movement area which has no operational or aeronautical function and which has the potential to be a hazard to aircraft operations.

Frangible object: An object of low mass designed to break, distort or yield on impact so as to present the minimum hazard to aircraft.

Geodetic datum: A minimum set of parameters required to define location and orientation of the local reference system with respect to the global reference system/frame.

Geoid: The equipotential surface in the gravity field of the Earth which coincides with the undisturbed mean sea level (MSL) extended continuously through the continents.

Note: The geoid is irregular in shape because of local gravitational disturbances (wind tides, salinity, current, etc.) and the direction of gravity is perpendicular to the geoid at every point.

Geoid undulation: The distance of the geoid above (positive) or below (negative) the mathematical reference ellipsoid.

Note: In respect to the World Geodetic System — 1984 (WGS-84) defined ellipsoid, the difference between the WGS-84 ellipsoidal height and orthometric height represents WGS-84 geoid undulation.

Gregorian calendar: Calendar in general use; first introduced in 1582 to define a year that more closely approximates the tropical year than the Julian calendar.

Note: In the Gregorian calendar, common years have 365 days and leap years 366 days divided into twelve sequential months.

Ground handling: Services necessary for an aircraft's arrival at, and departure from, an airport, other than air traffic services.

Hazard beacon: An aeronautical beacon used to designate a danger to air navigation.

Heliport: An aerodrome or a defined area on a structure intended to be used wholly or in part for the arrival, departure and surface movement of helicopters.

Holding bay: A defined area where aircraft can be held, or bypassed, to facilitate efficient surface movement of aircraft.

Holdover time: The estimated time the anti-icing fluid (treatment) will prevent the formation of ice and frost and the accumulation of snow on the protected (treated) surfaces of an aeroplane.

Hot spot: A location on an aerodrome movement area with a history or potential risk of collision or runway incursion, and where heightened attention by pilots/drivers is necessary.

Human Factors principles: Principles which apply to aeronautical design, certification, training, operations and maintenance and which seek safe interface between the human and other system components by proper consideration to human performance.

Human performance: Human capabilities and limitations which have an impact on the safety and efficiency of aeronautical operations.

Identification beacon: An aeronautical beacon emitting a coded signal by means of which a particular point of reference can be identified.

Independent parallel approaches: Simultaneous approaches to parallel or near-parallel instrument runways where radar separation minima between aircraft on adjacent extended runway centre lines are not prescribed.

Independent parallel departures: Simultaneous departures from parallel or near-parallel instrument runways.

Instrument runway: One of the following types of runways intended for the operation of aircraft using instrument approach procedures:

(a) ***Non-precision approach runway***. A runway served by visual aids and non-visual aid(s) intended for landing operations following an instrument approach operation type A and a visibility not less than 1000 m.

(b) ***Precision approach runway, category I.*** A runway served by visual aids and non-visual aid(s) intended for landing operations following an instrument approach operation type B with a decision height (DH) not lower than 60 m (200 ft) and either a visibility not less than 800 m or a runway visual range not less than 550 m.

(c) ***Precision approach runway, category II.*** A runway served by visual aids and non-visual aid(s) intended for landing operations following an instrument approach operation type B with a decision height (DH) lower than 60 m (200 ft) but not lower than 30 m (100 ft) and a runway visual range not less than 300 m.

(d) ***Precision approach runway, category III***. A runway served by visual aids and non-visual aid(s) intended for landing operations following an instrument approach operation type B with a decision height (DH) lower than 30 m (100 ft), or no decision height and a runway visual range less than 300 m, or no runway visual range limitations.

Note (1): Visual aids need not necessarily be matched to the scale of non-visual aids provided. The criterion for the selection of visual aids is the conditions in which operations are intended to be conducted.

Note (2): Refer to ICAO Annex 6 — Operation of Aircraft for instrument approach operation types.

Integrity classification (aeronautical data): Classification based upon the potential risk resulting from the use of corrupted data. Aeronautical data is classified as:

(a) ***Routine data.*** there is a very low probability when using corrupted routine data that the continued safe flight and landing of an aircraft would be severely at risk with the potential for catastrophe;

(b) ***Essential data.*** there is a low probability when using corrupted essential data that the continued safe flight and landing of an aircraft would be severely at risk with the potential for catastrophe; and

(c) ***Critical data.*** there is a high probability when using corrupted critical data that the continued safe flight and landing of an aircraft would be severely at risk with the potential for catastrophe.

Intermediate holding position: A designated position intended for traffic control at which taxiing aircraft and vehicles shall stop and hold until further cleared to proceed, when so instructed by the aerodrome control tower.

Landing area: That part of a movement area intended for the landing or take-off of aircraft.

Landing direction indicator: A device to indicate visually the direction currently designated for landing and for take-off.

Laser-beam critical flight zone (LCFZ): Airspace in the proximity of an aerodrome but beyond the LFFZ where the irradiance is restricted to a level unlikely to cause glare effects.

Laser-beam free flight zone (LFFZ): Airspace in the immediate proximity of the aerodrome where the irradiance is restricted to a level unlikely to cause any visual disruption.

Laser-beam sensitive flight zone (LSFZ): Airspace outside, and not necessarily contiguous with, the LFFZ and LCFZ where the irradiance is restricted to a level unlikely to cause flash-blindness or after-image effects

Lighting system reliability: The probability that the complete installation operates within the specified tolerances and that the system is operationally usable.

Manoeuvring area: That part of an aerodrome to be used for the take-off, landing and taxiing of aircraft, excluding aprons.

Marker: An object displayed above ground level in order to indicate an obstacle or delineate a boundary.

Marking: A symbol or group of symbols displayed on the surface of the movement area in order to convey aeronautical information.

Movement area: That part of an aerodrome to be used for the take-off, landing and taxiing of aircraft, consisting of the manoeuvring area and the apron(s).

Near-parallel runways: Non-intersecting runways whose extended centre lines have an angle of convergence/divergence of 15 degrees or less.

Non-instrument runway: A runway intended for the operation of aircraft using visual approach procedures or an instrument approach procedure to a point beyond which the approach may continue in visual meteorological conditions.

Note: Visual meteorological conditions (VMC) are described in Chapter 3 of ICAO Annex 2 — Rules of the Air.

Normal flight zone (NFZ): Airspace not defined as LFFZ, LCFZ or LSFZ but which must be protected from laser radiation capable of causing biological damage to the eye.

Obstacle: All fixed (whether temporary or permanent) and mobile objects, or parts thereof, that:

(a) are located on an area intended for the surface movement of aircraft; or

(b) extend above a defined surface intended to protect aircraft in flight**;** or

(c) stand outside those defined surfaces and that have been assessed as being a hazard to air navigation.

Obstacle free zone (OFZ): The airspace above the inner approach surface, inner transitional surfaces, and balked landing surface and that portion of the strip bounded by these surfaces, which is not penetrated by any fixed obstacle other than a low-mass and frangibly mounted one required for air navigation purposes.

Orthometric height: Height of a point related to the geoid, generally presented as an MSL elevation.

Outer main gear wheel span (OMGWS): The distance between the outside edges of the main gear wheels.

Pavement classification rating (PCR): A number expressing the bearing strength of a pavement.

Precision approach runway, see **Instrument runway.**

Primary runway(s): Runway(s) used in preference to others whenever conditions permit.

Protected flight zones: Airspace specifically designated to mitigate the hazardous effects of laser radiation.

Road: An established surface route on the movement area meant for the exclusive use of vehicles.

Road-holding position: A designated position at which vehicles may be required to hold.

Runway: A defined rectangular area on a land aerodrome prepared for the landing and take-off of aircraft.

Runway condition assessment matrix (RCAM): A matrix allowing the assessment of the runway condition code, using associated procedures, from a set of observed runway surface condition(s) and pilot report of braking action.

Runway condition code (RWYCC): A number describing the runway surface condition to be used in the runway condition report.

Note: The purpose of the runway condition code is to permit an operational aeroplane performance calculation by the flight crew. Procedures for the determination of the runway condition code are described in CARC Guidance Material 34-GM-16 PANS-Aerodromes.

Runway condition report (RCR): A comprehensive standardized report relating to runway surface condition(s) and its effect on the aeroplane landing and take-off performance.

Runway end safety area (RESA): An area symmetrical about the extended runway centre line and adjacent to the end of the strip primarily intended to reduce the risk of damage to an aeroplane undershooting or overrunning the runway.

Runway guard lights: A light system intended to caution pilots or vehicle drivers that they are about to enter an active runway.

Runway-holding position: A designated position intended to protect a runway, an obstacle limitation surface, or an ILS/MLS critical/sensitive area at which taxiing aircraft and vehicles shall stop and hold, unless otherwise authorized by the aerodrome control tower.

Note: In radiotelephony phraseologies, the expression "holding point" is used to designate the runway-holding position.

Runway strip: A defined area including the runway and stopway, if provided, intended:

(a) to reduce the risk of damage to aircraft running off a runway; and

(b) to protect aircraft flying over it during take-off or landing operations.

Runway surface condition(s): A description of the condition(s) of the runway surface used in the runway condition report which establishes the basis for the determination of the runway condition code for aeroplane performance purposes.

Note (1): The runway surface conditions used in the runway condition report establish the performance requirements between the aerodrome operator, aeroplane manufacturer and aeroplane operator.

Note (2): Aircraft de-icing chemicals and other contaminants are also reported but are not included in the list of runway surface condition descriptors because their effect on *runway surface friction characteristics and the runway condition code cannot be evaluated in a standardized manner.*

Note (3): Procedures on determining runway surface conditions are available in CARC Guidance Material 34-GM-16 PANS-Aerodromes.

(a) ***Dry runway.*** A runway is considered dry if its surface is free of visible moisture and not contaminated within the area intended to be used.

(b) ***Wet runway.*** The runway surface is covered by any visible dampness or water up to and including 3 mm deep within the intended area of use.

(c) ***Slippery wet runway.*** A wet runway where the surface friction characteristics of a significant portion of the runway have been determined to be degraded.

(d) ***Contaminated runway.*** A runway is contaminated when a significant portion of the runway surface area (whether in isolated areas or not) within the length and width being used is covered by one or more of the substances listed in the runway surface condition descriptors.

Note: Procedures on determination of contaminant coverage on runway are available in CARC Guidance Material 34-GM-16 PANS-Aerodromes.

(e) ***Runway surface condition descriptors.*** One of the following elements on the surface of the runway:

Note: The descriptions for e) i) to viii) are used solely in the context of the runway condition report and are not intended to supersede or replace any existing WMO definitions.

(i) ***Compacted snow.*** Snow that has been compacted into a solid mass such that aeroplane tires, at operating pressures and loadings, will run on the surface without significant further compaction or rutting of the surface.

(ii) ***Dry snow.*** Snow from which a snowball cannot readily be made.

(iii) ***Frost.*** Frost consists of ice crystals formed from airborne moisture on a surface whose temperature is below freezing. Frost differs from ice in that the frost crystals grow independently and therefore have a more granular texture.

Note (1): Below freezing refers to air temperature equal to or less than the freezing point of water (0 degree Celsius).

Note (2): Under certain conditions frost can cause the surface to become very slippery and it is then reported appropriately as reduced braking action.

(iv) ***Ice.*** Water that has frozen or compacted snow that has transitioned into ice, in cold and dry conditions.

(v) ***Slush.*** Snow that is so water-saturated that water will drain from it when a handful is picked up or will splatter if stepped on forcefully.

(vi) ***Standing water.*** Water of depth greater than 3 mm.

Note: Running water of depth greater than 3 mm is reported as standing water by convention.

(vii) ***Wet ice.*** Ice with water on top of it or ice that is melting.

Note: Freezing precipitation can lead to runway conditions associated with wet ice from an aeroplane performance point of view. Wet ice can cause the surface to become very slippery. It is then reported appropriately as reduced braking action in line with procedures in CARC Guidance Material 34-GM-16 PANS-Aerodromes.

(viii) ***Wet snow.*** Snow that contains enough water content to be able to make a well-compacted, solid snowball, but water will not squeeze out.

Runway turn pad: A defined area on a land aerodrome adjacent to a runway for the purpose of completing a 180-degree turn on a runway.

Runway visual range (RVR): The range over which the pilot of an aircraft on the centre line of a runway can see the runway surface markings or the lights delineating the runway or identifying its centre line.

Safety management system (SMS): A systematic approach to managing safety including the necessary organizational structure, accountabilities, policies and procedures.

Segregated parallel operations: Simultaneous operations on parallel or near-parallel instrument runways in which one runway is used exclusively for approaches and the other runway is used exclusively for departures.

Shoulder: An area adjacent to the edge of a pavement so prepared as to provide a transition between the pavement and the adjacent surface.

Sign:

(a) ***Fixed message sign.*** A sign presenting only one message.

(b) ***Variable message sign.*** A sign capable of presenting several predetermined messages or no message, as applicable.

Signal area: An area on an aerodrome used for the display of ground signals.

Station declination: An alignment variation between the zero-degree radial of a VOR and true north, determined at the time the VOR station is calibrated.

Stopway: A defined rectangular area on the ground at the end of take-off run available prepared as a suitable area in which an aircraft can be stopped in the case of an abandoned take-off.

Switch-over time (light): The time required for the actual intensity of a light measured in a given direction to fall from 50 per cent and recover to 50 per cent during a power supply changeover, when the light is being operated at intensities of 25 per cent or above.

Take-off runway: A runway intended for take-off only.

Taxiway: A defined path on a land aerodrome established for the taxiing of aircraft and intended to provide a link between one part of the aerodrome and another, including:

(a) ***Aircraft stand taxilane.*** A portion of an apron designated as a taxiway and intended to provide access to aircraft stands only.

(b) ***Apron taxiway.*** A portion of a taxiway system located on an apron and intended to provide a through taxi-route across the apron.

(c) ***Rapid exit taxiway.*** A taxiway connected to a runway at an acute angle and designed to allow landing aeroplanes to turn off at higher speeds than are achieved on other exit taxiways thereby minimizing runway occupancy times.

Taxiway intersection: A junction of two or more taxiways.

Taxiway strip: An area including a taxiway intended to protect an aircraft operating on the taxiway and to reduce the risk of damage to an aircraft accidentally running off the taxiway.

Threshold: The beginning of that portion of the runway usable for landing.

Touchdown zone: The portion of a runway, beyond the threshold, where it is intended landing aeroplanes first contact the runway.

Usability factor: The percentage of time during which the use of a runway or system of runways is not restricted because of the crosswind component.

Note: Crosswind component means the surface wind component at right angles to the runway centre line.

1.2 Common Reference Systems

1.2.1 Horizontal reference system

World Geodetic System — 1984 (WGS-84) shall be used as the horizontal (geodetic) reference system. Reported aeronautical geographical coordinates (indicating latitude and longitude) shall be expressed in terms of the WGS-84 geodetic reference datum.

1.2.2 Vertical reference system

Mean sea level (MSL) datum, which gives the relationship of gravity-related height (elevation) to a surface known as the geoid, shall be used as the vertical reference system. The geoid globally most closely approximates MSL. It is defined as the equipotential surface in the gravity field of the Earth which coincides with the undisturbed MSL extended continuously through the continents. Gravity-related heights (elevations) are also referred to as orthometric heights while distances of points above the ellipsoid are referred to as ellipsoidal heights.

1.2.3 Temporal reference system
The Gregorian calendar and Coordinated Universal Time (UTC) shall be used as the temporal reference system.

1.3 Certification of Aerodromes

When an aerodrome is granted a certificate, it signifies to aircraft operators and other organizations operating on the aerodrome that, at the time of certification, the aerodrome meets CARC specifications regarding the facility and its operation, and that it has, according to CARC, the capability to maintain these specifications for the period of validity of the certificate. The certification process also establishes the baseline for continued monitoring of compliance with CARC specifications.

1.4 Airport Design and Master Plan

Introductory Note: A master plan for the long-term development of an aerodrome displays the ultimate development in a phased manner and reports the data and logic upon which the plan is based. Master plans are prepared to support modernization of existing aerodromes and creation of new aerodromes, regardless of size, complexity, and role. It is important to note that a master plan does not constitute a confirmed implementation program. It provides information on the types of improvements to be undertaken in a phased manner. Guidance on all aspects of the planning of aerodromes is contained in CARC Guidance Material 34-GM-02 Aerodrome Maintenance Service.

1.4.1A master plan containing detailed plans for the development of aerodrome infrastructure shall be established for aerodromes deemed relevant by CARC.

Note (1): A master plan represents the development plan of a specific aerodrome. It is developed by the aerodrome operator based on economic feasibility, traffic forecasts, current and future requirements provided by, among others, aircraft operators (see 1.4.3).

Note (2): A master plan may be required when the lack of capacity at an airport, due to conditions such as, but not limited to expected traffic growth, changing weather and climatic conditions or major works to address safety or environmental concerns, would put the connectivity of a geographical area at risk or cause severe disruption to the air transport network.

1.4.2 The master plan shall:

(a) contain a schedule of priorities including a phased implementation plan; and

(b) be reviewed periodically to take into account current and future aerodrome traffic.

1.4.3 Aerodrome stakeholders, particularly aircraft operators, shall be consulted in order to facilitate the master planning process using a consultative and collaborative approach.

Note (1): Provision of advanced planning data to facilitate the planning process include future aircraft types, characteristics and numbers of aircraft expected to be used, the anticipated growth of aircraft movements, number of passengers and amount of cargo projected to be handled.

Note (2): See ICAO Annex 9, Chapter 6 on the need for aircraft operators to inform aerodrome operators concerning the former's service, schedule and fleet plans to enable rational planning of facilities and services in relation to the traffic anticipated.

Note (3): See ICAO's Policies on Charges for Airports and Air Navigation Services (ICAO Doc 9082), Section 1, regarding consultation with users concerning provision of advance planning data and protection of commercially sensitive data.

1.4.4 Architectural and infrastructure-related requirements for the optimum implementation of international civil aviation security measures shall be integrated into the design and construction of new facilities and alterations to existing facilities at an aerodrome.

1.4.5 The design of aerodromes shall take into account land-use and environmental control measures and shall develop an Environmental Management System.

Note: Guidance on land-use planning and environmental control measures is contained in CARC Guidance Material 34-GM-06 Land Use and Environmental Management.

1.5 Aerodrome Reference Code

The intent of the reference code is to provide a simple method for interrelating the numerous specifications concerning the characteristics of aerodromes so as to provide a series of aerodrome facilities that are suitable for the airplanes that are intended to operate at the aerodrome. The code is not intended to be used for determining runway length or pavement strength requirements. The code is composed of two elements which are related to the airplane performance characteristics and dimensions. Element 1 is a number based on the airplane reference field length and element 2 is a letter based on the airplane wing span. The code letter or number within an element selected for design purposes is related to the critical airplane characteristics for which the facility is provided. When applying this part, first identify the airplanes which the aerodrome is intended to serve and then determine the two elements of the code.

1.5.1 An aerodrome reference code — code number and letter — which is selected for aerodrome planning purposes shall be determined in accordance with the characteristics of the airplane for which an aerodrome facility is intended.

1.5.2 The aerodrome reference code numbers and letters shall have the meanings assigned to them in Table 1-1.

1.5.3 The code number for element 1 shall be determined from Table 1-1, column 1, selecting the code number corresponding to the highest value of the airplane reference field lengths of the airplanes for which the runway is intended.

Note (1): The determination of the aeroplane reference field length is solely for the selection of a code number and is not intended to influence the actual runway length provided.

Note (2): Guidance on determining the runway length is given in CARC Guidance Material 34-GM-11 Runway Design.

1.5.4 The code letter for element 2 shall be determined from Table 1-1, by selecting the code letter which corresponds to the greatest wing span of the airplanes for which the facility is intended.

Note: Guidance on determining the aerodrome reference code is given in CARC Guidance Material 34-GM-11 Runway Design.

Table 1-1. Aerodrome reference code (see 1.4.2 to 1.4.4)

	Code element 1
Code Number	**Airplane reference field length**
1	Less than 800 m
2	800 m up to but not including 1 200 m
3	1 200 m up to but not including 1 800 m
4	1 800 m and over

Code element 2	
Code Letter	**Wing Span**
A	Up to but not including 15 m
B	15 m up to but not including 24 m
C	24 m up to but not including 36 m
D	36 m up to but not including 52 m
E	52 m up to but not including 65 m
F	65 m up to but not including 80 m

Note (1): Guidance on planning for airplanes with wing spans greater than 80 m is given in CARC Guidance Material 34-GM-11 Runway Design.

Note (2): Procedures on conducting aerodrome compatibility study to accommodate aeroplanes with folding wing tips spanning two code letters are given in CARC Guidance Material 34-GM-16 PANS-Aerodromes. Further guidance can be found in the manufacturer's aircraft characteristics for airport planning manual.

1.6 Specific Procedures for Aerodrome Operations

Introductory Note: This section introduces CARC Guidance Material 34-GM-16 PANS-Aerodromes for use by an aerodrome undertaking an assessment of its compatibility with the type of traffic or operation it is intending to accommodate. The material in the PANS Aerodromes addresses operational issues faced by existing aerodromes and provides the necessary procedures to ensure the continued safety of operations. Where alternative measures, operational procedures and operating restrictions have been developed, these are detailed in the aerodrome manual and reviewed periodically to assess their continued validity. The PANS-Aerodromes does not substitute nor circumvent the provisions contained in JCAR Part 139. It is expected that infrastructure on an existing aerodrome or a new aerodrome will fully comply with the requirements in JCAR Part 139.

1.6.1 When the aerodrome accommodates an aeroplane that exceeds the certificated characteristics of the aerodrome, the compatibility between the operation of the aeroplane and aerodrome infrastructure and operations shall be assessed and appropriate measures developed and implemented in order to maintain an acceptable level of safety during operations.

Note: Procedures to assess the compatibility of the operation of a new aeroplane with an existing aerodrome can be found in the CARC Guidance Material 34-GM-16 PANS-Aerodromes.

1.6.2 Information concerning alternative measures, operational procedures and operating restrictions implemented at an aerodrome arising from 5.1 shall be promulgated.

Note: See CARC Guidance Material 34-GM-16 PANS-Aerodromes, Chapter 3, section 3.6, on promulgation of safety information.

1.7 Aeroplane Design Group

(Applicable as of 21 November 2030)

Note: The intent of the Aeroplane Design Group (ADG) is to provide a method for interrelating the specifications for the management of obstacles around aerodromes. The ADG utilizes two criteria related to the aeroplane performance characteristics and dimensions. The first criterion is based on the indicated airspeed of the aircraft at *threshold and the second criterion on the aeroplane wingspan.* (See Chapter 4 on the application of ADG for the provisions of obstacle restriction and removal.)

1.7.1 An ADG shall be determined for each runway in accordance with the characteristics of the critical aeroplane for which the runway is intended.

1.7.2 The ADG shall be determined from Table 1-2, by selecting the ADG corresponding to the highest values of indicated airspeed at threshold and wingspan of the aeroplanes for which the runway is intended.

Note: Indicated airspeed at threshold (Vat) is equal to the stall speed Vso multiplied by 1.3, or stall speed Vs1g multiplied by 1.23 in the landing configuration at the maximum certificated landing mass. If both Vso and Vs1g are available, the higher resulting Vat applies.

Table 1-2. Aeroplane Design Group (see 1.8.2)
(Applicable as of 21 November 2030)

Aeroplane Design Group	**Indicated airspeed at threshold**		**Wingspan**
I	Less than 169 km/h (91 kt)	and	Up to but not including 24 m
IIA	Less than 169 km/h (91 kt)	and	24 m up to but not including 36 m
IIB	169 km/h (91 kt) up to but not including 224 km/h (121 kt)	and	Up to but not including 36 m
IIC	224 km/h (121 kt) up to but not including 307 km/h (166 kt)	and	Up to but not including 36 m
III	Less than 307 km/h (166 kt)	and	36 m up to but not including 52 m
IV	Less than 307 km/h (166 kt)	and	52 m up to but not including 65 m
V	Less than 307 km/h (166 kt)	and	65 m up to but not including 80 m

Note (1): Detailed specifications concerning the application of the aeroplane design group are given in the CARC Guidance Material 34-GM-04 Control of Obstacles.

Note (2): The following examples illustrate how the ADG is determined.

Example (1) If the critical aeroplane that the runway is intended to serve has an indicated airspeed at threshold of 161 km/h (87 kt) and a wingspan of 20 m, then the aeroplane design group would be I.

Example (2) If the critical aeroplane that the runway is intended to serve has an indicated airspeed at threshold of 224 km/h (121 kt) and a wingspan of 52 m, then the aeroplane design group would be IV.

Chapter (2)
Aerodrome Data

2.1 Aeronautical Data

2.1.1 Determination and reporting of aerodrome related aeronautical data shall be in accordance with the accuracy and integrity classification required to meet the needs of the end-users of aeronautical data.

2.1.2 Aerodrome mapping data shall be made available to the aeronautical information services for aerodromes deemed relevant by CARC where safety and/or performance-based operations suggest possible benefits.

2.1.3 Where made available in accordance with 2.1.2, the selection of the aerodrome mapping data features to be collected shall be made with consideration of the intended applications.

Note (1): It is intended that the selection of the features to be collected match a defined operational need.

Note (2): Aerodrome mapping databases can be provided at one of two levels of quality - fine or medium.

2.1.4 Digital data error detection techniques shall be used during the transmission and/or storage of aeronautical data and digital data sets.

2.2 Aerodrome Reference Point

2.2.1 An aerodrome reference point shall be established for an aerodrome.

2.2.2 The aerodrome reference point shall be located near the initial or planned geometric center of the aerodrome and shall normally remain where first established.

2.2.3 The position of the aerodrome reference point shall be measured and reported to the concerned party responsible for aeronautical information services in degrees, minutes and seconds.

2.3 Aerodrome and Runway Elevations

2.3.1 The aerodrome elevation and geoid undulation at the aerodrome elevation position shall be measured to the accuracy of one-half meter or foot and reported to the concerned party responsible for aeronautical information services.

2.3.2 For an aerodrome used by international civil aviation for non-precision approaches, the elevation and geoid undulation of each threshold, the elevation of the runway end and any significant high and low intermediate points along the runway shall be measured to the accuracy of one-half meter or foot and reported to the Aeronautical Information Services.

2.3.3 For precision approach runway, the elevation and geoid undulation of the threshold, the elevation of the runway end and the highest elevation of the touchdown zone shall be measured to the accuracy of one-quarter meter or foot and reported to the Aeronautical Information Services.

Note: Geoid undulation must be measured in accordance with the appropriate system of coordinates.

2.4 Aerodrome Reference Temperature

2.4.1 An aerodrome reference temperature shall be determined for an aerodrome in degrees Celsius.

2.4.2 The aerodrome reference temperature shall be the monthly mean of the daily maximum temperatures for the hottest month of the year (the hottest month being that which has the highest monthly mean temperature). This temperature shall be averaged over a period of ten years.

2.5 Aerodrome Dimensions and Related Information

2.5.1 The following data shall be measured or described, as appropriate, for each facility provided on an aerodrome:

(a) runway — true bearing to one-hundredth of a degree, designation number, length, width, displaced threshold location to the nearest meter or foot, slope, surface type, type of runway and, for a precision approach runway category I, the existence of an obstacle free zone when provided;

– strip – runway end safety area – stopway	}	length, width to the nearest meter or foot, surface type; and

(b) arresting system — location (which runway end) and description;

(c) taxiway — designation, width, surface type;

(d) apron — surface type, aircraft stands;

(e) the boundaries of the air traffic control service;

(f) clearway — length to the nearest meter or foot, ground profile;

(g) visual aids for approach procedures, marking and lighting of runways, taxiways and aprons, other visual guidance and control aids on taxiways and aprons, including taxi-holding positions and stopbars, and location and type of visual docking guidance systems;

(h) location and radio frequency of any VOR aerodrome check-point;

(i) location and designation of standard taxi-routes; and

(j) distances to the nearest meter or foot of localizer and glide path elements comprising an instrument landing system (ILS) or azimuth and elevation antenna of microwave landing system (MLS) in relation to the associated runway extremities.

2.5.2 The geographical coordinates of each threshold shall be measured and reported to the Aeronautical Information Services in degrees, minutes, seconds and hundredths of seconds.

2.5.3 The geographical coordinates of appropriate taxiway center line points shall be measured and reported to the aeronautical information services authority in degrees, minutes, seconds and hundredths of seconds.

2.5.4 The geographical coordinates of each aircraft stand shall be measured and reported to the concerned party responsible for aeronautical information services in degrees, minutes, seconds and hundredths of seconds.

2.5.5 The geographical coordinates of obstacles in Area 2 (the part within the aerodrome boundary) and in Area 3 shall be measured and reported to the concerned party responsible for aeronautical information services in degrees, minutes, seconds and tenths of seconds. In addition, the top elevation, type, marking and lighting (if any) of obstacles shall be reported to the concerned party responsible for aeronautical information services.

Note (1): Appendix 5 of this Part provides requirements for obstacle data determination in Areas 2 and 3.

Note (2): ICAO PANS-AIM (Doc 10066), Appendix 8 provides requirements for obstacle data determination in Areas 2 and 3.

2.6 Strength of Pavements

2.6.1 The bearing strength of a pavement shall be determined.

2.6.2 The bearing strength of a pavement intended for aircraft of apron (ramp) mass greater than 5 700 kg shall be made available using the aircraft classification rating - pavement classification rating (ACR-PCR) method by reporting all of the following information:

(a) the pavement classification rating (PCR) and numerical value;

(b) pavement type for (ACR-PCR) determination;

(c) subgrade strength category;

(d) maximum allowable tire pressure category or maximum allowable tire pressure value; and

(e) evaluation method.

Note: Guidance on reporting and publishing of PCRs is contained in the CARC Guidance Material 34-GM-09 Pavement Design.

2.6.3 The pavement classification rating (PCR) reported shall indicate that an aircraft with an aircraft classification rating(ACR) equal to or less than the reported (PCR) can operate on the pavement subject to any limitation on the tire pressure, or aircraft all-up mass for specified aircraft type(s).

Note: Different PCRs may be reported if the strength of the pavement is subject to significant seasonal variation.

2.6.4 The ACR of an aircraft shall be determined in accordance with the standard procedures associated with the ACR-PCR method.

Note: The standard procedures for determining the ACR of an aircraft are given in CARC Guidance Material 34-GM-09 Pavement Design. For convenience several aircraft types currently in use have been evaluated on rigid and flexible pavements founded on the four subgrade categories in 6.6 b) below and the results tabulated in that manual.

2.6.5 For the purposes of determining the ACR, the behavior of a pavement shall be classified as equivalent to a rigid or flexible construction.

2.6.6 Information on pavement type for ACR-PCR determination, subgrade strength category, maximum allowable tire pressure category and evaluation method shall be reported using the following codes:

(a) Pavement type for ACR-PCR determination:

	Code
Rigid pavement	R
Flexible pavement	F

Note: If the actual construction is composite or nonstandard, include a note to that effect (see example 2 below).

(b) Subgrade strength category:

	Code
High strength: characterized by E=200 MPa, and representing all E values equal to or above 150 MPa for rigid and flexible pavements.	A

Medium strength: characterized by E=120 MPa and representing a range in E values equal to or above 100 MPa and strictly less than 150 MPa, for rigid and flexible pavements.	B
Low strength: characterized by E=80 MPa and representing a range in E values equal to or above 60 MPa and strictly less than 100 MPa, for rigid and flexible pavements.	C
Ultra-low strength: characterized by E=50 MPa and representing all E values strictly less than 60 MPa, for rigid and flexible pavements.	D

(c) Maximum allowable tire pressure category:

	Code
Unlimited : no pressure limit	W
High: pressure limited to 1.75 MPa	X
Medium: pressure limited to 1.25 MPa	Y
Low: pressure limited to 0.50 MPa	Z

Note: See Note 5 to Chapter 10, Section 10.2.1 where the pavement is used by aircraft with tire pressures in the upper categories.

(d) Evaluation method:

	Code
Technical evaluation: representing a specific study of the pavement characteristics and the types of aircraft which the pavement is intended to serve.	T
Using aircraft experience: representing a knowledge of the specific type and mass of aircraft satisfactorily being supported under regular use.	U

Note: The following examples illustrate how pavement strength data are reported under the ACR-PCR method. Further guidance on this topic is contained in the CARC Guidance Material 34-GM-09 Pavement Design.

Example 1 — If the bearing strength of a rigid pavement, resting on a medium strength subgrade, has been assessed by technical evaluation to be PCR 760 and there is no tire pressure limitation, then the reported information would be:

PCR 760 / R / B / W / T

Example 2 — If the bearing strength of a composite pavement, behaving like a flexible pavement and resting on a high strength subgrade, has been assessed by using aircraft experience to be PCR 550 and the maximum tire pressure allowable is 1.25 MPa, then the reported information would be:

PCR 550 / F / A / Y / U

Note: Composite construction.

2.6.7 Criteria to regulate the use of a pavement by an aircraft with an ACR higher than the PCR reported for that pavement in accordance with 6.2 and 6.3 is established in *CARC Guidance Material to Part 14 No. 34 GM-01.*

Note: CARC Guidance Material to Part 14 No. 34 GM-01, which details a simple method for regulating overload operations while CARC Guidance Material 34-GM-09 Pavement Design, includes the descriptions of more detailed procedures for evaluation of pavements and their suitability for restricted overload operations.

2.6.8 The bearing strength of a pavement intended for aircraft of apron (ramp) mass equal to or less than 5 700 kg shall be made available by reporting the following information:

(a) maximum allowable aircraft mass; and

(b) maximum allowable tire pressure.

Example: 4800kg/0.60 MPa.

2.7 Pre-Flight Altimeter Check Location

2.7.1 One or more pre-flight altimeter check locations shall be established for an aerodrome.

2.7.2 A pre-flight check location shall be located on an apron.

Note (1): Locating a pre-flight altimeter check location on an apron enables an altimeter check to be made prior to obtaining taxi clearance and eliminates the need for stopping for that purpose after leaving the apron.

Note (2): Normally an entire apron can serve as a satisfactory altimeter check location.

2.7.3 The elevation of a pre-flight altimeter check location shall be given as the average elevation, rounded to the nearest meter or foot, of the area on which it is located. The elevation of any portion of a pre-flight altimeter check location shall be within 3 m (10 ft) of the average elevation for that location.

2.8 Declared Distances

The following distances shall be calculated to the nearest meter or foot for a runway intended for use by international and/or domestic commercial air transport:

(a) take-off run available;

(b) take-off distance available;

(c) accelerate-stop distance available; and

(d) landing distance available.

Note: Guidance on calculation of declared distances is given in CARC Guidance Material to Part 14 No. 34 GM-01.

2.9 Condition of the Movement Area and Related Facilities

2.9.1 Information on the condition of the movement area and the operational status of related facilities shall be provided to the appropriate aeronautical information service units, and similar information of operational significance to the air traffic services units, to enable those units to provide the necessary information to arriving and departing aircraft. The information shall be kept up to date and changes in conditions shall be reported without delay.

Note: The nature, format and conditions of the information to be provided are specified in ICAO Annex 15, the ICAO PANS-AIM (Doc 10066) and the ICAO PANS-ATM (Doc 4444). Specific procedures pertaining to works in progress on the movement area and to the reporting of such works are specified in CARC Guidance Material 34-GM-16 PANS-Aerodromes.

2.9.2 The condition of the movement area and the operational status of related facilities shall accordingly be monitored and reports on matters of operational significance affecting aircraft and aerodrome operations shall be provided in order to take appropriate action, particularly in respect of the following:

(a) construction or maintenance work;

(b) rough or broken surfaces on a runway, a taxiway or an apron;

(c) water, snow, slush, ice, or frost on a runway, a taxiway or an apron.

(d) snow banks or drifts adjacent to a runway, a taxiway or an apron;

(e) anti-icing or de-icing liquid chemicals or other contaminants on a runway, taxiway or apron;

(f) other temporary hazards, including parked aircraft;

(g) failure or irregular operation of part or all of the aerodrome visual aids; and

(h) failure of the normal or secondary power supply.

Note (1): other contaminants may include mud, dust, sand, volcanic ash, oil and rubber. Procedures for monitoring and reporting the conditions of the movement area are included in CARC Guidance Material 34-GM-16 PANS-Aerodromes.

Note (2): the ICAO Aeroplane Performance Manual (Doc 10064) provides guidance on aircraft performance calculation requirements regarding the description of runway surface conditions in 2.9.2 c), e) and f).

Note (3): origin and evolution of data, assessment process and the procedures are prescribed in the CARC Guidance Material 34-GM-16 PANS-Aerodromes. These procedures are intended to fulfil the requirements to achieve the desired level of safety for aeroplane operations prescribed by ICAO Annex 6 and Annex 8 and to provide the information fulfilling the syntax requirements for dissemination specified in ICAO Annex 15 and the ICAO PANS-ATM (Doc 4444).

Note (4): Guidance on carrying out daily inspections of the movement area is given in CARC Guidance Materials 34-GM-03 Aerodrome Operational Services and 34-GM-21 Surface Movement Guidance and Control System (SMGCS).

2.9.3 To facilitate compliance with 2.9.1 and 2.9.2, the following inspections shall be carried out each day:

(a) for the movement area, at least once where the aerodrome reference code number is 1 or 2 and at least twice where the aerodrome reference code number is 3 or 4; and

(b) for the runway(s), inspections in addition to a) whenever the runway surface conditions may have changed significantly due to meteorological conditions.

Note (1): Procedures on carrying out daily inspections of the movement area are given in the CARC Guidance Material 34-GM-16 PANS-Aerodromes. Further guidance is available in the Guidance Material 34-GM-21 Surface Movement Guidance and Control System (SMGCS).) and in the ICAO Advanced Surface Movement Guidance and Control Systems (A-SMGCS) Manual (Doc 9830).

Note (2): CARC Guidance Material 34-GM-16 PANS-Aerodromes contains clarifications on the scope of a significant change in the runway surface conditions.

2.9.4 Personnel assessing and reporting runway surface conditions required in 2.9.2 and 2.9.5 shall be trained and competent to perform their duties.

Note (1): Guidance on training of personnel is given in CARC Guidance Material to Part 14 No. 34 GM-01

Note (2): Information on training for personnel assessing and reporting runway surface conditions is available in CARC Guidance Material 34-GM-16 PANS-Aerodromes.

Runway surface condition(s) for use in the runway condition report

Introductory Note: The philosophy of the runway condition report is that the aerodrome operator assesses the runway surface conditions whenever water, snow, slush, ice or frost are present on an operational runway. From this assessment, a runway condition code (RWYCC) and a description of the runway surface are reported which can be used by the flight crew for aeroplane performance calculations. This report, based on the type, depth and coverage of contaminants, is the best assessment of the runway surface condition by the aerodrome operator; however, all other pertinent information may be taken into consideration. See CARC Guidance Material to Part 14 No. 34 GM-01, for further details. The PANS-Aerodromes contains procedures on the use of the runway condition report and assignment of the RWYCC in accordance with the runway condition assessment matrix (RCAM).

2.9.5 The runway surface condition shall be assessed and reported through a runway condition code (RWYCC) and a description using the following terms:

- COMPACTED SNOW
- DRY
- DRY SNOW
- DRY SNOW ON TOP OF COMPACTED SNOW
- DRY SNOW ON TOP OF ICE
- FROST
- ICE
- SLUSH
- STANDING WATER
- WATER ON TOP OF COMPACTED SNOW
- WET
- WET ICE
- WET SNOW
- WET SNOW ON TOP OF COMPACTED SNOW
- WET SNOW ON TOP OF ICE
- CHEMICALLY TREATED
- LOOSE SAND

Note (1): The runway surface conditions are those conditions for which, by means of the methods described in the PANS-Aerodromes, the flight crew can derive appropriate aeroplane performance.

Note (2): The conditions, either singly or in combination with other observations, are criteria for which the effect on aeroplane performance is sufficiently deterministic to allow assignment of a specific runway condition code.

Note (3): The terms CHEMICALLY TREATED and LOOSE SAND do not appear in the aeroplane performance section but are used in the situational awareness section of the runway condition report.

2.9.6 Whenever an operational runway is contaminated, an assessment of the contaminant depth and coverage over each third of the runway shall be made and reported.

Note: Procedures on depth and coverage reporting are found in the PANS-Aerodromes.

2.9.7 When friction measurements are used as part of the overall runway surface assessment on compacted snow- or ice-covered surfaces, the friction measuring device shall meet the standard set or agreed by CARC.

2.9.8 Recommendation — Friction measurements made on runway surface conditions with contaminants other than compacted snow and ice should not be reported.

Note: Friction measurements on loose contaminants such as snow and slush, in particular, are unreliable due to drag effects on the measurement wheel.

2.9.9 Information that a runway or portion thereof is slippery wet shall be made available.

Note (1): The surface friction characteristics of a runway or a portion thereof can be degraded due to rubber deposits, surface polishing, poor drainage or other factors. The determination that a runway or portion thereof is slippery wet stems from various methods used solely or in combination. These methods may be functional friction measurements, using a continuous friction measuring device, that fall below a minimum standard as defined by CARC, observations by aerodrome maintenance personnel, repeated reports by pilots and aircraft operators based on flight crew experience, or through analysis of aeroplane stopping performance that indicates a substandard surface. Supplementary tools to undertake this assessment are described in the PANS-Aerodromes.

Note (2): See 2.9.1 and 2.13 concerning the provision of information to, and coordination between, appropriate authorities.

2.9.10 Notification shall be given to relevant aerodrome users when the friction level of a paved runway or portion thereof is less than the minimum friction level specified in table 10-1in accordance with 10.2.3.

Note (1): Guidance on determining and expressing the minimum friction level is provided in Assessment, Measurement and Reporting of Runway Surface Conditions (Cir 329).

Note (2): Procedures on conducting a runway surface friction characteristics evaluation program are provided in the PANS-Aerodromes.

Note (3): Information to be promulgated in a NOTAM includes specifying which portion of the runway is below the minimum friction level and its location on the runway.

2.10 Disabled Aircraft Removal

Note: Refer to Chapter 9 paragraph 9.3 for information on disabled aircraft removal services.

2.10.1 The telephone/telex number(s) of the office of the aerodrome coordinator of operations for the removal of an aircraft disabled on or adjacent to the movement area shall be made available, on request, to aircraft operators.

2.10.2 Information concerning the capability to remove an aircraft disabled on or adjacent to the movement area shall be made available.

Note: The capability to remove a disabled aircraft may be expressed in terms of the largest type of aircraft which the aerodrome is equipped to remove.

2.11 Rescue and Fire Fighting

Note: Refer to Chapter 9 paragraph 9.2 for information on rescue and firefighting services.

2.11.1 Information concerning the level of protection provided at an aerodrome for aircraft rescue and firefighting purposes shall be made available.

2.11.2 The level of protection normally available at an aerodrome shall be expressed in terms of the category of the rescue and firefighting services as described in Chapter 9 paragraph 9.2 and in accordance with the types and amounts of extinguishing agents normally available at the aerodrome.

2.11.3 Changes in the level of protection normally available at an aerodrome for rescue and firefighting shall be notified to the CEO and the appropriate air traffic services units and aeronautical information units to enable those units to provide the necessary information to arriving and departing aircraft. When such a change has been corrected, the above units shall be advised accordingly.

Note: Changes in the level of protection from that normally available at the aerodrome could result from a change in the availability of extinguishing agents, equipment to deliver the agents or personnel to operate the equipment, etc.

2.11.4 A change shall be expressed in terms of the new category of the rescue and firefighting service available at the aerodrome.

2.12 Visual Approach Slope Indicator Systems

The following information concerning a visual approach slope indicator system installation shall be made available:

(a) associated runway designation number;

(b) type of system according to chapter 5 paragraph 5.3.5.2. For an AT-VASIS, PAPI or APAPI installation, the side of the runway on which the lights are installed, i.e. left or right, shall be given;

(c) where the axis of the system is not parallel to the runway center line, the angle of displacement and the direction of displacement, i.e. left or right shall be indicated;

(d) nominal approach slope angle(s). For a T-VASIS or an AT-VASIS this shall be angle θ according to the formula in Figure 5-17 and for a PAPI and an APAPI this shall be angle (B + C) ÷ 2 and (A + B) ÷ 2, respectively as in Figure 5-19; and

(e) minimum eye height(s) over the threshold of the on-slope signal(s). For a T-VASIS or an AT-VASIS this shall be the lowest height at which only the wing bar(s) are visible; however, the additional heights at which the wing bar(s) plus one, two or three fly down light units come into view may also be reported if such information would be of benefit to aircraft using the approach. For a PAPI this shall be the setting angle of the third unit from the runway minus 2^o, i.e. angle B minus 2^o, and for an APAPI this shall be the setting angle of the unit farther from the runway minus 2^o, i.e. angle A minus 2^o.

2.13 Coordination between Aeronautical Information Services and Aerodrome Authorities and/or Aerodrome Operator

2.13.1 To ensure that aeronautical information services units obtain information to enable them to provide up-to-date pre-flight information and to meet the need for in-flight information, arrangements shall be made between aeronautical information services and aerodrome authorities and/or aerodrome operators responsible for aerodrome services to report to the responsible aeronautical information services unit, with a minimum of delay:

(a) information on the status of certification of aerodromes and aerodrome conditions (ref. 2.3, 2.9, 2.10, 2.11 and 2.12);

(b) the operational status of associated facilities, services and navigation aids within their area of responsibility;

(c) any other information considered to be of operational significance.

2.13.2 Before introducing changes to the air navigation system, due account shall be taken by the services responsible for such changes of the time needed by the aeronautical information service for the preparation, production and issue of relevant material for promulgation. To ensure timely provision of the information to the aeronautical information service, close coordination between those services concerned is therefore required.

2.13.3 Of a particular importance are changes to aeronautical information that affect charts and/or computer based navigation systems which qualify to be notified by the ICAO aeronautical information regulation and control (AIRAC) system, as specified in ICAO Annex 15, Chapter 6. The predetermined, internationally agreed AIRAC effective dates shall be observed by the responsible aerodrome services when submitting the raw information/data to aeronautical information services.

2.13.4 The aerodrome services responsible for the provision of raw aeronautical information/data to the aeronautical information services shall do that while taking into account accuracy and integrity requirements required to meet the needs of the end-user of aeronautical data.

2.13.5 The aerodrome operator shall report the information contained in this chapter to the AIS.

Note (1): AIRAC information is distributed by the AIS at least 42 days in advance of the AIRAC effective dates with the objective of reaching recipients at least 28 days in advance of the effective date.

Note (2): The schedule of the predetermined internationally agreed AIRAC common effective dates at intervals of 28 days, including 6 November 1997.

Chapter (3)
Physical Characteristics

3.1 Runways

Number and orientation of runways

Note: Many factors affect the determination of the orientation, siting and number of runways.

One important factor is the usability factor, as determined by the wind distribution, which is specified hereunder. Another important factor is the alignment of the runway to facilitate the provision of approaches conforming to the approach surface specifications of Chapter 4. In CARC Guidance Material to Part 14 No. 34 GM-01, information is given concerning these and other factors.

When a new instrument runway is being located, particular attention needs to be given to areas over which airplanes will be required to fly when following instrument approach and missed approach procedures, so as to ensure that obstacles in these areas or other factors will not restrict the operation of the airplanes for which the runway is intended.

3.1.1 The number and orientation of runways at an aerodrome shall be such that the usability factor of the aerodrome is not less than 95 per cent for the airplanes that the aerodrome is intended to serve.

3.1.2 The siting and orientation of runways at an aerodrome shall be such that the arrival and departure tracks minimize interference with areas approved for residential use and other noise sensitive areas close to the aerodrome in order to avoid future noise problems.

Note: Guidance on how to address noise problems is provided in CARC Guidance Materials 34-GM-06 Land Use and Environmental Control, and ICAO Guidance on the Balanced Approach to Aircraft Noise Management (Doc 9829).

3.1.3 Choice of maximum permissible cross-wind components
In the application of Chapter 3 paragraph 3.1.1 it shall be assumed that landing or take-off of airplanes is, in normal circumstances, precluded when the cross-wind component exceeds:

— **37 km/h (20 kt)** in the case of airplanes whose reference field length is 1 500 m or over, except that when poor runway braking action owing to an insufficient longitudinal coefficient of friction is experienced with some frequency, a cross-wind component not exceeding 24 km/h (13 kt) shall be assumed;

— **24 km/h (13 kt)** in the case of airplanes whose reference field length is1200 m or up to but not including 1 500 m; and

— **19 km/h (10 kt**) in the case of airplanes whose reference field length less than 1 200 m.

Note: In CARC Guidance Material to Part 14 No. 34 GM-01, guidance is given on factors affecting the calculation of the estimate of the usability factor and allowances which may have to be made to take account of the effect of unusual circumstances.

3.1.4 Data to be used.

The selection of data to be used for the calculation of the usability factor shall be based on reliable wind distribution statistics that extend over as long a period as possible, preferably of not less than ten years. The observations used shall be made at least eight times daily and spaced at equal intervals of time.

Note: These winds are mean winds. Reference to the need for some allowance for gusty conditions is made in CARC Guidance Material to Part 14 No. 34 GM-01.

Location of threshold

3.1.5 A threshold shall normally be located at the extremity of a runway unless operational considerations justify the choice of another location.

Note: Guidance on the sitting of the threshold is given in CARC Guidance Material to Part 14 No. 34 GM-01.

3.1.6 When it is necessary to displace a threshold, either permanently or temporarily, from its normal location, account shall be taken of the various factors which may have a bearing on the location of the threshold. Where this displacement is due to an unserviceable runway condition, a cleared and graded area of at least 60 m in length shall be available between the unserviceable area and the displaced threshold. Additional distance shall also be provided to meet the requirements of the runway end safety area as appropriate.

Note: Guidance on factors which may be considered in the determination of the location of a displaced threshold is given in CARC Guidance Material to Part 14 No. 34 GM-01.

Actual length of runways

3.1.7 Primary runway.

Except as provided in Chapter 3 paragraph 3.1.9, the actual runway length to be provided for a primary runway shall be adequate to meet the operational requirements of the airplanes for which the runway is intended and shall be not less than the longest length determined by applying the corrections for local conditions to the operations and performance characteristics of the relevant airplanes.

Note (1): This specification does not necessarily mean providing for operations by the critical airplane at its maximum mass.

Note (2): Both take-off and landing requirements need to be considered when determining the length of runway to be provided and the need for operations to be conducted in both directions of the runway.

Note (3): Local conditions that may need to be considered include elevation, temperature, runway slope, humidity and the runway surface characteristics.

Note (4): When performance data on airplanes for which the runway is intended are not known, guidance on the determination of the actual length of a primary runway by application of general correction factors is given in CARC Guidance Material 34-GM-11 Runway Design.

3.1.8 Secondary runway.

The length of a secondary runway shall be determined similarly to primary runways except that it needs only to be adequate for those airplanes which require to use that secondary runway in addition to the other runway or runways in order to obtain a usability factor of at least 95 per cent.

3.1.9 Runways with stopways or clearways.

Where a runway is associated with a stopway or clearway, an actual runway length less than that resulting from application of Chapter 3 paragraph 3.1.7 or 3.1.8, as appropriate, may be considered satisfactory, but in such a case any combination of runway, stopway and clearway provided shall permit compliance with the operational requirements for take-off and landing of the airplanes the runway is intended to serve.

Note: Guidance on use of stopways and clearways is given in CARC Guidance Material to Part 14 No. 34 GM-01.

Width of runways

3.1.10 The width of a runway shall be not less than the appropriate dimension specified in the following tabulation:

Note (1): The combinations of code numbers and OMGWS *for which widths are specified have been developed for typical airplane characteristics.*

Note (2): Factors affecting runway width are given in CARC Guidance Material 34-GM-11 Runway Design.

Note (3): See 3.2 concerning the provision of runway shoulders, in particular for Code F aeroplanes with four (or more) engines.

Outer Main Gear Wheel Span (OMGWS)

Code number	Up to but not including 4.5 m	4.5 m up to but not including 6 m	6 m up to but not including 9 m	9 m up to but not including 15 m
1[a]	18 m	18 m	23 m	-
2[a]	23 m	23 m	30 m	-
3	30 m	30 m	30 m	45 m
4	-	-	45 m	45

(a). The width of a precision approach runway shall be not less than 30 m where the code number is 1 or 2.

Minimum distance between parallel runways

3.1.11 Where parallel non-instrument runways are intended for simultaneous use, the minimum distance between their center lines shall be:

— 210 m where the higher code number is 3 or 4;

— 150 m where the higher code number is 2; and

— 120 m where the code number is 1.

3.1.12 Where parallel instrument runways are intended for simultaneous, the minimum distance between their center lines shall be:

— 1 035 m for independent parallel approaches;

— 915 m for dependent parallel approaches;

— 760 m for independent parallel departures;

— 760 m for segregated parallel operations;

except that:

(a) for segregated parallel operations the specified minimum distance:

(1) may be decreased by 30 m for each 150 m that the arrival runway is staggered toward the arriving aircraft, to a minimum of 300 m; and

(2) shall be increased by 30 m for each 150 m that the arrival runway is staggered away from the arriving aircraft;

(b) for independent parallel approaches, combinations of minimum distances and associated conditions other than those specified in the ICAO PANS-ATM (Doc 4444) may be applied when it is determined that such combinations would not adversely affect the safety of aircraft operations.

Slopes on runways

3.1.13 Longitudinal slopes.

The slope computed by dividing the difference between the maximum and minimum elevation along the runway center line by the runway length shall not exceed:

— 1 per cent where the code number is 3 or 4; and

— 2 per cent where the code number is 1 or 2.

3.1.14 Along no portion of a runway shall the longitudinal slope exceed:

— 1.25 per cent where the code number is 4, except that for the first and last quarter of the length of the runway the longitudinal slope shall not exceed 0.8 per cent;

— 1.5 per cent where the code number is 3, except that for the first and last quarter of the length of a precision approach runway category II or III the longitudinal slope shall not exceed 0.8 per cent; and

— 2 per cent where the code number is 1 or 2.

3.1.15 Longitudinal slope changes.

Where slope changes cannot be avoided, a slope change between two consecutive slopes shall not exceed:

— 1.5 per cent where the code number is 3 or 4; and

— 2 per cent where the code number is 1 or 2.

Note: Guidance on slope changes before a runway is given in CARC Guidance Material to Part 14 No. 34 GM-01.

3.1.16 The transition from one slope to another shall be accomplished by a curved surface with a rate of change not exceeding:

— 0.1 per cent per 30 m (minimum radius of curvature of 30 000 m) where the code number is 4;

— 0.2 per cent per 30 m (minimum radius of curvature of 15 000 m) where the code number is 3; and

— 0.4 per cent per 30 m (minimum radius of curvature of 7 500 m) where the code number is 1 or 2.

3.1.17 Sight distance.

Where slope changes cannot be avoided, they shall be such that there will be an unobstructed line of sight from:

— any point 3 m above a runway to all other points 3 m above the runway within a distance of at least half the length of the runway where the code letter is C, D, E or F.

— any point 2 m above a runway to all other points 2 m above the runway within a distance of at least half the length of the runway where the code letter is B; and

— any point 1.5 m above a runway to all other points 1.5 m above the runway within a distance of at least half the length of the runway where the code letter is A.

Note: Consideration will have to be given to providing an unobstructed line of sight over the entire length of a single runway where a full-length parallel taxiway is not available. Where an aerodrome has intersecting runways, additional criteria on the line of sight of the intersection area would need to be considered for operational safety. See CARC Guidance Material 34-GM-11 Runway Design.

3.1.18 Distance between slope changes.

Undulations or appreciable changes in slopes located close together along a runway shall be avoided. The distance between the points of intersection of two successive curves shall not be less than:

(a) the sum of the absolute numerical values of the corresponding slope changes multiplied by the appropriate value as follows:

— 30 000 m where the code number is 4;

— 15 000 m where the code number is 3; and

— 5 000 m where the code number is 1 or 2; or

(b) 45 m;

whichever is greater.

Note: Guidance on implementing this specification is given in CARC Guidance Material to Part 14 No. 34 GM-01.

3.1.19 Transverse slopes.

To promote the most rapid drainage of water, the runway surface shall be cambered except where a single crossfall from high to low in the direction of the wind most frequently associated with rain would ensure rapid drainage. The transverse slope shall be:

— 1.5 per cent where the code letter is C, D, E or F; and

— 2 per cent where the code letter is A or B;

but in any event shall not exceed 1.5 per cent or 2 per cent, as applicable, nor be less than 1 per cent except at runway or taxiway intersections where flatter slopes may be necessary.

For a cambered surface the transverse slope on each side of the center line shall be symmetrical.

Note: On wet runways with cross-wind conditions the problem of aquaplaning from poor drainage is apt to be accentuated. In CARC Guidance Material to Part 14 No. 34 GM-01, information is given concerning this problem and other relevant factors.

3.1.20 The transverse slope shall be substantially the same throughout the length of a runway except at an intersection with another runway or a taxiway where an even transition shall be provided taking account of the need for adequate drainage.

Note: Guidance on transverse slope is given in CARC Guidance Material 34-GM-09 Pavement Design.

Strength of runways

3.1.21 A runway shall be capable of withstanding the traffic of airplanes the runway is intended to serve.

Surface of runways

3.1.22 The surface of a runway shall be constructed without irregularities that would impair the runway surface friction characteristics or otherwise adversely affect the take-off or landing of an airplane.

Note (1): Surface irregularities may adversely affect the take-off or landing of an airplane by causing excessive bouncing, pitching, vibration, or other difficulties in the control of an airplane.

Note (2): Guidance on design tolerances and other information is given in CARC Guidance Material to Part 14 No. 34 GM-01. Additional guidance is included in CARC Guidance Material 34-GM-09 Pavement Design.

3.1.23 A paved runway shall be so constructed or resurfaced as to provide surface friction at or above the minimum friction level specified in table 10-1.

3.1.24 The surface of a paved runway shall be evaluated when constructed or resurfaced to determine that the surface friction characteristics achieve the design objectives.

Note: Guidance on surface friction characteristics of a new or resurfaced runway is given in CARC Guidance Material to Part 14 No. 34 GM-01. Additional guidance is included in CARC Guidance Material 34-GM-08 Pavement Surface Condition.

3.1.25 Measurements of the surface friction characteristics of a new or resurfaced paved runway shall be made with a continuous friction measuring device using self-wetting features.

Note: Guidance on surface friction characteristics of new runway surfaces is given in CARC Guidance Material to Part 14 No. 34 GM-01. Additional guidance is included in CARC Guidance Material 34-GM-08 Pavement Surface Condition.

3.1.26 The average surface texture depth of a new surface shall be not less than 1.0 mm.

Macro-texture and micro-texture are taken into consideration in order to provide the required surface friction characteristics.

Note (1): Guidance on surface design is given in CARC Guidance Material to Part 14 No. 34 GM-01.

Note (2): Guidance on methods used to measure surface texture is given in CARC Guidance Material 34-GM-08 Pavement Surface Condition.

Note (3): Guidance on design and methods for improving surface texture is given in CARC Guidance Material 34-GM-09 Pavement Design.

3.1.27 When the surface is grooved or scored, the grooves or scorings shall be either perpendicular to the runway center line or parallel to non-perpendicular transverse joints, where applicable.

Note: Guidance on methods for improving the runway surface texture is given in CARC Guidance Material 34-GM-08 Pavement Surface Condition.

3.2 Runway Shoulders

General

Note: Guidance on characteristics and treatment of runway shoulders is given in CARC Guidance Material to Part 14 No. 34 GM-01, and in CARC Guidance Material 34-GM-11 Runway Design. Runway shoulders shall be provided for a runway where the code letter is D, E or F.

Width of runway shoulders

3.2.1 For aeroplanes with OMGWS from 9 m up to but not including 15 m, the runway shoulders shall extend symmetrically on each side of the runway so that the overall width of the runway and its shoulders is not less than:

— 60 m where the code letter is D or E;

— 60 m where the code letter is F with two- or three-engined aeroplanes; and

— 75 m where the code letter is F with four (or more)-engined aeroplanes.

Slopes on runway shoulders

3.2.2 The surface of the shoulder that abuts the runway shall be flush with the surface of the runway and its transverse slope shall not exceed 2.5 per cent.

Strength of runway shoulders

3.2.3 The portion of a runway shoulder between the runway edge and a distance of 30 m from the runway centre line shall be prepared or constructed so as to be capable, in the event of an airplane running off the runway, of supporting the airplane without inducing structural damage to the airplane and of supporting ground vehicles which may operate on the shoulder.

Note: Guidance on strength of runway shoulder is given in CARC Guidance Material 34-GM-11 Runway Design.

Surface of runway shoulders

3.2.4 A runway shoulder shall be prepared or constructed so as to resist erosion and the ingestion of the surface material by aeroplane engines.

3.2.5 Runway shoulders for code letter F aeroplanes shall be paved to a minimum overall width of runway and shoulder of not less than 60 m.

Note: Guidance on surface of runway shoulders is given in CARC Guidance Material 34-GM-11 Runway Design.

3.3 Runway Turn Pads

General

3.3.1 Where the end of a runway is not served by a taxiway or a taxiway turnaround, a runway turn pad shall be provided to facilitate a 180-degree turn of airplanes. (See Figure 3-1).

3.3.2 Reserved.

Note (1): Such areas may also be useful if provided along a runway to reduce taxiing time and distance for airplanes which may not require the full length of the runway.

Note (2): Guidance on the design of the runway turn pads is available in CARC Guidance Material 34-GM-11 Runway Design. Guidance on taxiway turnaround as an alternate facility is available in ICAO Aerodrome Design Manual, Part 2 — Taxiways, Aprons and Holding Bays (Doc 9157).

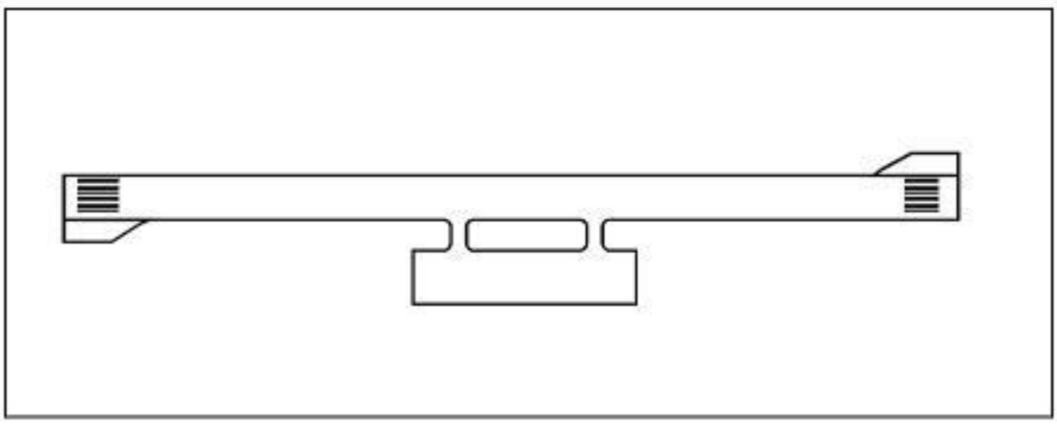


Figure 3-1. Typical turn pad layout

3.3.3 The runway turn pad may be located on either the left or right side of the runway and adjoining the runway pavement at both ends of the runway and at some intermediate locations where deemed necessary.

Note: The initiation of the turn would be facilitated by locating the turn pad on the left side of the runway, since the left seat is the normal position of the pilot-in-command.

3.3.4 The intersection angle of the runway turn pad with the runway shall not exceed 30 degrees.

3.3.5 The nose wheel steering angle to be used in the design of the runway turn pad shall not exceed 45 degrees.

3.3.6 The design of a runway turn pad shall be such that, when the cockpit of the airplane for which the turn pad is intended remains over the turn pad marking, the clearance distance between any wheel of the airplane landing gear and the edge of the turn pad shall be not less than that given by the following tabulation:

Outer Main Gear Wheel Span (OMGWS)

	Up to but not including 4.5 m	4.5 m up to but not including 6 m	6 m up to but not including 9 m	9 m up to but not including 15 m
Clearance	1.50 m	2.25 m	3 m[a] or 4 m[b]	4 m

(a) If the turn pad is intended to be used by aeroplanes with a wheel base less than 18 m.
(b) If the turn pad is intended to be used by aeroplanes with a wheel base equal to or greater than 18 m.
Note: Wheel base means the distance from the nose gear to the geometric center of the main gear.

Slopes on runway turn pads

3.3.7 The longitudinal and transverse slopes on a runway turn pad shall be sufficient to prevent the accumulation of water on the surface and facilitate rapid drainage of surface water. The slopes shall be the same as those on the adjacent runway pavement surface.

Strength of runway turn pads

3.3.8 The strength of a runway turn pad shall be at least equal to that of the adjoining runway which it serves, due consideration being given to the fact that the turn pad will be subjected to slow-moving traffic making hard turns and consequent higher stresses on the pavement.

Note: Where a runway turn pad is provided with flexible pavement, the surface would need to be capable of withstanding the horizontal shear forces exerted by the main landing gear tires during turning maneuvers.

Surface of runway turn pads

3.3.9 The surface of a runway turn pad shall not have surface irregularities that may cause damage to an airplane using the turn pad.

3.3.10 The surface of a runway turn pad shall be so constructed or resurfaced as to provide surface friction characteristics at least equal to that of the adjoining runway.

Shoulders for runway turn pads

3.3.11 The runway turn pads shall be provided with shoulders of such width as is necessary to prevent surface erosion by the jet blast of the most demanding airplane for which the turn pad is intended, and any possible foreign object damage to the airplane engines.

Note: As a minimum, the width of the shoulders would need to cover the outer engine of the most demanding airplane and thus may be wider than the associated runway shoulders.

3.3.12 The strength of runway turn pad shoulders shall be capable of withstanding the occasional passage of the airplane it is designed to serve without inducing structural damage to the airplane and to the supporting ground vehicles that may operate on the shoulder.

3.4 Runway Strips

General

3.4.1 A runway and any associated stopways shall be included in a strip.

Length of runway strips

3.4.2 A strip shall extend before the threshold and beyond the end of the runway or stopway for a distance of at least:

— 60 m where the code number is 2, 3 or 4;

— 60 m where the code number is 1 and the runway is an instrument one; and

— 30 m where the code number is 1 and the runway is a non-instrument one.

Width of runway strips

3.4.3 A strip including a precision approach runway shall extend laterally to a distance of at least:

— 140 m where the code number is 3 or 4; and

— 70 m where the code number is 1 or 2;

on each side of the center line of the runway and its extended center line throughout the length of the strip.

3.4.4 A strip including a non-precision approach runway shall extend laterally to a distance of at least:

— 140 m where the code number is 3 or 4; and

— 70 m where the code number is 1 or 2;

on each side of the center line of the runway and its extended center line throughout the length of the strip.

3.4.5 A strip including a non-instrument runway shall extend on each side of the center line of the runway and its extended center line throughout the length of the strip, to a distance of at least:

— 75 m where the code number is 4;

— 55 m where the code number is 3;

— 40 m where the code number is 2; and

— 30 m where the code number is 1.

Objects on runway strips

Note: Refer to Chapter 9 section 9.9 for information regarding siting of equipment and installations on runway strips.

3.4.6 An object situated on a runway strip which may endanger airplanes shall be regarded as an obstacle and shall be removed.

Note (1): Consideration will have to be given to the location and design of drains on a runway strip to prevent damage to an aeroplane accidentally running off a runway. Suitably designed drain covers may be required. For further guidance, see CARC Guidance Material 34-GM-11 Runway Design.

Note (2): Where open-air or covered storm water conveyances are installed, consideration will have to be given to ensure that their structure does not extend above the surrounding ground so as not to be considered an obstacle. See also Note 1 to 3.4.16.

Note (3): Particular attention needs to be given to the design and maintenance of an open-air storm water conveyance in order to prevent wildlife attraction, notably birds. If needed, it can be covered by a net. Procedures on wildlife management are specified in the CARC Guidance Material 34-GM-16 PANS-Aerodromes. Further guidance on Wildlife Control and Reduction can be found in CARC Guidance Material 34-GM-15 Wildlife Control and Reduction.

3.4.7 No fixed object, other than visual aids required for air navigation or those required for aircraft safety purposes and which must be sited on the runway strip, and satisfying the relevant frangibility requirement in Chapter 5, shall be permitted on any part of a runway strip of a precision approach runway delineated by the lower edges of the inner transitional surfaces. No mobile object shall be permitted on this part of the runway strip during the use of the runway for landing or take-off.

Note: See Chapter 4, section 4.1 for characteristics of inner transitional surface.

Grading of runway strips

3.4.8 That portion of a strip of an instrument runway within a distance of at least:

— 75 m where the code number is 3 or 4; and

— 40 m where the code number is 1 or 2;

from the center line of the runway and its extended center line shall provide a graded area for airplanes which the runway is intended to serve in the event of an airplane running off the runway.

Note: Guidance on grading of a greater area of a strip including a precision approach runway where the code number is 3 or 4 is given in CARC Guidance Material to Part 14 No. 34 GM-01.

3.4.9 That portion of a strip of a non-instrument runway within a distance of at least:

— 75 m where the code number is 4;

— 55 m where the code number is 3;

— 40 m where the code number is 2; and

— 30 m where the code number is 1;

from the center line of the runway and its extended center line shall provide a graded area for airplanes which the runway is intended to serve in the event of an airplane running off the runway.

3.4.10 The surface of that portion of a strip that abuts a runway, shoulder or stopway shall be flush with the surface of the runway, shoulder or stopway.

3.4.11 That portion of a strip to at least 60 m before the start of a runway shall be prepared against blast erosion in order to protect a landing airplane from the danger of an exposed edge.

Note (1): The area provided to reduce the erosive effects of jet blast and propeller wash may be referred to as a blast pad.

Note (2): Guidance on protection against aeroplane engine blast is available in ICAO Aerodrome Design Manual, Part 2 — Taxiways, Aprons and Holding Bays Design (Doc 9157).

3.4.12 Where the areas in 3.4.11 have paved surfaces, they shall be able to withstand the occasional passage of the critical aeroplane for runway pavement design.

Slopes on runway strips

3.4.13 Longitudinal slopes

A longitudinal slope along that portion of a strip to be graded shall not exceed:

— 1.5 per cent where the code number is 4;

— 1.75 per cent where the code number is 3; and

— 2 per cent where the code number is 1 or 2.

3.4.14 Longitudinal slope changes

Slope changes on that portion of a strip to be graded shall be as gradual as practicable and abrupt changes or sudden reversals of slopes avoided.

3.4.15 Transverse Slopes

Transverse slopes on that portion of a strip to be graded shall be adequate to prevent the accumulation of water on the surface but shall not exceed:

— 2.5 per cent where the code number is 3 or 4; and

— 3 per cent where the code number is 1 or 2;

except that to facilitate drainage the slope for the first 3 m outward from the runway, shoulder or stopway edge shall be negative as measured in the direction away from the runway and may be as great as 5 per cent.

3.4.16 The transverse slopes of any portion of a strip beyond that to be graded shall not exceed an upward slope of 5 per cent as measured in the direction away from the runway.

Note (1): Where deemed necessary for proper drainage, an open-air storm water conveyance may be allowed in the non-graded portion of a runway strip and would be placed as far as practicable from the runway.

Note (2): The aerodrome RFF procedure would need to take into account the location of open-air water conveyances within the non-graded portion of a runway strip.

Strength of runway strips

3.4.17 That portion of a strip of an instrument runway within a distance of at least:

— 75 m where the code number is 3 or 4; and

— 40 m where the code number is 1 or 2;

from the center line of the runway and its extended center line shall be so prepared or constructed as to minimize hazards arising from differences in load bearing capacity to airplanes which the runway is intended to serve in the event of an airplane running off the runway.

Note: Guidance on preparation of runway strips is given in CARC Guidance Material 34-GM-11 Runway Design.

3.4.18 That portion of a strip containing a non-instrument runway within a distance of at least:

— 75 m where the code number is 4;

— 55 m where the code number is 3;

— 40 m where the code number is 2; and

— 30 m where the code number is 1;

from the center line of the runway and its extended center line shall be so prepared or constructed as to minimize hazards arising from differences in load bearing capacity to airplanes which the runway is intended to serve in the event of an airplane running off the runway.

3.5 Runway End Safety Areas (RESA)

General

3.5.1 A runway end safety area shall be provided at each end of a runway strip where:

(a) the code number is 3 or 4; and

(b) the code number is 1 or 2 and the runway is an instrument one.

Note: Guidance on runway end safety areas is given in CARC Guidance Material to Part 14 No. 34 GM-01.

3.5.2 A runway end safety area shall be provided at each end of a runway strip where the code number is 1 or 2 and the runway is a non-instrument one.

Dimensions of runway end safety areas

3.5.3 Reserved.

3.5.4 A runway end safety area shall extend from the end of a runway strip to a distance of at least:

(a) 240 m where the code number is 3, or 4; or a reduced length when an arresting system is installed;

(b) 120 m where the code number is 1, or 2 and the runway is an instrument one; or a reduced length when an arresting system is installed; and

(c) 30 m where the code number is 1 or 2 and the runway is a non-instrument one.

3.5.5 Reserved.

3.5.6 The width of a runway end safety area shall be equal to that of the graded portion of the associated runway strip.

Objects on runway end safety areas

Note: Refer to Chapter 9 section 9.9 for information regarding siting of equipment and installations on runway end safety areas.

3.5.7 An object situated on a runway end safety area which may endanger airplanes shall be regarded as an obstacle and shall be removed.

Clearing and grading of runway end safety areas

3.5.8 A runway end safety area shall provide a cleared and graded area for airplanes which the runway is intended to serve in the event of an airplane undershooting or overrunning the runway.

Slopes on runway end safety areas

3.5.9 General

The slopes of a runway end safety area shall be such that no part of the runway end safety area penetrates the approach or take-off climb surface.

3.5.10 Longitudinal slopes

The longitudinal slopes of a runway end safety area shall not exceed a downward slope of 5 per cent. Longitudinal slope changes shall be gradual and abrupt changes or sudden reversals of slopes avoided.

3.5.11 Transverse slopes

The transverse slopes of a runway end safety area shall not exceed an upward or downward slope of 5 per cent. Transitions between differing slopes shall be gradual.

Strength of runway end safety areas

3.5.12 A runway end safety area shall be so prepared or constructed as to reduce the risk of damage to an airplane undershooting or overrunning the runway, enhance airplane deceleration and facilitate the movement of rescue and fire fighting vehicles as required in Chapter 9 Sections 9.2.34 to 9.2.36.

Note: Guidance on strength of a runway end safety area is given in CARC Guidance Material 34-GM-11 Runway Design.

3.6 Clearways

Note: CARC Guidance Material to Part 14 No. 34 GM-01 provides information on the use of clearways.

Location of clearways

3.6.1 The origin of a clearway shall be at the end of the take-off run available.

Length of clearways

3.6.2 The length of a clearway shall not exceed half the length of the take-off run available.

Width of clearways

3.6.3 A clearway shall extend laterally on each side of the extended center line of the runway, to a distance of at least:

(a) 75 m for instrument runways; and

(b) half of the width of the runway strip for non-instrument runways.

Slopes on clearways

3.6.4 The ground in a clearway shall not project above a plane having an upward slope of 1.25 per cent, the lower limit of this plane being a horizontal line which:

(a) is perpendicular to the vertical plane containing the runway center line; and

(b) passes through a point located on the runway center line at the end of the take-off run available.

Note: Because of transverse or longitudinal slopes on a runway, shoulder or strip, in certain cases the lower limit of the clearway plane specified above may be below the corresponding elevation of the runway, shoulder or strip. It is not intended that these surfaces be graded to conform with the lower limit of the clearway plane nor is it intended that terrain or objects which are above the clearway plane beyond the end of the strip but below the level of the strip be removed unless it is considered they may endanger airplanes.

3.6.5 Abrupt upward changes in slope shall be avoided when the slope on the ground in a clearway is relatively small or when the mean slope is upward. In such situations, in that portion of the clearway within a distance of 22.5 m or half the runway width whichever is greater on each side of the extended center line, the slopes, slope changes and the transition from runway to clearway shall conform with those of the runway with which the clearway is associated.

Objects on clearways

Note: Refer to Chapter section 9.9 for information regarding siting of equipment and installations on clearways.

3.6.6 An object situated on a clearway which may endanger airplanes in the air shall be regarded as an obstacle and shall be removed.

3.7 Stopways

Note: CARC Guidance Material to Part 14 No. 34 GM-01 provides information on the use of stopways.

Width of stopways

3.7.1 A stopway shall have the same width as the runway with which it is associated.

Slopes on stopways

3.7.2 Slopes and changes in slope on a stopway, and the transition from a runway to a stopway, shall comply with the specifications of Chapter 3 paragraphs 3.1.13 to 3.1.19 for the runway with which the stopway is associated except that:

(a) the limitation in Chapter 3 paragraph 3.1.14 of a 0.8 per cent slope for the first and last quarter of the length of a runway need not be applied to the stopway; and

(b) at the junction of the stopway and runway and along the stopway the maximum rate of slope change may be 0.3 per cent per 30 m (minimum radius of curvature of 10 000 m) for a runway where the code number is 3 or 4.

Strength of stopways

3.7.3 A stopway shall be prepared or constructed so as to be capable, in the event of an abandoned take-off, of supporting the airplane which the stopway is intended to serve without inducing structural damage to the airplane.

Note: CARC Guidance Material to Part 14 No. 34 GM-01 presents guidance relative to the support capability of a stopway.

Surface of stopways

3.7.4 The surface of a paved stopway shall be so constructed or resurfaced as to provide surface friction characteristics at or above those of the associated runway.

3.8 Radio Altimeter Operating Area

General

3.8.1 A radio altimeter operating area shall be established in the pre-threshold area of a precision approach runway.

Length of the area

3.8.2 A radio altimeter operating area shall extend before the threshold for a distance of at least 300 m.

Width of the area

3.8.3 A radio altimeter operating area shall extend laterally, on each side of the extended center line of the runway, to a distance of 60 m, except that, when special circumstances so warrant, the distance may be reduced to no less than 30 m if an aeronautical study indicates that such reduction would not affect the safety of operations of aircraft.

Longitudinal slope changes

3.8.4 On a radio altimeter operating area, slope changes shall be avoided or kept to a minimum. Where slope changes cannot be avoided, the slope changes shall be as gradual as practicable and abrupt changes or sudden reversals of slopes avoided. The rate of change between two consecutive slopes shall not exceed 2 per cent per 30 m.

Note: Guidance on radio altimeter operating area is given in CARC Guidance Material to Part 14 No. 34 GM-01.

3.9 Taxiways

Note (1): Unless otherwise indicated the requirements in this section are applicable to all types of taxiways.

Note (2): See section 5.4.3 for a standardized scheme for the nomenclature of taxiways which may be used to improve situational awareness and as a part of an effective runway incursion prevention measure.

Note (3): See CARC Guidance Material to Part 14 No. 34 GM-01 for specific taxiway design guidance which may assist in the prevention of runway incursions when developing a new taxiway or improving existing ones with a known runway incursion safety risk.

General

3.9.1 Taxiways shall be provided, as dictated by operational requirements, to permit the safe and expeditious surface movement of aircraft.

Note: Guidance on layout of taxiways and standardized nomenclature is given in the ICAO Aerodrome Design Manual, Part 2 — Taxiways, Aprons and Holding Bays Design (Doc 9157).

3.9.2 Sufficient entrance and exit taxiways for a runway shall be provided to expedite the movement of airplanes to and from the runway and provision of rapid exit taxiways considered when traffic volumes are high.

3.9.3 The design of a taxiway shall be such that, when the cockpit of the airplane for which the taxiway is intended remains over the taxiway center line markings, the clearance distance between the outer main wheel of the airplane and the edge of the taxiway shall be not less than that given by the following tabulation:

	Outer Main Gear Wheel Span (OMGWS)			
	Up to but not including 4.5 m	**4.5 m up to but not including 6 m**	**6 m up to but not including 9 m**	**9 m up to but not including 15 m**
Clearance	1.50 m	2.25 m	3 ma, b or 4 mc	4 m

(a) *On straight portions.*
(b) *On curved portions if the taxiway is intended to be used by aeroplanes with a wheel base of less than 18 m.*
(c) *On curved portions if the taxiway is intended to be used by aeroplanes with a wheel base equal to or greater than 18 m.*

Note: Wheel base means the distance from the nose gear to the geometric center of the main gear.

Width of taxiways

3.9.4 A straight portion of a taxiway shall have a width of not less than that given by the following tabulation:

	Outer Main Gear Wheel Span (OMGWS)			
	Up to but not including 4.5 m	**4.5 m up to but not including 6 m**	**6 m up to but not including 9 m**	**9 m up to but not including 15 m**
Taxiway width	7.5 m	10.5 m	15 m	23 m

Note: Guidance on width of taxiways is given in ICAO Aerodrome Design Manual, Part 2 — Taxiways, Aprons and Holding Bays Design (Doc 9157).

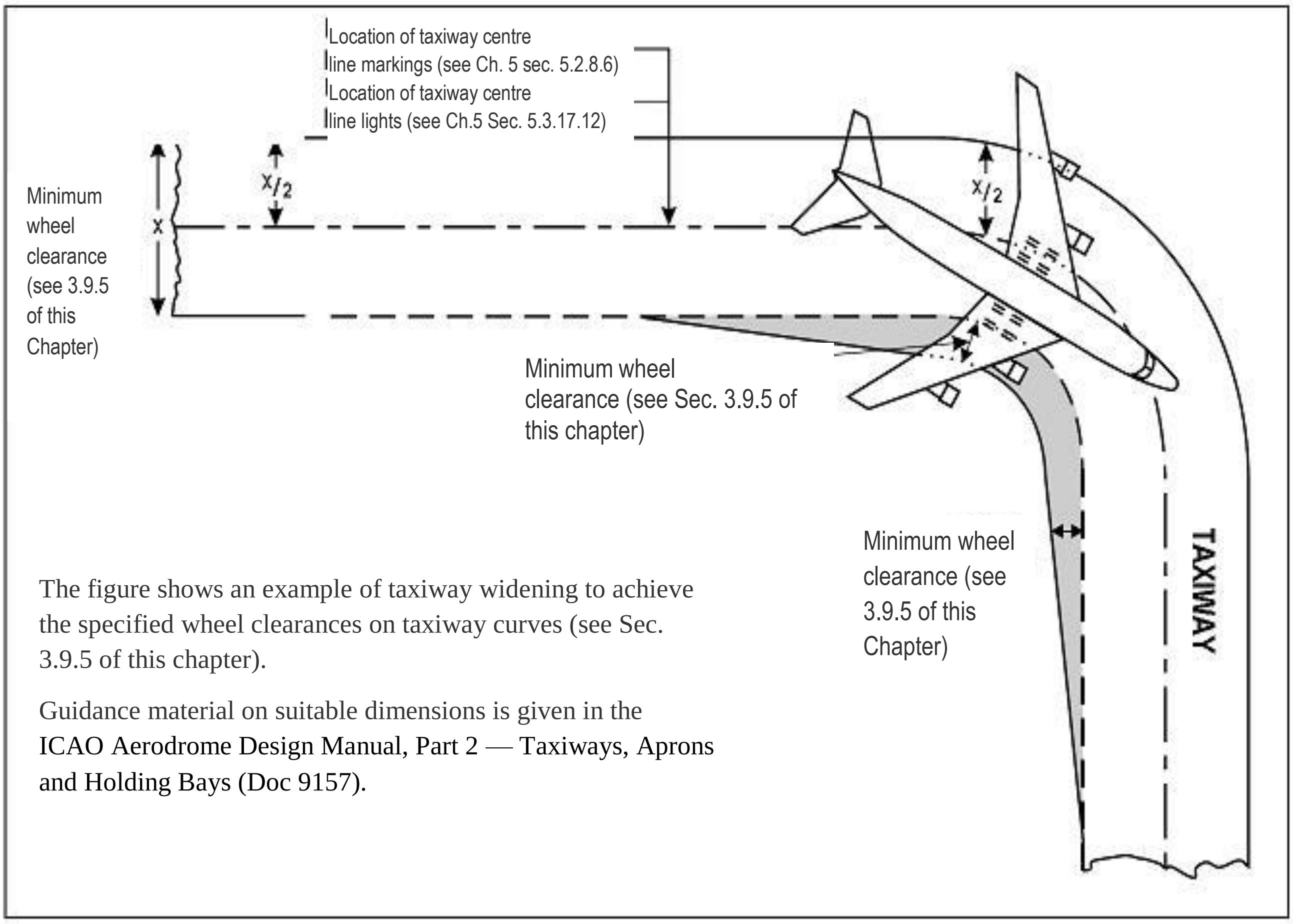
Taxiway curves

3.9.5 Changes in direction of taxiways shall be as few and small as possible. The radii of the curves shall be compatible with the maneuvering capability and normal taxiing speeds of the airplanes for which the taxiway is intended. The design of the curve shall be such that, when the cockpit of the airplane remains over the taxiway center line markings, the clearance distance between the outer main wheels of the airplane and the edge of the taxiway shall not be less than those specified in 3.9.3.

Note (1): An example of widening taxiways to achieve the wheel clearance specified is illustrated in Figure 3-2. Guidance on the values of suitable dimensions is given in ICAO Aerodrome Design Manual, Part 2 — Taxiways, Aprons and Holding Bays Design (Doc 9157).

Note (2): The location of taxiway center line markings and lights is specified in Chapter 5 paragraphs 5.2.8.6 and 5.3.17.12.

Note (3): Compound curves may reduce or eliminate the need for extra taxiway width.



The figure shows an example of taxiway widening to achieve the specified wheel clearances on taxiway curves (see Sec. 3.9.5 of this chapter).

Guidance material on suitable dimensions is given in the ICAO Aerodrome Design Manual, Part 2 — Taxiways, Aprons and Holding Bays (Doc 9157).

Figure 3-2. Taxiway curve

Junctions and intersections

3.9.6 To facilitate the movement of airplanes, fillets shall be provided at junctions and intersections of taxiways with runways, aprons and other taxiways. The design of the fillets shall ensure that the minimum wheel clearances specified in 3.9.3 are maintained when airplanes are maneuvering through the junctions or intersections.

Note: Consideration will have to be given to the airplane datum length when designing fillets. Guidance on the design of fillets and the definition of the term airplane datum length are given in ICAO Aerodrome Design Manual, Part 2 — Taxiways, Aprons and Holding Bays Design (Doc 9157).

Taxiway minimum separation distances

3.9.7 The separation distance between the center line of a taxiway and the center line of a runway, the center line of a parallel taxiway or an object shall not be less than the appropriate dimension specified in Table 3-1, except that it may be permissible to operate with lower separation distances at an existing aerodrome if an aeronautical study indicates that such lower separation distances would not adversely affect the safety or significantly affect the regularity of operations of airplanes.

Note (1): Guidance on factors which may be considered in the aeronautical study is given in ICAO Aerodrome Design Manual, Part 2 — Taxiways, Aprons and Holding Bays Design (Doc 9157).

Note (2): ILS and MLS installations may also influence the location of taxiways due to interferences to ILS and MLS signals by a taxiing or stopped aircraft. Information on critical and sensitive areas surrounding ILS and MLS installations is contained in ICAO Annex 10, Volume I, Attachments C and G (respectively).

Note (3): The separation distances of Table 3-1, column 10, do not necessarily provide the capability of making a normal turn from one taxiway to another parallel taxiway. Guidance for this condition is given in ICAO Aerodrome Design Manual, Part 2 — Taxiways, Aprons and Holding Bays Design (Doc 9157).

Note (4): The separation distance between the center line of an aircraft stand taxilane and an object shown in Table 3-1, column 13, may need to be increased when jet exhaust wake velocity may cause hazardous conditions for ground servicing.

Slopes on taxiways

3.9.8 Longitudinal slopes

The longitudinal slope of a taxiway shall not exceed:

— 1.5 per cent where the code letter is C, D, E or F; and

— 3 per cent where the code letter is A or B.

3.9.9 Longitudinal slope changes

Where slope changes on a taxiway cannot be avoided, the transition from one slope to another slope shall be accomplished by a curved surface with a rate of change not exceeding:

— 1 per cent per 30 m (minimum radius of curvature of 3 000 m) where the code letter is C, D, E or F; and

— 1 per cent per 25 m (minimum radius of curvature of 2 500 m) where the code letter is A or B.

3.9.10 Sight distance

Where a change in slope on a taxiway cannot be avoided, the change shall be such that, from any point:

— 3 m above the taxiway, it will be possible to see the whole surface of the taxiway for a distance of at least 300 m from that point, where the code letter is C, D, E or F;

— 2 m above the taxiway, it will be possible to see the whole surface of the taxiway for a distance of at least 200 m from that point, where the code letter is B; and

— 1.5 m above the taxiway, it will be possible to see the whole surface of the taxiway for a distance of at least 150 m from that point, where the code letter is A.

3.9.11 Transverse slopes

The transverse slopes of a taxiway shall be sufficient to prevent the accumulation of water on the surface of the taxiway but shall not exceed:

— 1.5 per cent where the code letter is C, D, E or F; and

— 2 per cent where the code letter is A or B.

Note: Refer to 3.13.4 regarding transverse slopes on an aircraft stand taxilane.

Strength of taxiways

3.9.12 The strength of a taxiway shall be at least equal to that of the runway it serves, due consideration being given to the fact that a taxiway will be subjected to a greater density of traffic and, as a result of slow moving and stationary airplanes, to higher stresses than the runway it serves.

Note: Guidance on the relation of the strength of taxiways to the strength of runways is given in CARC Guidance Material 34-GM-09 Pavement Design.

Table 3-1. Taxiway minimum separation distances

Code Letter	Distance between taxiway center line and runway center line (meter) — Instrument runways Code number				Non-instrument runways Code number				Taxiway center line to taxiway center line	Taxiway (other than aircraft stand taxilane) center line to object	Aircraft stand taxilane centre line to aircraft stand taxilane centre line	Aircraft stand taxilane center line to object
	1	2	3	4	1	2	3	4	(meter)	(meter)	(meter)	(meter)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
A	77.5	77.5	-	-	37.5	47.5	-	-	23	15.5	19.5	12
B	82	82	152	-	42	52	67	-	32	20	28.5	16.5
C	88	88	158	158	48	58	73	93	44	26	40.5	22.5
D	-	-	166	166	-	-	81	101	63	37	59.5	33.5
E	-	-	172.5	172.5	-	-	87.5	107.5	76	43.5	72.5	40
F	-	-	180	180	-	-	95	115	91	51	87.5	47.5

The separation distances shown in columns (2) to (9) represent ordinary combinations of runways and taxiways. The basis for development of these distances is given in ICAO Aerodrome Design Manual, Part 2 — Taxiways, Aprons and Holding Bays Design (Doc 9157).

The distances in columns (2) to (9) do not guarantee sufficient clearance behind a holding airplane to permit the passing of another airplane on a parallel taxiway. Refer to ICAO Aerodrome Design Manual, Part 2 — Taxiways, Aprons and Holding Bays Design (Doc 9157).

Surface of taxiways

3.9.13 The surface of a taxiway shall not have irregularities that cause damage to airplane structures.

3.9.14 The surface of a paved taxiway shall be so constructed or resurfaced as to provide suitable surface friction characteristics.

Note: Suitable surface friction characteristics are those surface properties required on taxiways that assure safe operation of aeroplanes.

Rapid exit taxiways

Note: The following specifications detail requirements particular to rapid exit taxiways. See Figure 3-3. General requirements for taxiways also apply to this type of taxiway. Guidance on the provision, location and design of rapid exit taxiways is included in ICAO Aerodrome Design Manual, Part 2 — Taxiways, Aprons and Holding Bays Design (Doc 9157).

3.9.15 A rapid exit taxiway shall be designed with a radius of turn-off curve of at least:

— 550 m where the code number is 3 or 4; and

— 275 m where the code number is 1 or 2;

To enable exit speeds under wet conditions of:

— 93 km/h where the code number is 3 or 4; and

— 65 km/h where the code number is 1 or 2.

Note: The locations of rapid exit taxiways along a runway are based on several criteria described in ICAO Aerodrome Design Manual, Part 2 — Taxiways, Aprons and Holding Bays Design (Doc 9157)., in addition to different speed criteria.

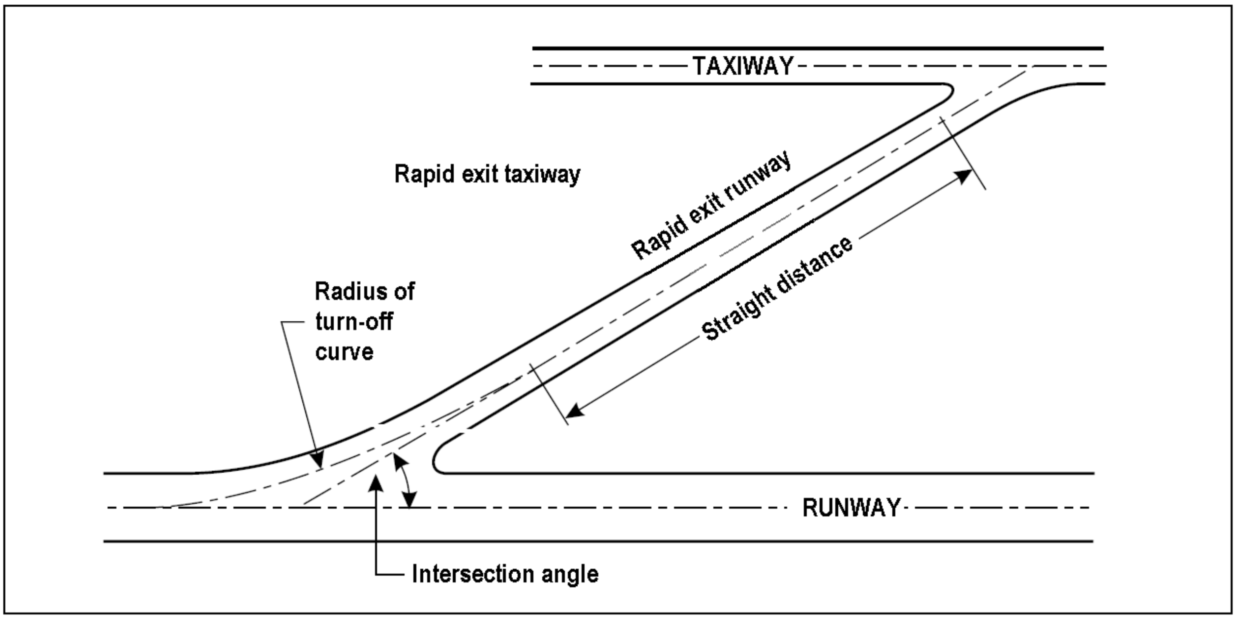


Figure 3-3. Rapid exit taxiway

3.9.16 The radius of the fillet on the inside of the curve at a rapid exit taxiway shall be sufficient to provide a widened taxiway throat in order to facilitate early recognition of the entrance and turn-off onto the taxiway.

3.9.17 A rapid exit taxiway shall include a straight distance after the turn-off curve sufficient for an exiting aircraft to come to a full stop clear of any intersecting taxiway.

3.9.18 The intersection angle of a rapid exit taxiway with the runway shall not be greater than 45° nor less than 25° and preferably shall be 30°.

Taxiways on bridges

3.9.19 The width of that portion of a taxiway bridge capable of supporting airplanes, as measured perpendicularly to the taxiway center line, shall not be less than the width of the graded area of the strip provided for that taxiway, unless a proven method of lateral restraint is provided which shall not be hazardous for airplanes for which the taxiway is intended.

3.9.20 Access shall be provided to allow rescue and fire fighting vehicles to intervene in both directions within the specified response time to the largest airplane for which the taxiway bridge is intended.

Note: If airplane engines overhang the bridge structure, protection of adjacent areas below the bridge from engine blast is required.

3.9.21 A bridge shall be constructed on a straight section of the taxiway with a straight section on both ends of the bridge to facilitate the alignment of airplanes approaching the bridge.

3.10 Taxiway Shoulders

Note: Guidance on characteristics of taxiway shoulders and on shoulder treatment is given in ICAO Aerodrome Design Manual, Part 2 — Taxiways, Aprons and Holding Bays Design (Doc 9157).

3.10.1 Straight portions of a taxiway where the code letter is C, D, E or F shall be provided with shoulders which extend symmetrically on each side of the taxiway so that the overall width of the taxiway and its shoulders on straight portions is not less than:

— 44 m where the code letter is F;

— 38 m where the code letter is E;

— 34 m where the code letter is D; and

— 25 m where the code letter is C.

On taxiway curves and on junctions or intersections where increased pavement is provided, the shoulder width shall be not less than that on the adjacent straight portions of the taxiway.

3.10.2 When a taxiway is intended to be used by turbine-engine airplanes, the surface of the taxiway shoulder shall be so prepared as to resist erosion and the ingestion of the surface material by airplane engines.

3.11 Taxiway Strips

Note: Guidance on characteristics of taxiway strips is given in ICAO Aerodrome Design Manual, Part 2 — Taxiways, Aprons and Holding Bays Design (Doc 9157).

General

3.11.1 A taxiway, other than an aircraft stand taxilane, shall be included in a strip.

Width of taxiway strips

3.11.2 A taxiway strip shall extend symmetrically on each side of the center line of the taxiway throughout the length of the taxiway to at least the distance from the center line given in Table 3-1, column 11.

Objects on taxiway strips

Note: Refer to Chapter 9 section 9.9 for information regarding siting of equipment and installations on taxiway strips.

3.11.3 The taxiway strip shall provide an area clear of objects which may endanger taxiing airplanes.

Note (1): Consideration shall be given to the location and design of drains on a taxiway strip to prevent damage to an airplane accidentally running off a taxiway. Suitably designed drain covers are required. For further guidance, see ICAO Aerodrome Design Manual, Part 2 — Taxiways, Aprons and Holding Bays Design (Doc 9157).

Note (2): Where open-air or covered storm water conveyances are installed, consideration will have to be given to ensure that their structure do not extend above the surrounding ground so as not to be considered an obstacle. See also Note 1 to 3.11.6.

Note (3): Particular attention needs to be given to the design and maintenance of an open-air storm water conveyance in order to prevent wildlife attraction, notably birds. If needed, it can be covered by a net. Guidance on Wildlife Control and Reduction can be found in CARC Guidance Material 34-GM-15 Wildlife Control and Reduction.

Grading of taxiway strips

3.11.4 The center portion of a taxiway strip shall provide a graded area to a distance from the center line of the taxiway of not less than that given by the following tabulation:

- — 10.25 m where the OMGWS is up to but not including 4.5 m.
- — 11 m where the OMGWS is 4.5 m up to but not including 6 m.
- — 12.50 m where the OMGWS is 6 m up to but not including 9 m.
- — 17m where the OMGWS is 9 m up to but not including 15 m, where the code letter is D.

— 19 m where the OMGWS is 9 m up to but not including 15 m, where the code letter is E.

— 22 m where the OMGWS is 9 m up to but not including 15 m, where the code letter is F.

Note: Guidance on width of the graded portion of a taxiway is given in ICAO Aerodrome Design Manual, Part 2 — Taxiways, Aprons and Holding Bays Design (Doc 9157).

Slopes on taxiway strips

3.11.5 The surface of the strip shall be flush at the edge of the taxiway or shoulder, if provided, and the graded portion shall not have an upward transverse slope exceeding:

— 2.5 per cent for strips where the code letter is C, D, E or F; and

— 3 per cent for strips of taxiways where the code letter is A or B;

the upward slope being measured with reference to the transverse slope of the adjacent taxiway surface and not the horizontal. The downward transverse slope shall not exceed 5 per cent measured with reference to the horizontal.

3.11.6 The transverse slopes on any portion of a taxiway strip beyond that to be graded shall not exceed an upward or downward slope of 5 per cent as measured in the direction away from the taxiway.

Note (1): Where deemed necessary for proper drainage, an open-air storm water conveyance may be allowed in the non-graded portion of a taxiway strip and would be placed as far as practicable from the taxiway.

Note (2): The aerodrome RFF procedure would need to take into account the location of open-air storm water conveyances within the non-graded portion of a taxiway strip.

3.12 Holding Bays, Runway-Holding Positions, Intermediate Holding Positions and Road-Holding Positions

General

3.12.1 Holding bay(s) shall be provided when the traffic density is medium or heavy.

3.12.2 A runway-holding position or positions shall be established:

(a) on the taxiway, at the intersection of a taxiway and a runway; and

(b) at an intersection of a runway with another runway when the former runway is part of a standard taxi-route.

3.12.3 A runway-holding position shall be established on a taxiway if the location or alignment of the taxiway is such that a taxiing aircraft or vehicle can infringe an obstacle limitation surface or interfere with the operation of radio navigation aids.

3.12.4 An intermediate holding position shall be established on a taxiway at any point other than a runway-holding position where it is desirable to define a specific holding limit.

3.12.5 A road-holding position shall be established at an intersection of a road with a runway.

Location

3.12.6 The distance between a holding bay, runway-holding position established at a taxiway/runway intersection or road-holding position and the center line of a runway shall be in accordance with Table (3-2) and, in the case of a precision approach runway, such that a holding aircraft or vehicle will not interfere with the operation of radio navigation aids or penetrate the inner transitional surface.

Note: Guidance for the positioning of runway-holding positions is given ICAO Aerodrome Design Manual, Part 2 — Taxiways, Aprons and Holding Bays Design (Doc 9157).

3.12.7 At elevations greater than 700 m (2 300 ft) the distance of 90 m specified in Table (3-2) for a precision approach runway code number 4 shall be increased as follows:

(a) up to an elevation of 2 000 m (6 600 ft); 1 m for every 100 m (330 ft) in excess of 700 m (2 300 ft);

(b) elevation in excess of 2 000 m (6 600 ft) and up to 4 000 m (13 320 ft); 13 m plus 1.5 m for every 100 m (330 ft) in excess of 2 000 m (6 600 ft); and

(c) elevation in excess of 4 000 m (13 320 ft) and up to 5 000 m (16 650 ft); 43 m plus 2 m for every 100 m (330 ft) in excess of 4 000 m (13 320 ft).

3.12.8 If a holding bay, runway-holding position or road-holding position for a precision approach runway code number 4 is at a greater elevation compared to the threshold, the distance specified in Table (3-2) shall be further increased 5 m for every meter the bay or position is higher than the threshold.

3.12.9 (Until 20 November 2030), the location of a runway-holding position established in accordance with (3.12.3) shall be such that a holding aircraft or vehicle will not infringe the obstacle free zone, approach surface, take-off climb surface or ILS/MLS critical/sensitive area or interfere with the operation of radio navigation aids.

3.12.10 (As of 21 November 2030), the location of a runway-holding position established in accordance with 3.12.3 shall be such that a holding aircraft or vehicle will not infringe the inner approach surface, inner transitional surfaces, balked landing surface, approach surface, take-off climb surface or ILS/MLS critical/sensitive area or interfere with the operation of other radio navigation aids.

Table 3-2. Minimum distance from the runway center line to a holding bay, runway-holding position or road-holding position

Type of runway	Code number 1	2	3	4
Non-instrument	30 m	40 m	55m	75 m
Non-precision approach	40 m	40 m	75 m	75 m
Precision approach category I	60 m [b]	60 m [b]	90 m [a, b]	90 m [a, b]
Precision approach categories II and III	-	-	90 m [a, b]	90 m [a, b]
Take-off runway	30 m	40 m	55m	75 m

(a) If a holding bay, runway-holding position or road-holding position is at a lower elevation compared to the threshold, the distance may be decreased 5m for every meter the bay or holding position is lower than the threshold, contingent upon not infringing the inner transitional surface.

(b) This distance may need to be increased to avoid interference with radio navigation aids, particularly the glide path and localizer facilities. Information on critical and sensitive areas of ILS and MLS is contained in ICAO Annex 10, Volume I, Attachments C and G, respectively (see also 3.12.6)

Note (1): The distance of 90 m for code number 3 or 4 is based on an aircraft with a tail height of 20 m, a distance from the nose to the highest part of the tail of 52.7 m and a nose height of 10 m holding at an angle of 45° or more with respect to the runway centerline, being clear of the obstacle free zone and not accountable for the calculation of OCA/H.

Note (2): The distance of 60 m for code number 2 is based on an aircraft with a tail height of 8 m, a distance from the nose to the highest part of the tail of 24.6 m and a nose height of 5.2 m holding at an angle of 45° or more with respect to the runway centerline, being clear of the obstacle free zone.

Note (3): For code number 4 where the width of the inner edge of the inner approach surface is more than 120 m, a distance greater than 90 m may be necessary to ensure that a holding aircraft is clear of the obstacle free zone. For example a distance of 100 m is based on an aircraft with a tail height of 24 m, a distance from the nose to the highest part of the tail of 62.2 m and a nose height of 10 m holding at an angle of 45° or more with respect to the runway centerline, being clear of the obstacle free zone.

3.13 Aprons

General

3.13.1 Aprons shall be provided where necessary to permit the on- and off-loading of passengers, cargo or mail as well as the servicing of aircraft without interfering with the aerodrome traffic.

3.13.2 The design of aprons shall take into consideration criteria for safe ground handling, including:

a) sufficient space between aircraft stands to enable personnel and equipment to move safely and efficiently;

b) adequate apron markings, apron signs and apron floodlighting;

c) adequate staging and storage areas for ground support equipment (GSE);

d) positioning of fixed ground services;

e) storage areas for unit load devices (ULD);

f) adequate access and egress routes for fuel, GSE and emergency vehicles;

g) clearly delineated and visible access and egress routes for passengers;

h) new technologies (electric charging points, autonomous vehicles, etc.);

i) avoidance of rear of aircraft stand service roads wherever practicable; and

j) appropriate protection for persons, equipment and infrastructure from jet blast and propeller wash.

Note: Further guidance on apron design and markings is given in the CARC Guidance Material 34-GM-17 Visual Aids for Navigation, and the ICAO Airport Planning Manual (Doc 9184), Part 1— Master Planning.

Size of aprons

3.13.3 The total apron area shall be adequate to permit safe and expeditious handling of the aerodrome traffic at its maximum anticipated density.

Strength of aprons

3.13.4 Each part of an apron shall be capable of withstanding the traffic of the aircraft it is intended to serve, due consideration being given to the fact that some portions of the apron will be subjected to a higher density of traffic and, as a result of slow moving or stationary aircraft, to higher stresses than a runway.

Slopes on aprons

3.13.5 Slopes on an apron, including those on an aircraft stand taxilane, shall be sufficient to prevent accumulation of water on the surface of the apron but shall be kept as level as drainage requirements permit.

3.13.6 On an aircraft stand the maximum slope shall not exceed 1 per cent.

Clearance distances on aircraft stands

3.13.7 An aircraft stand shall provide the following minimum clearances between an aircraft entering or exiting the stand and any adjacent building, aircraft on another stand and other objects:

Code letter	Clearance
A	3 m
B	3 m
C	4.5 m
D	7.5 m
E	7.5 m
F	7.5 m

When special circumstances so warrant, these clearances may be reduced at a nose-in aircraft stand, where the code letter is D, E or F:

(a) between the terminal, including any fixed passenger boarding bridge, and the nose of an aircraft; and

(b) over any portion of the stand provided with azimuth guidance by a visual docking guidance system.

Note: On aprons, consideration also has to be given to the provision of service roads and to maneuvering and storage area for ground equipment (Refer to ICAO Aerodrome Design Manual, Part 2 — Taxiways, Aprons and Holding Bays Design (Doc 9157). for guidance on storage of ground equipment).

3.14 Isolated Aircraft Parking Position

3.14.1 An isolated aircraft parking position shall be designated or the aerodrome control tower shall be advised of an area or areas suitable for the parking of an aircraft which is known or believed to be the subject of unlawful interference, or which for other reasons needs isolation from normal aerodrome activities.

3.14.2 The isolated aircraft parking position shall be located at the maximum distance practicable and in any case never less than 100 m from other parking positions, buildings or public areas, etc. Care shall be taken to ensure that the position is not located over underground utilities such as gas and aviation fuel and, to the extent feasible, electrical or communication cables.

3.15 De-Icing/Anti-Icing Facilities

*Note: Safe and efficient airplane operations are of primary importance in the development of an airplane deicing/anti-icing facility. For further guidance, refer to ICAO Manual of Aircraft Ground De-icing/Anti-icing Operations (Doc 9640)***.**

General

3.15.1 Airplane de-icing/anti-icing facilities shall be provided at an aerodrome where icing conditions are expected to occur.

Location

3.15.2 De-icing/anti-icing facilities shall be provided either at aircraft stands or at specified remote areas along the taxiway leading to the runway meant for take-off, provided that adequate drainage arrangements for the collection and safe disposal of excess de-icing/anti-icing fluids are available to prevent ground water contamination. The effect of volume of traffic and departure flow rates shall also be considered.

Note (1): One of the primary factors influencing the location of a de-icing/anti-icing facility is to ensure that the holdover time of the anti-icing treatment is still in effect at the end of taxiing and when take-off clearance of the treated airplane is given.

Note (2): Remote facilities compensate for changing weather conditions when icing conditions or blowing snow are expected to occur along the taxi route taken by the airplane to the runway meant for take-off.

3.15.3 The remote de-icing/anti-icing facility shall be located to be clear of the obstacle limitation surfaces specified in Chapter 4 of this Part, not cause interference to the radio navigation aids and be clearly visible from the air traffic control tower for clearing the treated airplane.

3.15.4 The remote de-icing/anti-icing facility shall be so located as to provide for an expeditious traffic flow, perhaps with a bypass configuration, and not require unusual taxiing maneuver into and out of the pads.

Note: The jet blast effects caused by a moving airplane on other airplanes receiving the anti-icing treatment or taxiing behind will have to be taken into account to prevent degradation of the treatment.

Size and number of de-icing/anti-icing pads

Note: An airplane de-icing/anti-icing pad consists of:

(a) *an inner area for parking of an airplane to be treated, and*

(b) *an outer area for movement of two or more mobile de-icing/ anti-icing equipment.*

3.15.5 The size of a de-icing/anti-icing pad shall be equal to the parking area required by the most demanding airplane in a given category with at least 3.8 m clear paved area all-round the airplane for the movement of the de-icing/anti-icing vehicles.

Note: Where more than one de-icing/anti-icing pad is provided, consideration will have to be given to providing deicing/anti-icing vehicle movement areas of adjacent pads that do not overlap, but are exclusive for each pad. Consideration will also need to be given to bypassing of the area by other airplanes with the clearances specified in 3.15.9 and 3.15.10.

3.15.6 The number of de-icing/anti-icing pads required shall be determined based on the meteorological conditions, the type of airplanes to be treated, the method of application of de-icing/anti-icing fluid, the type and capacity of the dispensing equipment used, and the departure flow rates.

Note: Refer to ICAO Aerodrome Design Manual, Part 2 — Taxiways, Aprons and Holding Bays Design (Doc 9157).

Slopes on de-icing/anti-icing pads

3.15.7 The de-icing/anti-icing pads shall be provided with suitable slopes to ensure satisfactory drainage of the area and to permit collection of all excess de-icing/anti-icing fluid running off an airplane. The maximum longitudinal slope shall be as little as practicable and the transverse slope shall not exceed 1 per cent.

Strength of de-icing/anti-icing pads

3.15.8 The de-icing/anti-icing pad shall be capable of withstanding the traffic of the aircraft it is intended to serve, due consideration being given to the fact that the de-icing/anti-icing pad (like an apron) will be subjected to a higher density of traffic and, as a result of slow-moving or stationary aircraft, to higher stresses than a runway.

Clearance distances on a de-icing/anti-icing pad

3.15.9 A de-icing/anti-icing pad shall provide the minimum clearances specified in 3.13.6 for aircraft stands. If the pad layout is such as to include bypass configuration, the minimum separation distances specified in Table (3-1), column 13, shall be provided.

3.15.10 Where the de-icing/anti-icing facility is located adjoining a regular taxiway, the taxiway minimum separation distance specified in Table (3-1), column 11, shall be provided. (See Figure (3-4))

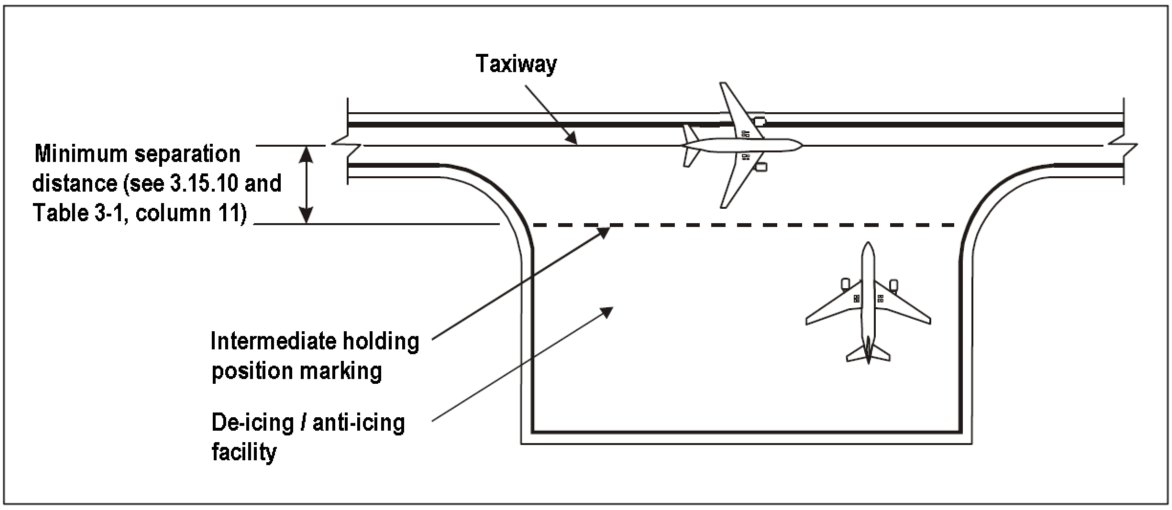


Figure 3-4. Minimum separation distance on a de-icing/anti-icing facility

Environmental considerations

Note: The excess de-icing/anti-icing fluid running off an airplane poses the risk of contamination of ground water in addition to affecting the pavement surface friction characteristics.

3.15.11 Where de-icing/anti-icing activities are carried out, the surface drainage shall be planned to collect the run-off separately, preventing its mixing with the normal surface run-off so that it does not pollute the ground water.

Chapter (4)
Obstacle Restriction and Removal
(Applicable until 20 November 2030)

Note (1): The objectives of the specifications in this chapter are to define the airspace around aerodromes to be maintained free from obstacles so as to permit the intended airplane operations at the aerodromes to be conducted safely and to prevent the aerodromes from becoming unusable by the growth of obstacles around the aerodromes. This is achieved by establishing a series of obstacle limitation surfaces that define the limits to which objects may project into the airspace.

Note (2): Objects which penetrate the obstacle limitation surfaces contained in this chapter may in certain circumstances cause an increase in the obstacle clearance altitude/height for an instrument approach procedure or any associated visual circling procedure or have other operational impact on flight procedure design.

Note (3): The establishment of, and requirements for, an obstacle protection surface for visual approach slope indicator systems are specified in Chapter 5 paragraph 5.5.42 to 5.5.46.

4.1 Obstacle Limitation Surfaces

Note: See Figure 4-1.

Outer horizontal surface

Note: Guidance on the need to provide an outer horizontal surface and its characteristics is contained in CARC Guidance Material 34-GM-04 Control of Obstacles.

Conical surface

4.1.1 **Description** — Conical surface: A surface sloping upwards and outwards from the periphery of the inner horizontal surface.

4.1.2 **Characteristics** — The limits of the conical surface shall comprise:

— a lower edge coincident with the periphery of the inner horizontal surface; and

— an upper edge located at a specified height above the inner horizontal surface.

4.1.3 The slope of the conical surface shall be measured in a vertical plane perpendicular to the periphery of the inner horizontal surface.

Inner horizontal surface

4.1.4 **Description** — Inner horizontal surface: A surface located in a horizontal plane above an aerodrome and its environs.

4.1.5 **Characteristics** — The radius or outer limits of the inner horizontal surface shall be measured from a reference point or points established for such purpose.

Note: The shape of the inner horizontal surface need not necessarily be circular. Guidance on determining the extent of the inner horizontal surface is contained in CARC Guidance Material 34-GM-04 Control of Obstacles.

4.1.6 The height of the inner horizontal surface shall be measured above an elevation datum established for such purpose.

Note: Guidance on determining the elevation datum is contained in CARC Guidance Material 34-GM-04 Control of Obstacles.

Approach surface

4.1.7 **Description** — Approach surface: An inclined plane or combination of planes preceding the threshold.

4.1.8 **Characteristics** — The limits of the approach surface shall comprise:

(a) an inner edge of specified length, horizontal and perpendicular to the extended center line of the runway and located at a specified distance before the threshold;

(b) two sides originating at the ends of the inner edge and diverging uniformly at a specified rate from the extended center line of the runway;

(c) an outer edge parallel to the inner edge; and

(d) The above surfaces shall be varied when lateral offset, offset or curved approaches are utilized, specifically, two sides originating at the ends of the inner edge and diverging uniformly at a specified rate from the extended center line of the lateral offset, offset or curved ground track.

4.1.9 The elevation of the inner edge shall be equal to the elevation of the mid-point of the threshold.

4.1.10 The slope(s) of the approach surface shall be measured in the vertical plane containing the center line of the runway and shall continue containing the center line of any lateral offset or curved ground track.

Inner approach surface

4.1.11 **Description** — Inner approach surface: A rectangular portion of the approach surface immediately preceding the threshold.

4.1.12 **Characteristics** — The limits of the inner approach surface shall comprise:

(a) an inner edge coincident with the location of the inner edge of the approach surface but of its own specified length;

(b) two sides originating at the ends of the inner edge and extending parallel to the vertical plane containing the center line of the runway; and

(c) an outer edge parallel to the inner edge.

Transitional surface

4.1.13 **Description** — Transitional surface: A complex surface along the side of the strip and part of the side of the approach surface, that slopes upwards and outwards to the inner horizontal surface.

4.1.14 **Characteristics** — The limits of a transitional surface shall comprise:

(a) a lower edge beginning at the intersection of the side of the approach surface with the inner horizontal surface and extending down the side of the approach surface to the inner edge of the approach surface and from there along the length of the strip parallel to the runway center line; and

(b) an upper edge located in the plane of the inner horizontal surface.

4.1.15 The elevation of a point on the lower edge shall be:

(a) <u>along the side of the approach surface</u>: equal to the elevation of the approach surface at that point; and

(b) <u>along the strip</u>: equal to the elevation of the nearest point on the center line of the runway or its extension.

Note: As a result of b) the transitional surface along the strip will be curved if the runway profile is curved, or a plane if the runway profile is a straight line. The intersection of the transitional surface with the inner horizontal surface will also be a curved or a straight line depending on the runway profile.

4.1.16 The slope of the transitional surface shall be measured in a vertical plane at right angles to the center line of the runway.

Inner transitional surface

Note: It is intended that the inner transitional surface be the controlling obstacle limitation surface for navigation aids, aircraft and other vehicles that must be near the runway and which is not to be penetrated except for frangible objects. The transitional surface described in 4.1.13 is intended to remain as the controlling obstacle limitation surface for buildings, etc.

4.1.17 **Description** — Inner transitional surface: A surface similar to the transitional surface but closer to the runway.

4.1.18 **Characteristics** — The limits of an inner transitional surface shall comprise:

(a) a lower edge beginning at the end of the inner approach surface and extending down the side of the inner approach surface to the inner edge of that surface, from there along the strip parallel to the runway center line to the inner edge of the balked landing surface and from there up the side of the balked landing surface to the point where the side intersects the inner horizontal surface; and

(b) an upper edge located in the plane of the inner horizontal surface.

4.1.19 The elevation of a point on the lower edge shall be:

(a) along the side of the inner approach surface and balked landing surface — equal to the elevation of the particular surface at that point; and

(b) along the strip — equal to the elevation of the nearest point on the center line of the runway or its extension.

Note: As a result of b) the inner transitional surface along the strip will be curved if the runway profile is curved or a plane if the runway profile is a straight line. The intersection of the inner transitional surface with the inner horizontal surface will also be a curved or straight line depending on the runway profile.

4.1.20 The slope of the inner transitional surface shall be measured in a vertical plane at right angles to the center line of the runway.

Balked landing surface

4.1.21 **Description** — Balked landing surface: An inclined plane located at a specified distance after the threshold, extending between the inner transitional surface.

4.1.22 **Characteristics** — The limits of the balked landing surface shall comprise:

(a) an inner edge horizontal and perpendicular to the center line of the runway and located at a specified distance after the threshold;

(b) two sides originating at the ends of the inner edge and diverging uniformly at a specified rate from the vertical plane containing the center line of the runway; and

(c) an outer edge parallel to the inner edge and located in the plane of the inner horizontal surface.

4.1.23 The elevation of the inner edge shall be equal to the elevation of the runway center line at the location of the inner edge.

4.1.24 The slope of the balked landing surface shall be measured in the vertical plane containing the center line of the runway.

Take-off climb surface

4.1.25 **Description** — Take-off climb surface: An inclined plane or other specified surface beyond the end of a runway or clearway.

4.1.26 **Characteristics** — The limits of the take-off climb surface shall comprise:

(a) an inner edge horizontal and perpendicular to the center line of the runway and located either at a specified distance beyond the end of the runway or at the end of the clearway when such is provided and its length exceeds the specified distance;

(b) two sides originating at the ends of the inner edge, diverging uniformly at a specified rate from the take-off track to a specified final width and continuing thereafter at that width for the remainder of the length of the takeoff climb surface; and

(c) an outer edge horizontal and perpendicular to the specified take-off track.

4.1.27 The elevation of the inner edge shall be equal to the highest point on the extended runway center line between the end of the runway and the inner edge, except that when a clearway is provided the elevation shall be equal to the highest point on the ground on the center line of the clearway.

4.1.28 In the case of a straight take-off flight path, the slope of the take-off climb surface shall be measured in the vertical plane containing the center line of the runway.

4.1.29 In the case of a take-off flight path involving a turn, the take-off climb surface shall be a complex surface containing the horizontal normals to its center line, and the slope of the center line shall be the same as that for a straight take-off flight path.

4.2 Obstacle Limitation Requirements

Note: The requirements for obstacle limitation surfaces are specified on the basis of the intended use of a runway, i.e. take-off or landing and type of approach, and are intended to be applied when such use is made of the runway. In cases where operations are conducted to or from both directions of a runway, then the function of certain surfaces may be nullified because of more stringent requirements of another lower surface.

Non-instrument runways

4.2.1 The following obstacle limitation surfaces shall be established for a non-instrument runway:

— conical surface;

— inner horizontal surface;

— approach surface; and

— transitional surfaces.

4.2.2 The heights and slopes of the surfaces shall not be greater than, and their other dimensions not less than, those specified in Table 4-1.

4.2.3 New objects or extensions of existing objects shall not be permitted above an approach or transitional surface except when, in the opinion of the CARC, the new object or extension would be shielded by an existing immovable object.

Note: Circumstances in which the shielding principle may reasonably be applied are described in CARC Guidance Material 34-GM-04 Control of Obstacles.

4.2.4 New objects or extensions of existing objects shall not be permitted above the conical surface or inner horizontal surface except when, in the opinion of the CARC, the object would be shielded by an existing immovable object, or after aeronautical study it is determined that the object would not adversely affect the safety or significantly affect the regularity of operations of airplanes.

4.2.5 Existing objects above any of the surfaces required by 4.2.1 shall be removed except when, in the opinion of the CARC, the object is shielded by an existing immovable object, or after aeronautical study it is determined that the object would not adversely affect the safety or significantly affect the regularity of operations of airplanes.

Note: Because of transverse or longitudinal slopes on a strip, in certain cases the inner edge or portions of the inner edge of the approach surface may be below the corresponding elevation of the strip. It is not intended that the strip be graded to conform with the inner edge of the approach surface, nor is it intended that terrain or objects which are above the approach surface beyond the end of the strip, but below the level of the strip, be removed unless it is considered they may endanger airplanes.

4.2.6 In considering proposed construction, account shall be taken of the possible future development of an instrument runway and consequent requirement for more stringent obstacle limitation surfaces.

Non-precision approach runways

4.2.7 The following obstacle limitation surfaces shall be established for a non-precision approach runway:

— conical surface;

— inner horizontal surface;

— approach surface; and

— transitional surfaces.

4.2.8 The heights and slopes of the surfaces shall not be greater than, and their other dimensions not less than, those specified in Table 4-1, except in the case of the horizontal section of the approach surface (see 4.2.9).

4.2.9 The approach surface shall be horizontal beyond the point at which the 2.5 per cent slope intersects:

(a) a horizontal plane 150 m above the threshold elevation; or

(b) the horizontal plane passing through the top of any object that governs the obstacle clearance altitude/height (OCA/H);

whichever is the higher.

4.2.10 New objects or extensions of existing objects shall not be permitted above an approach surface within 3 000 m of the inner edge or above a transitional surface except when, in the opinion of the CARC, the new object or extension would be shielded by an existing immovable object.

Note: Circumstances in which the shielding principle may reasonably be applied are described in CARC Guidance Material 34-GM-04 Control of Obstacles.

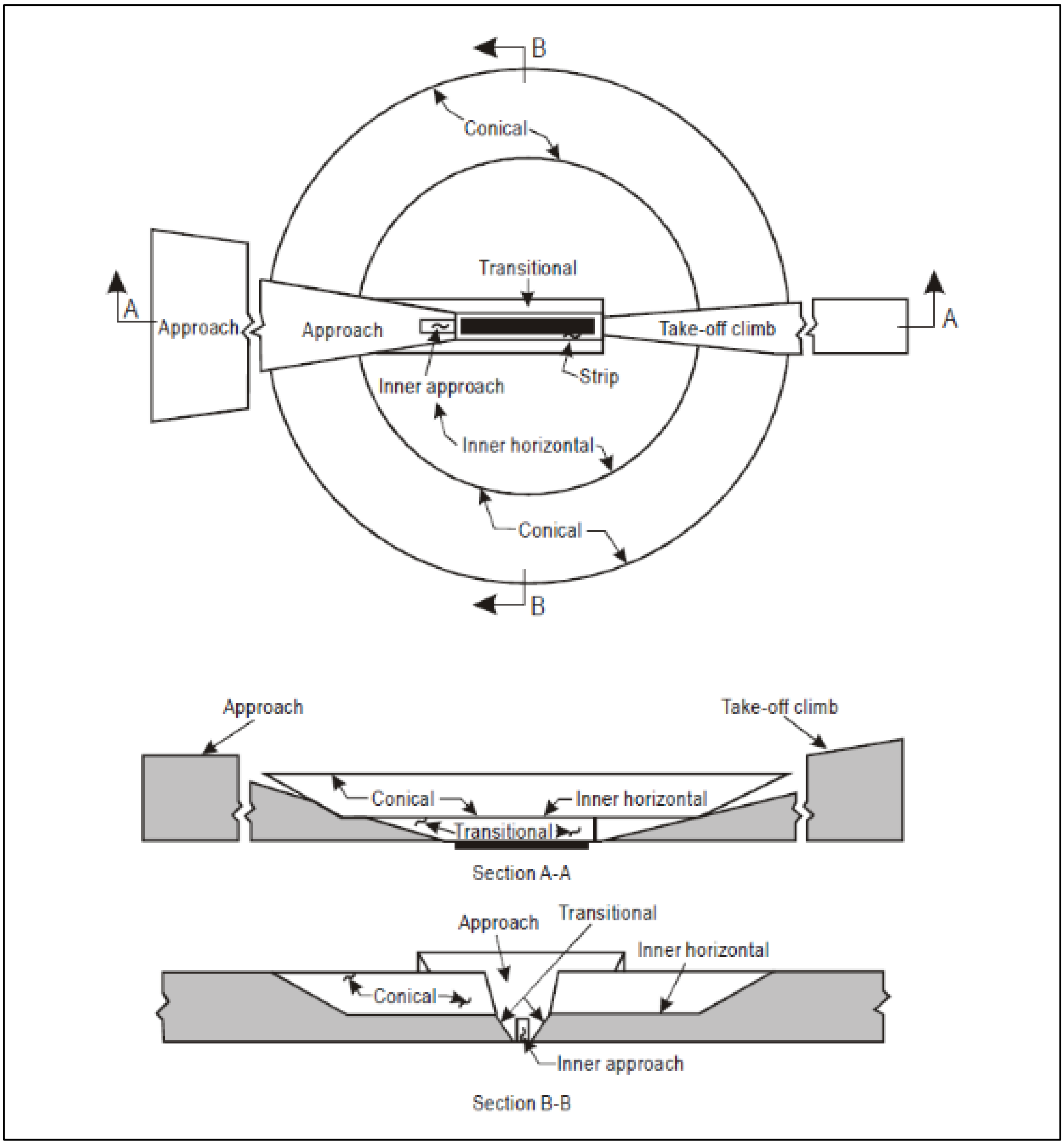


Figure 4-1. Obstacle Limitation Surfaces

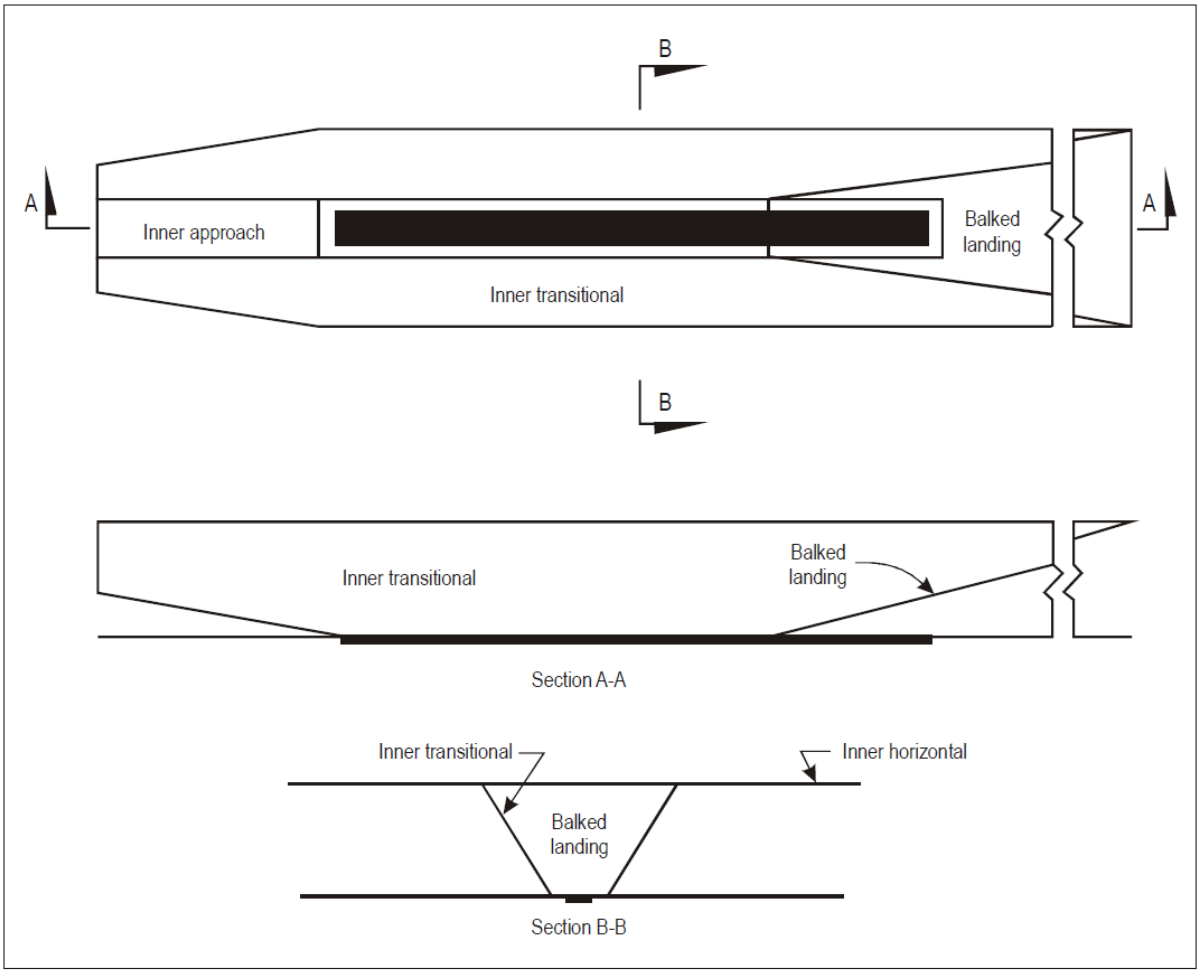


Figure 4-2. Inner approach, inner transitional and balked landing Obstacle limitation surfaces

4.2.11 New objects or extensions of existing objects shall not be permitted above the approach surface beyond 3 000 m from the inner edge, the conical surface or inner horizontal surface except when, in the opinion of the CARC, the object would be shielded by an existing immovable object, or after aeronautical study it is determined that the object would not adversely affect the safety or significantly affect the regularity of operations of airplanes.

4.2.12 Existing objects above any of the surfaces required by 4.2.7 shall be removed except when, in the opinion of the CARC, the object is shielded by an existing immovable object, or after aeronautical study it is determined that the object would not adversely affect the safety or significantly affect the regularity of operations of airplanes.

Note: Because of transverse or longitudinal slopes on a strip, in certain cases the inner edge or portions of the inner edge of the approach surface may be below the corresponding elevation of the strip. It is not intended that the strip be graded to conform with the inner edge of the approach surface, nor is it intended that terrain or *objects which are above the approach surface beyond the end of the strip, but below the level of the strip, be removed unless it is considered they may endanger airplanes.*

Precision approach runways

Note (1): Guidance on obstacle limitation surfaces for precision approach runways is given in CARC Guidance Material 34-GM-04 Control of Obstacles.

Note (2): Refer to Chapter 9 section 9.9 for information regarding siting of equipment and installations on operational areas.

4.2.13 The following obstacle limitation surfaces shall be established for a precision approach runway:

— conical surface;

— inner horizontal surface;

— approach surface;

— transitional surfaces;

— inner approach surface;

— inner transitional surfaces;

— balked landing surface.

4.2.14 Reserved.

4.2.15 The following obstacle limitation surfaces shall be established for a precision approach runway category II or III:

— conical surface;

— inner horizontal surface;

— approach surface and inner approach surface;

— transitional surfaces;

— inner transitional surfaces; and

— balked landing surface.

4.2.16 The heights and slopes of the surfaces shall not be greater than, and their other dimensions not less than, those specified in Table 4-1, except in the case of the horizontal section of the approach surface (see 4.2.17).

4.2.17 The approach surface shall be horizontal beyond the point at which the 2.5 per cent slope intersects:

(a) a horizontal plane 150 m above the threshold elevation; or

(b) the horizontal plane passing through the top of any object that governs the obstacle clearance limit; whichever is the higher.

4.2.18 Fixed objects shall not be permitted above the inner approach surface, the inner transitional surface or the balked landing surface, except for frangible objects which because of their function must be located on the strip. Mobile objects shall not be permitted above these surfaces during the use of the runway for landing.

4.2.19 New objects or extensions of existing objects shall not be permitted above an approach surface or a transitional surface except when, in the opinion of the CARC, the new object or extension would be shielded by an existing immovable object.

Note: Circumstances in which the shielding principle may reasonably be applied are described in CARC Guidance Material 34-GM-04 Control of Obstacles.

4.2.20 New objects or extensions of existing objects shall not be permitted above the conical surface and the inner horizontal surface except when, in the opinion of the CARC, an object would be shielded by an existing immovable object, or after aeronautical study it is determined that the object would not adversely affect the safety or significantly affect the regularity of operations of airplanes.

4.2.21 Existing objects above an approach surface, a transitional surface, the conical surface and inner horizontal surface shall be removed except when, in the opinion of the CARC, an object is shielded by an existing immovable object, or after aeronautical study it is determined that the object would not adversely affect the safety or significantly affect the regularity of operations of airplanes.

Note: Because of transverse or longitudinal slopes on a strip, in certain cases the inner edge or portions of the inner edge of the approach surface may be below the corresponding elevation of the strip. It is not intended that the strip be graded to conform with the inner edge of the approach surface, nor is it intended that terrain or objects which are above the approach surface beyond the end of the strip, but below the level of the strip, be removed unless it is considered they may endanger airplanes.

Runways meant for take-off

4.2.22 The following obstacle limitation surface shall be established for a runway meant for take-off:

— take-off climb surface.

4.2.23 The dimensions of the surface shall be not less than the dimensions specified in Table 4-2, except that a lesser length may be adopted for the take-off climb surface where such lesser length would be consistent with procedural measures adopted to govern the outward flight of airplanes.

4.2.24 The operational characteristics of airplanes for which the runway is intended shall be examined to see if it is desirable to reduce the slope specified in Table 4-2 when critical operating conditions are to be catered to. If the specified slope is reduced, corresponding adjustment in the length of take-off climb surface shall be made so as to provide protection to a height of 300 m.

Note: When local conditions differ widely from sea level standard atmospheric conditions, it may be advisable for the slope specified in Table 4-2 to be reduced. The degree of this reduction depends on the divergence between local conditions and sea level standard atmospheric conditions, and on the performance characteristics and operational requirements of the airplanes for which the runway is intended.

4.2.25 New objects or extensions of existing objects shall not be permitted above a take-off climb surface except when, in the opinion of the CARC, the new object or extension would be shielded by an existing immovable object.

Note: Circumstances in which the shielding principle may reasonably be applied are described in CARC Guidance Material 34-GM-04 Control of Obstacles.

Table 4-1. Dimensions and Slopes of Obstacle Limitation Surfaces
Approach Runways

	RUNWAY CLASSIFICATION									
	Non-instrument				**Non-precision approach**			**Precision approach category**		
								I		**II or III**
	Code number				**Code number**			**Code number**		**Code number**
Surface and dimensions [a]	**1**	**2**	**3**	**4**	**1,2**	**3**	**4**	**1,2**	**3,4**	**3,4**
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**
CONICAL										
Slope	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Height	35 m	55 m	75 m	100 m	60 m	75 m	100 m	60 m	100 m	100 m
INNER HORIZONTAL										
Height	45 m	45 m	45 m	45 m	45 m	45 m	45 m	45 m	45 m	45 m
Radius	2 000 m	2 500 m	4 000 m	4 000 m	3 500 m	4 000 m	4 000 m	3 500 m	4 000 m	4 000 m
INNER APPROACH										
Width	—	—	—	—	—	—	—	90 m	120 m [e]	120 m [e]
Distance from threshold	—	—	—	—	—	—	—	60 m	60 m	60 m
Length	—	—	—	—	—	—	—	900 m	900 m	900 m
Slope	—	—	—	—	—	—	—	2.5%	2%	2%
APPROACH										
Length of inner edge	60 m	80 m	110m	150 m	140 m	280 m	280 m	140 m	280 m	280 m
Distance from threshold	30 m	60 m	60 m	60 m	60 m	60 m	60 m	60 m	60 m	60 m

Divergence (each side)	10%	10%	10%	10%	15%	15%	15%	15%	15%	15%
First section										
Length	1 600 m	2 500 m	3 000 m	3 000 m	2 500 m	3 000 m	3 000 m	3 000 m	3 000 m	3 000 m
Slope	5%	4%	3.33%	2.5%	3.33%	2%	2%	2.5%	2%	2%
Second section										
Length	—	—	—	—	—	3 600 m [b]	3 600 m [b]	12 000 m	3 600 m [b]	3 600 m [b]
Slope	—	—	—	—	—	2.5%	2.5%	3%	2.5%	2.5%
Horizontal section										
Length	—	—	—	—	—	8 400 m [b]	8 400 m [b]	—	8 400 m [b]	8 400 m [b]
Total length	—	—	—	—	—	15 000 m	15 000 m	15 000 m	15 000 m	15 000 m
TRANSITIONAL										
Slope	20%	20%	14.3%	14.3%	20%	14.3%	14.3%	14.3%	14.3%	14.3%
INNER TRANSITIONAL										
Slope	—	—	—	—	—	—	—	40%	33.3%	33.3%
BALKED LANDING SURFACE										
Length of inner edge	—	—	—	—	—	—	—	90 m	120 m [e]	120 m [e]
Distance from threshold	—	—	—	—	—	—	—	[c]	1 800 m [d]	1 800 m [d]
Divergence (each side)	—	—	—	—	—	—	—	10%	10%	10%
Slope	—	—	—	—	—	—	—	4%	3.33%	3.33%
OUTER HORIZONTAL										
Radius	—	—	—	—	—	—	—	15 000 m	15 000 m	15 000 m

(a) All dimensions are measured horizontally unless specified otherwise.
(b) Variable length (see 4.2.9 or 4.2.17).
(c) Distance to the end of the strip.
(d) Or end of runway whichever is less.
(e) Where the code letter is F (Column (3) of Table 1-1), the width is increased to 140 m. except for those aerodromes that accommodate a code letter F airplanes equipped with digital avionics that provide steering commands to maintain an established track during the go-around maneuver, see ICAO Circular 301 – New Larger Aeroplanes - Infringement of the Obstacle Free Zone: Operational Measures and Aeronautical Study.

4.2.26 If no object reaches the 2 per cent (1:50) take-off climb surface, new objects shall be limited to preserve the existing obstacle free surface or a surface down to a slope of 1.6 per cent (1:62.5).

4.2.27 Existing objects that extend above a take-off climb surface shall be removed except when, in the opinion of the appropriate authority, an object is shielded by an existing immovable object, or after aeronautical study it is determined that the object would not adversely affect the safety or significantly affect the regularity of operations of airplanes.

Note: Because of transverse slopes on a strip or clearway, in certain cases portions of the inner edge of the take-off climb surface may be below the corresponding elevation of the strip or clearway. It is not intended that the strip or clearway be graded to conform with the inner edge of the take-off climb surface, nor is it intended that terrain or objects which are above the take-off climb surface beyond the end of the strip or clearway, but below the level of the strip or clearway, be removed unless it is considered they may endanger airplanes. Similar considerations apply at the junction of a clearway and strip where differences in transverse slopes exist.

Table 4-2. Dimensions and Slopes of Obstacle Limitation Surface
Runways Meant for Take-Off

Surface and dimensions [a]	Code number		
	1	2	3
(1)	(2)	(3)	(4)
TAKE-OFF CLIMB			
Length of inner edge	60 m	80 m	180 m
Distance from runway end [b]	30 m	60 m	60 m
Divergence (each side)	10%	10%	12.5%
Final width	380 m	580 m	1 200 m 1 800 m [c]
Length	1 600 m	2 500 m	15 000 m
Slope	5%	4%	2% [d]

(a) All dimensions are measured horizontally unless specified otherwise.
(b) The take-off climb surface starts at the end of the clearway if the clearway length exceeds the specified distance.
(c) 1 800 m when the intended track includes changes of heading greater than 15º for operations conducted in IMC, VMC by night
(d) See 4.2.24 and 4.2.26.

4.3 Objects Outside the Obstacle Limitation Surfaces

4.3.1 Arrangements shall be made with municipalities to enable the CARC to be consulted concerning proposed construction beyond the limits of the obstacle limitation surfaces that extend above a height established by the CARC, in order to permit an aeronautical study of the effect of such construction on the operation of airplanes.

4.3.2 In areas beyond the limits of the obstacle limitation surfaces, at least those objects which extend to a height of 150 m or more above ground elevation shall be regarded as obstacles, unless a special aeronautical study indicates that they do not constitute a hazard to airplanes.

Note: This study may have regard to the nature of operations concerned and may distinguish between day and night operations.

4.4 Other Objects

4.4.1 Objects which do not project through the approach surface but which would nevertheless adversely affect the optimum siting or performance of visual or non-visual aids shall be removed.

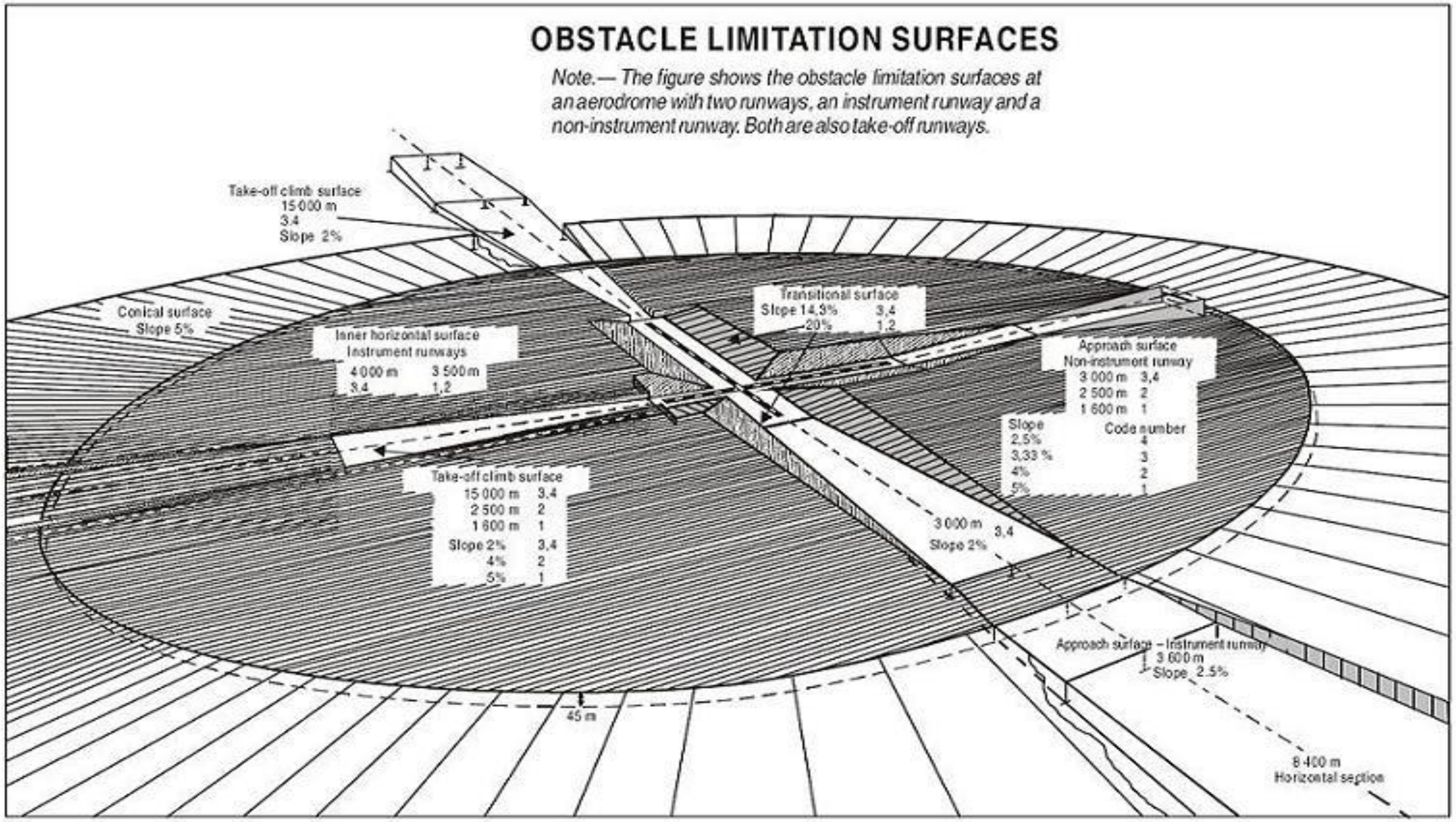
4.4.2 Anything which may, in the opinion of the CARC after aeronautical study, endanger airplanes on the movement area or in the air within the limits of the inner horizontal and conical surfaces shall be regarded as an obstacle and shall be removed in so far as practicable.

Note (1): In certain circumstances, objects that do not project above any of the surfaces enumerated in 4.1 may constitute to airplanes as, for example, where there are one or more isolated objects in the vicinity of an aerodrome.

Note (2): Figure 4-3 the following page illustrates a three dimensional view of the obstacle limitation surfaces at an aerodrome.

Figure 4-3. Obstacle Limitation Surfaces

3-Dimensional View



Chapter 4.
Obstacle Restriction and Removal
(Applicable as of 21 November 2030)

Note (1): This chapter describes the management of obstacles within the aerodrome boundary and in its vicinity. The following specifications allow CARC to define the airspace around aerodromes to be maintained free from obstacles and the airspace where flexibility can be applied in managing the obstacle environment. This permits the existing and intended aeroplane operations at the aerodromes to be conducted safely and prevent the aerodromes from becoming restricted and eventually unusable by the growth of obstacles. This is achieved by establishing obstacle limitation surfaces (OLS) consisting of obstacle free surfaces (OFS) and obstacle evaluation surfaces (OES).

Note (2): The lateral and vertical extent of the OLS are being used in defining the requirements for the collection of terrain and obstacle data sets. Provisions on terrain and obstacle data sets are contained in ICAO Annex 15 — Aeronautical Information Services, *Chapter 5.*

Note (3): The establishment of, and requirements for, an obstacle protection surface for visual approach slope indicator systems are specified in Chapter 5, 5.3.5.41 to 5.3.5.45.

4.1 General

4.1.1 CARC will establish a process to prevent the growth of obstacles, both fixed and mobile, that may affect the safety or regularity of flight operations at an aerodrome.

Note (1): Specifications concerning the process to be established by CARC are contained in CARC Guidance Material 34-GM-16 PANS-Aerodromes, Part II, Chapter 10.

Note (2): Taxiing aircraft, aircraft on tow and traversing vehicles are considered mobile objects whereas buildings, parked aircraft and vehicles are considered fixed objects.

4.2 Obstacle free surfaces (OFS)

Note: The purpose of the obstacle free surfaces is to establish airspace that preserves the accessibility of the aerodrome and the safety of operations by protecting aeroplanes during approaches and go-arounds.

4.2.1 Approach surface

Note: The purpose of the approach surface is to establish the airspace to be maintained free from obstacles to protect an aeroplane in the visual phase of the approach-to-land manoeuvres following a standard 3.0° approach. See Figure 4-1.

Description

4.2.1.1 An inclined surface preceding the threshold.

Characteristics

4.2.1.2 The limits of the approach surface shall comprise:

(a) an inner edge of specified length, horizontal and perpendicular to the extended centre line of the runway and located at a specified distance before the threshold;

(b) two sides originating at the ends of the inner edge and diverging uniformly at a specified rate from the extended centre line of the runway; and

(c) an outer edge parallel to the inner edge.

4.2.1.3 The surface mentioned in 4.2.1.2 shall be varied when lateral offset, angular offset or curved approaches are utilized; two sides originating at the ends of the inner edge and diverging uniformly at a specified rate from the extended centre line of the lateral offset, angular offset or curved ground track.

4.2.1.4 The elevation of the inner edge shall be equal to the elevation of the midpoint of the threshold.

4.2.1.5 The slope of the approach surface shall be measured:

(a) when straight-in approaches are utilized in the vertical plane containing the centre line of the runway and its extension; and

(b) when lateral offset, angular offset or curved approaches are utilized along any straight part of the approach, in the vertical plane containing the centre line of the lateral offset, angular offset or curved ground track or, along any curved part of the approach, in the vertical plane tangent with the curved ground track.

4.2.1.6 Except where the approach surface is raised to comply with approach angles greater than 3.0°, the slope of the approach surface shall not be greater than, and their other dimensions not less than, those specified in Table 4-1 for non-instrument runways and Table 4-2 for instrument runways.

4.2.1.7 The slope of the approach surface shall not be increased to facilitate the growth of obstacles.

Note: The slope of the approach surface is intended to adapt to approach operations that have a slope higher than 3.0°. Specifications concerning the modification of the approach surface are contained in CARC Guidance Material 34-GM-16 PANS-Aerodromes, Part II, Chapter 10.

4.2.1.8 Where the approach angle is lower than 3.0°, the slope of the approach surface shall be decreased.

4.2.1.9 Where the slope of the obstacle protection surface of a visual approach slope indicator system is lower than that indicated in Table 4-1 and Table 4-2, the slope of the approach surface shall be decreased to match that of the obstacle protection surface.

Note: See Chapter 5, 5.3.5 on the obstacle protection surface.

4.2.1.10 Where the slope of the approach surface is reduced, corresponding adjustment in the length of the approach surface shall be made to provide protection to a height equal to that reached with the slopes and lengths in Table 4-1 and Table 4-2.

4.2.1.11 On instrument approach runways, where the obstacle clearance height is higher than 150 m (500 ft) above the threshold, the length of the approach surface shall not be less than:

(a) the value indicated in Table 4-2; or

(b) that necessary to reach the obstacle clearance height; whichever is greater.

Table 4-1. Dimensions and slopes of approach surface — Non-instrument runways

Aeroplane design group	I	IIA-IIB	IIC	III	IV	V
Distance from threshold	30 m	60 m	60 m	60 m	60 m	60 m
Length of inner edge	60 m[a b]	80 m[c d]	100 m[d]	125 m	135 m	150 m
Divergence	10 %	10 %	10 %	10 %	10 %	10 %
Length	1 600 m[e]	2 500 m[e]	2 500 m[e]	2 500 m[e]	2 500 m[e]	2 500 m[e]
Slope	5 %[f]	4 %[f]	3.33 %[f]	3.33 %[f]	3.33 %[f]	3.33 %[f]

[a] Where runway width is above 23 m and up to 30 m, the length of inner edge is increased to 80 m.
[b] Where runway width is above 30 m, the length of inner edge is increased to 100 m.
[c] Where runway width is above 30 m and up to 45 m, the length of inner edge is increased to 100 m.
[d] Where runway width is above 45 m, the length of inner edge is increased to 110 m.
[e] See 4.2.1.10.
[f] See 4.2.1.8 and 4.2.1.9.

Table 4-2. Dimensions and slopes of approach surface — Instrument runways

Aeroplane design group	I	IIA-IIB	IIC	III	IV	V
Distance from threshold	60 m	60 m	60 m	60 m	60 m	60 m
Length of inner edge	110 m [a]	125 m [b]	155 m [c]	175 m	185 m	200 m
Divergence	10%	10%	10%	10 %	10%	10%
Length	4 500 m [d]	4 500 m [d]	4 500 m [d]	4 500 m [d]	4 500 m [d]	4 500 m [d]
Slope	3.33% [e]	3.33% [e]	3.33% [e]	3.33% [e]	3.33% [e]	3.33% [e]

[a] When the runway width is above 30 m, the length of inner edge is increased to 125 m.
[b] When the runway width is above 30 m, the length of inner edge is increased to 140 m.
[c] When the runway width is 30 m or less, the length of inner edge is decreased to 140 m.
[d] See 4.2.1.10 and 4.2.1.11.
[e] See 4.2.1.8 and 4.2.1.9.

4.2.2 Transitional surfaces

Note: The purpose of the transitional surfaces is to establish the airspace to be maintained free from fixed obstacles to protect an aeroplane in the overflight of the runway or go-around manoeuvre following a standard 3.0° approach, beyond the approach surface. See Figure 4-1.

Description

4.2.2.1 *Transitional surfaces.* A complex surface along and at a specified distance from the runway centre line and part of the side of the approach surface that slopes upwards and outwards to a specified height.

Characteristics

4.2.2.2 The limits of a transitional surface shall comprise:

(a) a lower edge beginning on the side of the approach surface at the elevation of the upper edge and extending down the side of the approach surface to the inner edge of the approach surface and from there along a line extending parallel to and at a specified distance from the runway centre line and its extension, to the end of the strip; and

(b) an upper edge located at 60 m above the elevation of the highest threshold of the runway.

4.2.2.3 The elevation of a point on the lower edge shall be:

(a) along the side of the approach surface equal to the elevation of the approach surface at that point; and

(b) along the runway centre line and its extension after the threshold equal to the elevation of the nearest point on the centre line of the runway or its extension.

Note: As a result of b) the transitional surfaces along the line parallel to the runway centre line will be curved if the runway profile is curved, or a plane if the runway profile is a straight line. The upper edge of the transitional surfaces will also be a curved or a straight line depending on the runway profile.

4.2.2.4 The slope of the transitional surfaces shall be measured in a vertical plane perpendicular to the vertical plane containing the runway centre line or its extension.

4.2.2.5 The slope of the transitional surface shall not be greater than 20 per cent.

4.2.3 Inner approach surface

Note: The inner approach surface protects an aeroplane against fixed and mobile obstacles before the threshold, in the descent phase of the balked landing or late go-around manoeuvres following a standard 3.0° approach. See Figure 4-2 and Figure 4-3.

Description
4.2.3.1 *Inner approach surface.* A rectangular portion of the approach surface immediately preceding the threshold.

Characteristics
4.2.3.2 The limits of the inner approach surface shall comprise:

(a) an inner edge coincident with the location of the inner edge of the approach surface but of its own specified length;

(b) two sides originating at the ends of the inner edge and extending parallel to the vertical plane containing the centre line of the runway; and

(c) an outer edge parallel to the inner edge.

4.2.3.3 The surface mentioned in 4.2.3.2 shall be varied when lateral offset, angular offset or curved approaches are utilized; two sides originating at the ends of the inner edge and extending parallel to the extended centre line of the lateral offset, angular offset or curved ground track.

4.2.3.4 The dimensions of the inner approach surface for non-instrument runway shall not be less than those specified in Table 4-3.

4.2.3.5 The dimensions of the inner approach surface for non-precision approach runway shall not be less than those specified in Table 4-4.

4.2.3.6 The dimensions of the inner approach surface for precision approach runway shall not be less than those specified in Table 4-5.

4.2.3.7 If the slope of the approach surface is reduced, the length of the inner approach surface shall be increased to provide protection to a height of 45 m (150 ft).

Table 4-3. Dimensions of inner approach surface — Non-instrument runways

Aeroplane design group	I	IIA-IIB	IIC	III	IV	V
Length of inner edge	60 m	80 m	100 m	110 m	120 m	120 m[a]
Length	900 m[b]	1 125 m[b]	1 350 m[b]	1 350 m[b]	1 350 m[b]	1 350 m[b]

[a] The length of inner edge is increased to 140 m on those aerodromes that accommodate a code letter F aeroplane that is not equipped with digital avionics that provide steering commands to maintain an established track during the go-around manoeuvre.
[b] See 4.2.3.7.

Table 4-4. Dimensions of inner approach surface — Non-precision approach runways

Aeroplane design group	I	IIA-IIB	IIC	III	IV	V
Length of inner edge	80 m	80 m	120 m	120 m	120 m	120 m[a]
Length	1 350 m[b]	1 350 m[b]	1 350 m[b]	1 350 m[b]	1 350 m[b]	1 350 m[b]

[a] The length of inner edge is increased to 140 m on those aerodromes that accommodate a code letter F aeroplane that is not equipped with digital avionics that provide steering commands to maintain an established track during the go-around manoeuvre.
[b] See 4.2.3.7.

Table 4-5. Dimensions of inner approach surface — Precision approach runways

Aeroplane design group	I	IIA-IIB	IIC	III	IV	V
Length of inner edge	90 m	90 m	120 m	120 m	120 m	120 m[a]
Length	1 350 m[b]	1 350 m[b]	1 350 m[b]	1 350 m[b]	1 350 m[b]	1 350 m[b]

[a] The length of inner edge is increased to 140 m on those aerodromes that accommodate a code letter F aeroplane that is not equipped with digital avionics that provide steering commands to maintain an established track during the go-around manoeuvre.
[b] See 4.2.3.7.

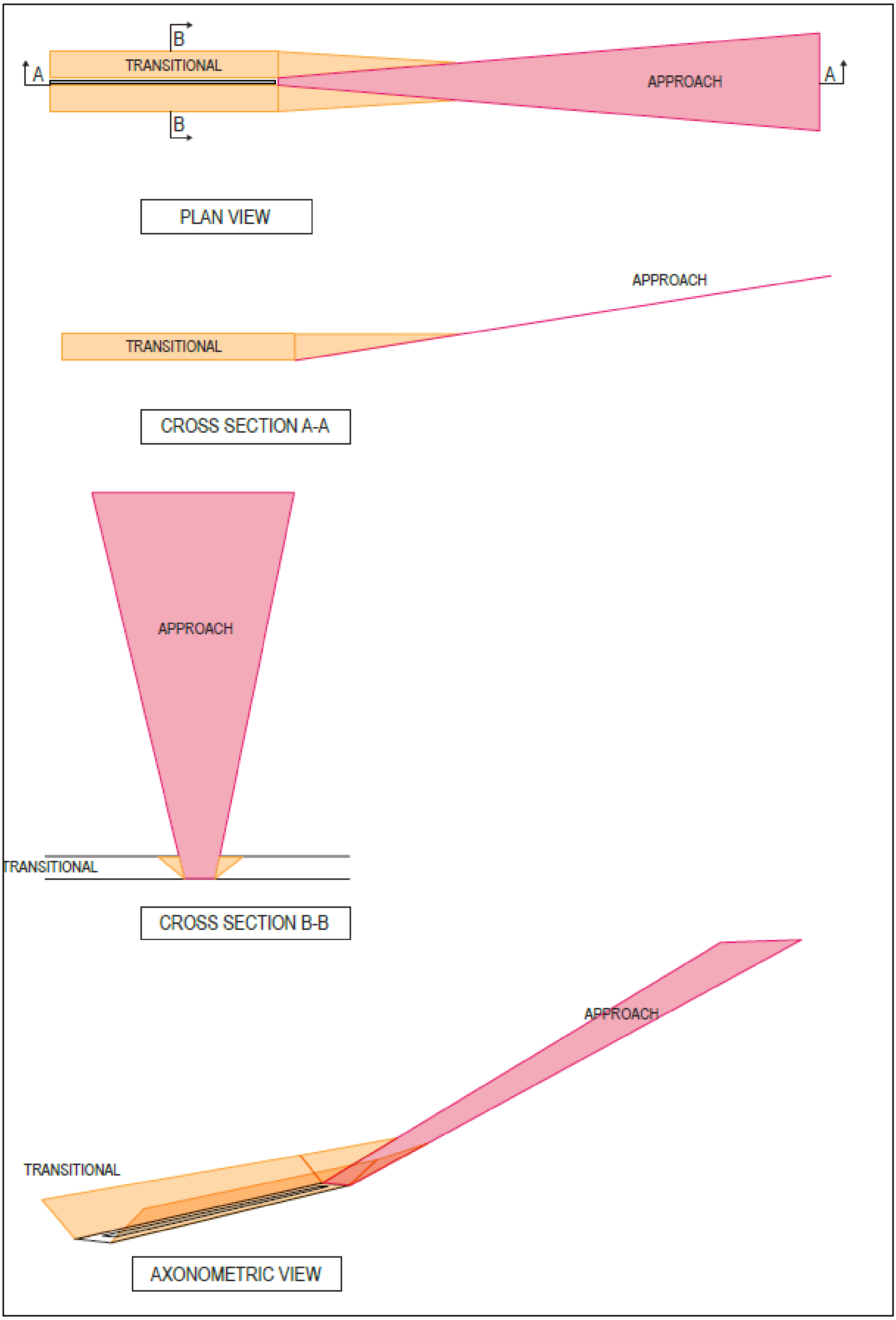


Figure 4-1. Approach surface and transitional surfaces

4.2.4 Inner transitional surfaces

Note: The inner transitional surfaces aim at establishing the airspace to be maintained free from fixed and mobile obstacles to protect an aeroplane in the climb phase of the balked landing or late go-around manoeuvres following a standard 3.0° approach, beyond the inner approach surface. See Figure 4-2 and Figure 4-3.

Description

4.2.4.1 *Inner transitional surfaces:*

(a) *Non-instrument and non-precision approach runways* — A complex surface at a specified distance from the runway centre line consisting of two successive sections: a first section that rises vertically to a given height, followed by a second inclined section that slopes upwards and outwards to a specified height; and

(b) *Precision approach runways* — A surface similar to the transitional surface but closer to the runway.

Characteristics

4.2.4.2 On non-instrument and non-precision approach runways:

(a) the limits of the vertical section of the inner transitional surface shall comprise:

1) a lower edge beginning on the side of the inner approach surface at a specified height above the inner edge of that surface, extending down the side of the inner approach surface to its inner edge, from there along a line parallel to and at a specified distance from the runway centre line, and its extension, to a specified length after the threshold and from there, vertically to a specific height; and

2) an upper edge parallel to, and at a specified height above, the runway centre line;

(b) the limits of the inclined section of the inner transitional surface shall comprise:

1) a lower edge beginning at the end of the inner approach surface and extending down the side of the inner approach surface to the upper edge of the vertical section, from there along the upper edge of the vertical section; and

2) an upper edge parallel to and at 60 m above the elevation of the highest threshold of the runway.

Characteristics

4.2.4.3 On precision approach runways, the limits of the inner transitional surface shall comprise:

(a) a lower edge beginning at the end of the inner approach surface and extending down the side of the inner approach surface to the inner edge of that surface, from there along a line parallel to and at a specified distance from the runway centre line and its extension to the inner edge of the balked landing surface and from there up the side of the balked landing surface to the upper edge; and

(b) an upper edge located at 60 m above the elevation of the highest threshold of the runway.

4.2.4.4 On non-instrument and non-precision approach runways, the elevation of a point shall be:

(a) on the lower edge of the vertical section:

1) along the side of the inner approach surface equal to the elevation of the inner approach surface at that point; and

2) after the inner edge of the inner approach surface equal to the elevation of the nearest point on the centre line of the runway or its extension;

(b) on the upper edge of the vertical section equal to a specific height above the nearest point on the centre line of the runway or its extension;

(c) on the lower edge of the inclined section:

1) along the side of the inner approach surface equal to the elevation of the inner approach surface at that point; and

2) along the upper edge of the lower section equal to the elevation of the upper edge of the lower section at that point.

Note: As a result of a), b) and c) the two sections of the inner transitional surfaces along the centre line of the runway will be curved if the runway profile is curved, or a plane if the runway profile is a straight line. The upper edges of both sections of the inner transitional surfaces will also be curved or straight lines depending on the runway profile.

4.2.4.5 On precision approach runways, the elevation of a point on the lower edge shall be:

(a) along the side of the inner approach surface and balked landing surface equal to the elevation of the particular surface at that point; and

(b) along the runway centre line and its extension equal to the elevation of the nearest point on the centre line of the runway or its extension;

Note: As a result of b) the inner transitional surfaces along the centre line of the runway will be curved if the runway profile is curved, or a plane if the runway profile is a straight line. The upper edge of the inner transitional surfaces will also be a curved or a straight line depending on the runway profile.

4.2.4.6 The slope of the inner transitional surfaces shall be measured:

(a) between the inner edges of the inner approach surface and balked landing surface: in a vertical plane perpendicular to the vertical plane containing the runway centre line and its extension;

(b) before the inner edge of the inner approach surface:

1) where straight-in approaches are utilized: in a vertical plane perpendicular to the vertical plane containing the runway centre line and its extension; and

2) where lateral offset, angular offset or curved approaches are utilized: along any straight part of the approach, in a vertical plane perpendicular to the vertical plane containing the straight part of the approach or, along any curved part of the approach, in the vertical plane tangent with the curved ground track.

4.2.4.7 The slope of the inner transitional surfaces for non-instrument runway shall not be greater than, and the height of the vertical section not lower than, that specified in Table 4-6.

4.2.4.8 The slope of the inner transitional surfaces for non-precision approach runway shall not be greater than, and the height of the vertical section not lower than, that specified in Table 4-7.

4.2.4.9 The slope of the inner transitional surfaces for precision runway shall not be greater than that specified in Table 4-8.

Table 4-6. Dimensions of inner transitional surfaces — Non-instrument runways

Aeroplane design group	I	IIA-IIB	IIC	III	IV	V
Height of the vertical section	6 m	6 m	8.4 m	10 m	5 m	5 m
Slope of the inclined section	40 %	40 %	33.3%	33.3%	33.3%	33.3%
Length	a	a	1 800 m[b]	1 800 m[b]	1 800 m[b]	1 800 m[b]

[a] To the end of the strip.
[b] Or to the end of the runway, whichever is less.

Table 4-7. Dimensions of inner transitional surfaces — Non-precision approach runways

Aeroplane design group	I	IIA-IIB	IIC	III	IV	V
Height of the vertical section	6 m	6 m	5 m	5 m	5 m	5 m
Slope of the inclined section	40 %	40 %	33.3%	33.3%	33.3%	33.3%
Length	a	a	1 800 m[b]	1 800 m[b]	1 800 m[b]	1 800 m[b]

[a] To the end of the strip.
[b] Or to the end of the runway, whichever is less.

Table 4-8. Slopes of inner transitional surfaces — Precision approach runways

Aeroplane design group	I	IIA-IIB	IIC	III	IV	V
Slope	40 %	40 %	33.3%	33.3%	33.3%	33.3%
Length	a	a	a	a	a	a

[a] See 4.2.4.3.

4.2.5 Balked landing surface

Note: The balked landing surface is intended to be implemented on precision approach runways, where the balked landing might be initiated at low height above the threshold and the climb phase of the manoeuvre is not necessarily covered by the inner transitional surfaces. The balked landing surface aims at establishing the airspace to be maintained free from fixed and mobile obstacles to protect an aeroplane in the climb phase of the balked landing or late go-around manoeuvres following a standard 3.0° approach, beyond the inner transitional surfaces. See Figure 4-3.

Description

4.2.5.1 *Balked landing surface*. An inclined surface located at a specified distance after the threshold, extending between the inner transitional surfaces.

Characteristics

4.2.5.2 The limits of the balked landing surface shall comprise:

(a) an inner edge horizontal and perpendicular to the centre line of the runway and located at a specified distance after the threshold;

(b) two sides originating at the ends of the inner edge and diverging uniformly at a specified rate from the vertical plane containing the centre line of the runway; and

(c) an outer edge parallel to the inner edge and located at 60 m above the elevation of the highest threshold of the runway.

4.2.5.3 The elevation of the inner edge shall be equal to the elevation of the nearest point on the runway centre line.

4.2.5.4 The slope of the balked landing surface shall be measured in the vertical plane containing the centre line of the runway and its extension;

4.2.5.5 The slope of the balked landing surface shall not be greater than, and its other dimensions not less than, those specified in Table 4-9.

Table 4-9. Dimensions and slopes of balked landing surface

Aeroplane design group	I	IIA-IIB	IIC	III	IV	V
Distance from threshold	a	a	1 800 m[b]	1 800 m[b]	1 800 m[b]	1 800 m[b]
Length of inner edge	90 m	90 m	120 m	120 m	120 m	120 m[c]
Divergence (each side)	10%	10%	10%	10%	10%	10%
Slope	5%	4%	3.33%	3.33%	3.33%	3.33%

a. End of the strip.
b. Or end of runway whichever is less.
c. The length of inner edge is increased to 140 m on those aerodromes that accommodate a code letter F aeroplane that is not equipped with digital avionics that provide steering commands to maintain an established track during the go-around manoeuvre.

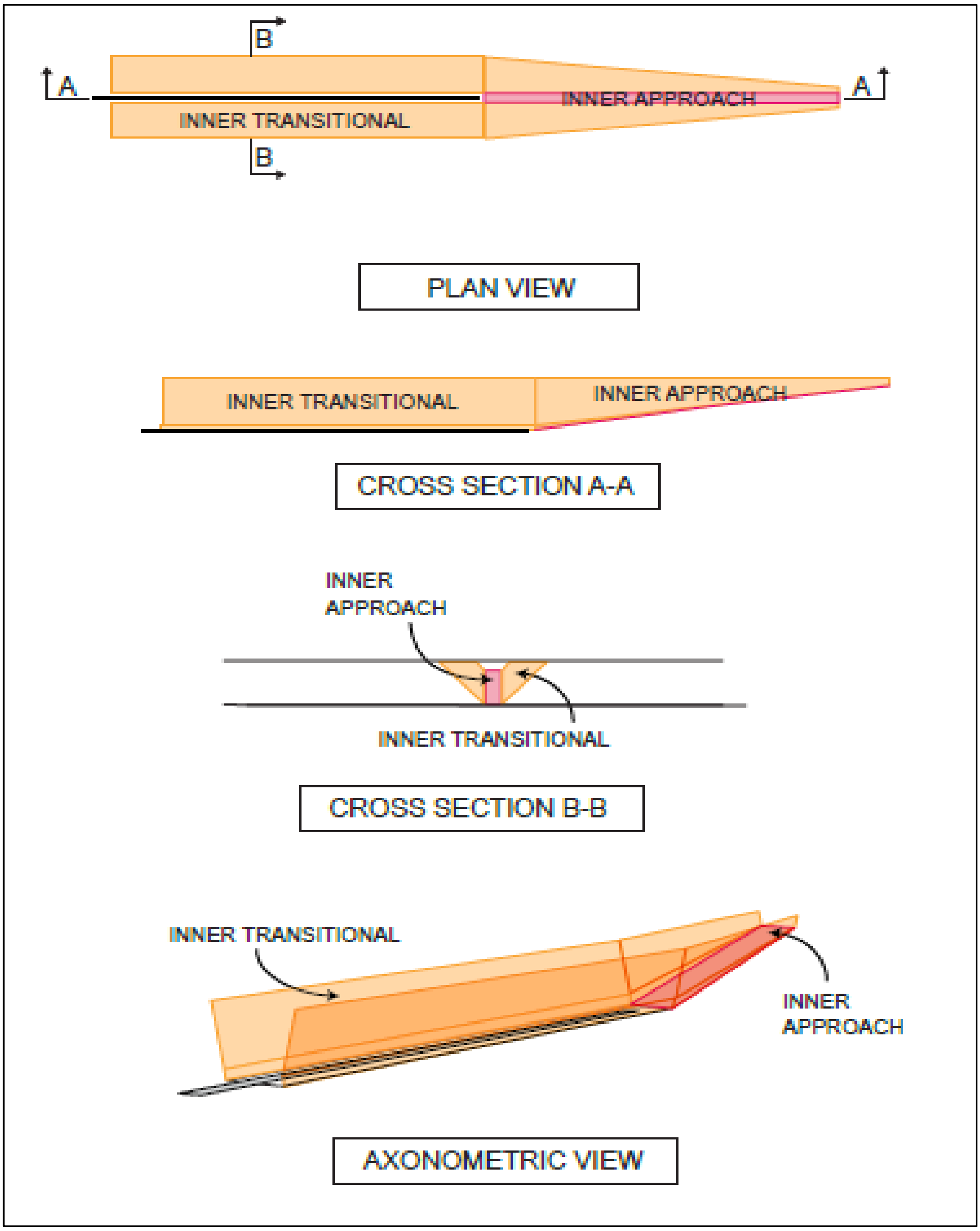


Figure 4-2. Inner approach and inner transitional surfaces on a non-precision approach runway

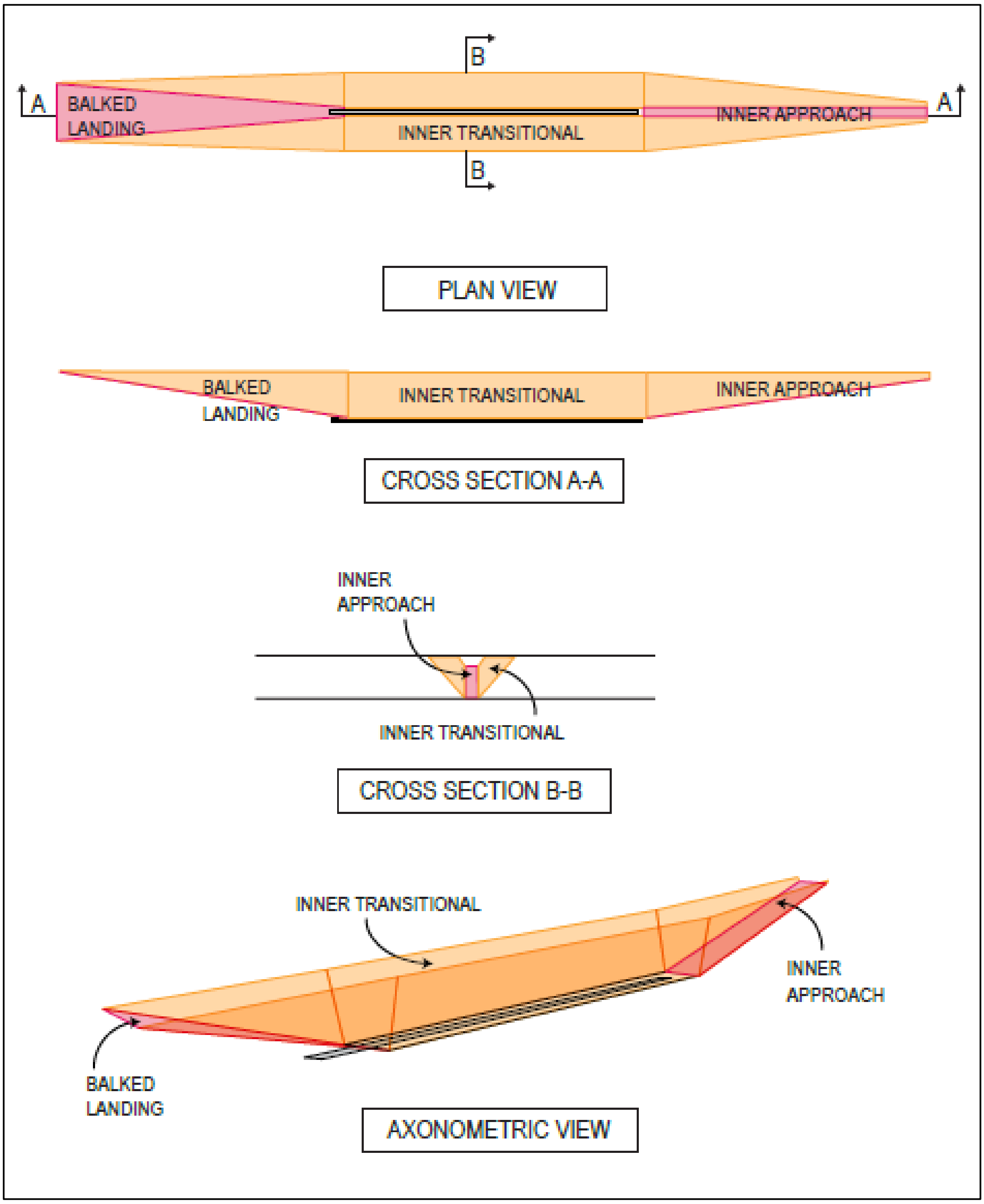


Figure 4-3. Obstacle free zone on a precision approach runway

4.3 Obstacle evaluation surfaces (OES)

Note (1): The purpose of the obstacle evaluation surfaces is to establish the airspace necessary to determine the acceptability of obstacles by evaluating their impact on existing and/or intended aeroplane operations at an aerodrome. The impact is evaluated on safety, regularity and demand of the operations identified by CARC.

Note (2): The OES detailed in the following specifications address most common flight operations and operating minima. When the flight operations differ (e.g. variance in alignment, approach slope, approach minima) specific obstacle evaluation surfaces may need to be established. Depending on the flight operations and procedures available at an aerodrome, the OES may have specifications as specified in the following provisions or may be varied to fit the operations at the aerodrome (e.g. in case of increased minima or where circling does not occur on one side of the runway). There will be instances where additional obstacle evaluation surfaces, beyond what are specified in this section, may be required as the OES or its variations do not satisfactorily cover the local aeroplane operations specific to the aerodrome.

Note (3): Detailed specifications on the variation of the OES and their design are contained in CARC Guidance Material 34-GM-16 PANS-Aerodromes.

4.3.1 General

4.3.1.1 CARC will ensure that the obstacle evaluation surfaces specified in 4.5.2 have been established to protect the existing and/or intended aeroplane operations at an aerodrome.

4.3.1.2 The characteristics and dimensions of the obstacle evaluation surfaces shall be in accordance with the provisions contained in 4.3.2 to 4.3.6.

4.3.1.3 Where it is necessary to preserve the accessibility of an aerodrome to existing and planned operations, the provisions applicable to OFS contained in 4.4.4 to 4.4.8 shall apply to the identified obstacle evaluation surface.

Note: Detailed specifications are contained in CARC Guidance Material 34-GM-16 PANS-Aerodromes, Part II, Chapter 10.

4.3.2 Horizontal surface

Note: The purpose of the horizontal surface is to protect the airspace for circling procedures. The horizontal surface also provides some protection for visual circuits and terminal instrument flight procedures, including PBN approaches, early turning missed approaches and early turning departures. The design of the horizontal surface is consistent with the dimensions of the visual manoeuvring area provided in ICAO PANS-OPS, (Doc 8168, Volume II, Part 1, Section 4, Chapter 7).

Description
4.3.2.1 *Horizontal surface*. A surface, or a combination of surfaces, located in a horizontal plane, or in a series of horizontal planes, above an aerodrome and its environs.

Characteristics

4.3.2.2 The outer limits of the horizontal surface should be circular arcs centred on runway thresholds joined tangentially by straight lines.

4.3.2.3 The height of the horizontal surface shall be measured above the aerodrome elevation.

4.3.2.4 A horizontal surface shall have a radius of not less than, and a height of not greater than, those specified in Table 4-10.

Table 4-10. Dimensions of horizontal surface

Aeroplane design group	I-IIA	IIB	IIC	III	IV	V
Radius	3 350 m	5 350 m	10 750 m	10 750 m	10 750 m	10 750 m
Height	45 m	60 m	90 m	90 m	90 m	90 m

Note: Where a runway is intended for the operations of aeroplanes of different aeroplane design groups, all the horizontal surfaces specified by the radii and heights associated with these groups are retained and the horizontal surface is composed of multiple surfaces located at different heights above the aerodrome elevation.

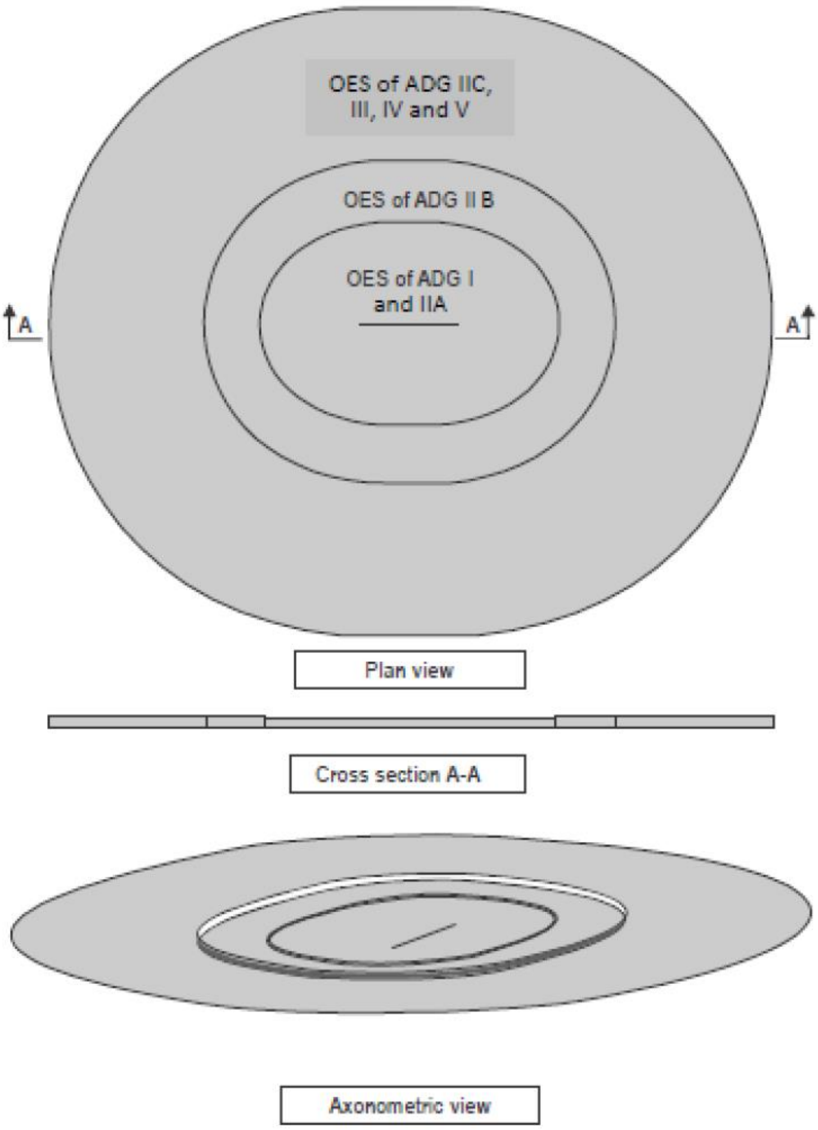


Figure 4-4. Horizontal surface

4.3.3 Surface for straight-in instrument approaches

Note: The purpose of the surface for straight-in instrument approaches is to establish the airspace where obstacles may have an impact on straight-in instrument approaches, where the horizontal surface(s) or parts thereof are not established. As a single obstacle evaluation surface cannot address the variety of all possible instrument approach procedures, only most common straight-in instrument approaches other than precision approaches are considered. The surfaces for precision approaches are established in 4.3.4.

Description

4.3.3.1 *Surface for straight-in instrument approaches*. A combination of surfaces, located in a series of horizontal planes above an aerodrome and its environs.

Characteristics

4.3.3.2 The surface for straight-in instrument approaches should consist of:

(a) a lower part corresponding to the horizontal surface applicable to ADG I;

(b) an upper part corresponding to that part of the horizontal surface applicable to ADG II and III extending beyond the lateral limit of the lower section and delineated by the rectangle of following sides:

1) two shorter sides perpendicular to and centred on the runway centre line and its extension; and

2) two longer sides extending parallel to the runway centre line and its extension from a given distance before and after the thresholds of the runway.

Note: The characteristics of the surface for straight-in instrument approaches specified in 4.3.3.2 are applicable to all ADGs.

4.3.3.3 The heights of the lower section and upper section shall be measured above the aerodrome elevation.

4.3.3.4 The heights of the surface for straight-in instrument approaches shall not be greater than, and its other dimensions not less than, those specified in Table 4-11.

Table 4-11. Dimensions of surface for straight-in instrument approaches

	Aeroplane design group	**I to V**
Lower section	**Height**	45 m
	Length	Horizontal OES as per ADG I
Upper section	**Height**	60 m
	Length of shorter side	7 410 m
	Length of longer side from the threshold or thresholds	5 350 m

4.3.4 Surface for precision approaches

Note: The purpose of the surface for precision approaches is to establish the airspace where obstacles may have an impact on common straight-in precision approach procedures (using ILS or MLS, ground based augmentation system *(GBAS*) *or* satellite-based augmentation system *(SBAS*) *CAT I). The design of the surface is consistent with the dimensions of the basic ILS surfaces provided in ICAO PANS-OPS (Doc 8186) Volume II, Part II, Section I, Chapter 1. Adjustments to the surface may be necessary in case of offset procedures.*

Description

4.3.4.1 *Surface for precision approaches*. A complex surface composed of:

(a) an approach component consisting of an inclined surface preceding the threshold;

(b) a missed approach component consisting of an inclined surface located at a specific distance after the threshold;

(c) transitional components consisting of complex surfaces at a specified distance from the runway centre line and along the approach component and missed approach component, that slopes upwards and outwards; and

(d) a lower component specified by a rectangular surface within the inner edges of the above components.

Note: The transitional components consist of a pair of surfaces, located on either side of the runway centre line. Each surface of this pair is called a transitional component.

Characteristics

4.3.4.2 The limits of the approach component of the surface for precision approaches should comprise:

(a) an inner edge of specified length, horizontal and perpendicular to the extended centre line of the runway and located at a specified distance before the threshold;

(b) two sides originating at the ends of the inner edge and diverging uniformly at a specified rate from the extended centre line of the runway to a specified distance and diverging uniformly thereafter at another specified rate for the remainder of the length of the approach component; and

(c) an outer edge parallel to the inner edge.

4.3.4.3 The elevation of the inner edge of the approach component shall be equal to the elevation of the midpoint of the threshold.

4.3.4.4 The slope of the approach component shall be measured in the vertical plane containing the centre line of the runway and its extension.

Characteristics

4.3.4.5 The limits of the missed approach component of surface for precision approaches should comprise:

(a) an inner edge of specified length, horizontal and perpendicular to the extended centre line of the runway and located at a specified distance after the threshold;

(b) two sides originating at the ends of the inner edge and diverging uniformly at a specified rate from the extended centre line of the runway to a specified distance and diverging uniformly thereafter at another specified rate for the remainder of the length of the missed approach component; and

(c) an outer edge parallel to the inner edge.

4.3.4.6 The elevation of the inner edge of the missed approach component shall be equal to the elevation of the midpoint of the threshold.

Note: In some cases, the inner edge of the missed approach component may be below the elevation of the midpoint of the threshold, for example where runways slope upward.

4.3.4.7 The slope of the missed approach component shall be measured in the vertical plane containing the centre line of the runway and its extension.

Characteristics

4.3.4.8 The limits of the transitional component of the surface for precision approaches should comprise:

(a) a lower edge beginning on the side of the approach component at the elevation of the upper edge and extending down the side of the approach component to the inner edge of the approach component, from there along a line extending horizontally to the inner edge of the missed approach component, and from there extending up the side of the missed approach component to the upper edge; and

(b) an upper edge located at 300 m above the threshold elevation.

4.3.4.9 The elevation of a point on the lower edge of the transitional component shall be:

(a) along the side of the approach component and missed approach component — equal to the elevation of the particular surface at that point; and

(b) between the inner edges of the approach component and missed approach component — equal to the elevation of the midpoint of the threshold.

Note: In some cases, the lower edge of the transitional component may be below the elevation of the midpoint of the threshold, for example where runways slope upward.

4.3.4.10 The slope of the transitional component shall be measured in the vertical plane perpendicular to the centre line of the runway and its extension.

Characteristics

4.3.4.11 The limits of the lower component of the surface for precision approaches should comprise:

(a) two shorter sides corresponding with the inner edge of the approach component and missed approach component; and

(b) two longer sides corresponding with the inner edges of the transitional components.

4.3.4.12 The elevation of a point on the lower component shall be equal to the elevation of the midpoint of the threshold.

4.3.4.13 The slopes of the different components of the surface for precision approach runways shall not be greater than, and their other dimensions not less than, those specified in Table 4-12.

Table 4-12. Dimensions of surface for precision approaches

Aeroplane design group			I to V
Approach component		**Distance from threshold**	60 m
		Length of inner edge	300 m
	1st section	**Length**	3 000 m
		Divergence (each side)	15 %
		Slope	2 %
	2nd section	**Length**	9 600 m
		Divergence (each side)	15 %
		Slope	2.5 %
Missed approach component		**Distance after threshold**	900 m
		Length of inner edge	300 m
	1st section	**Length**	1 800 m
		Divergence (each side)	17.48 %
		Slope	2.5 %
	2nd section	**Length**	10 200 m
		Divergence (each side)	25 %
		Slope	2.5 %
Transitional component		**Slope**	14.3 %

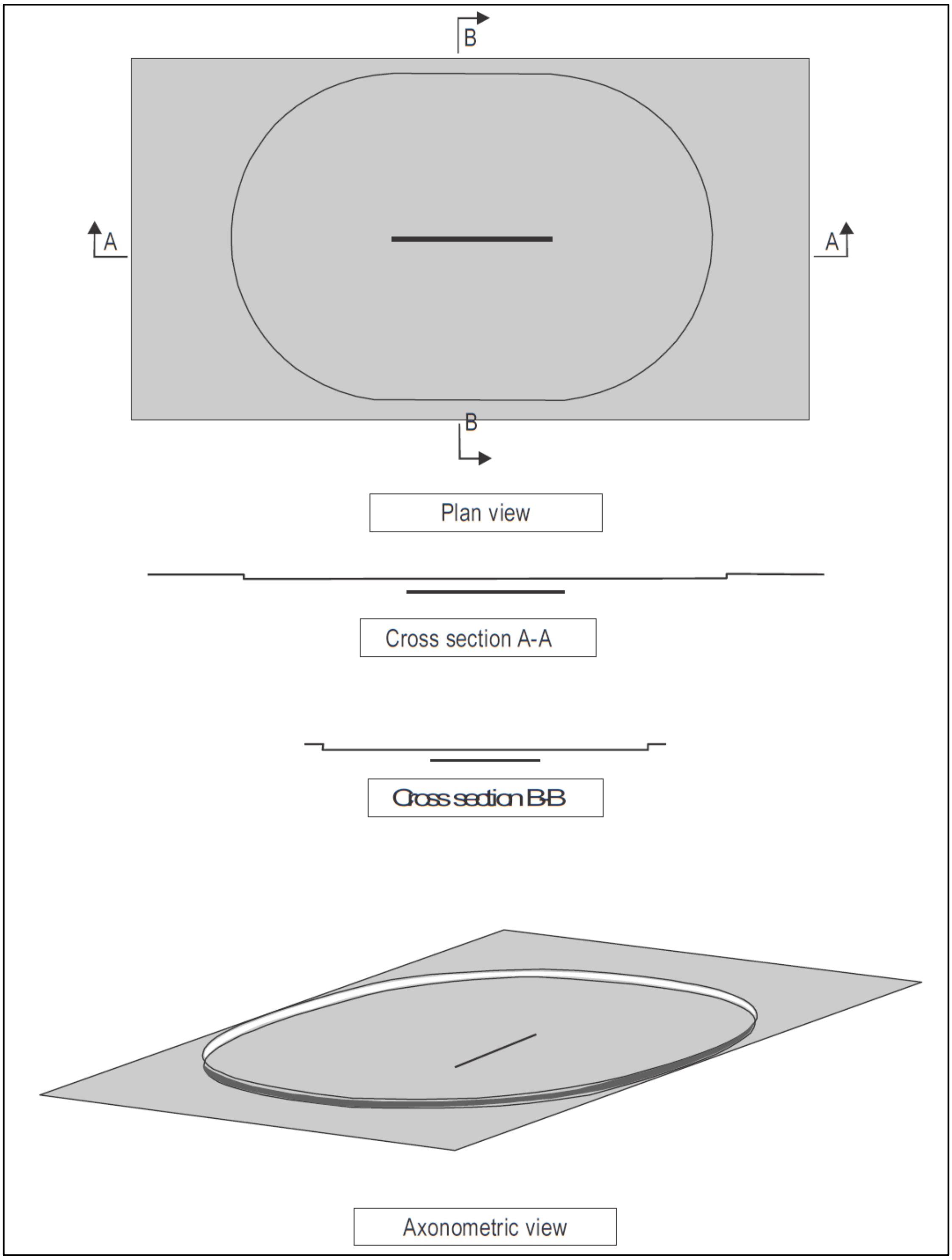


Figure 4-5. Surface for straight-in instrument approaches

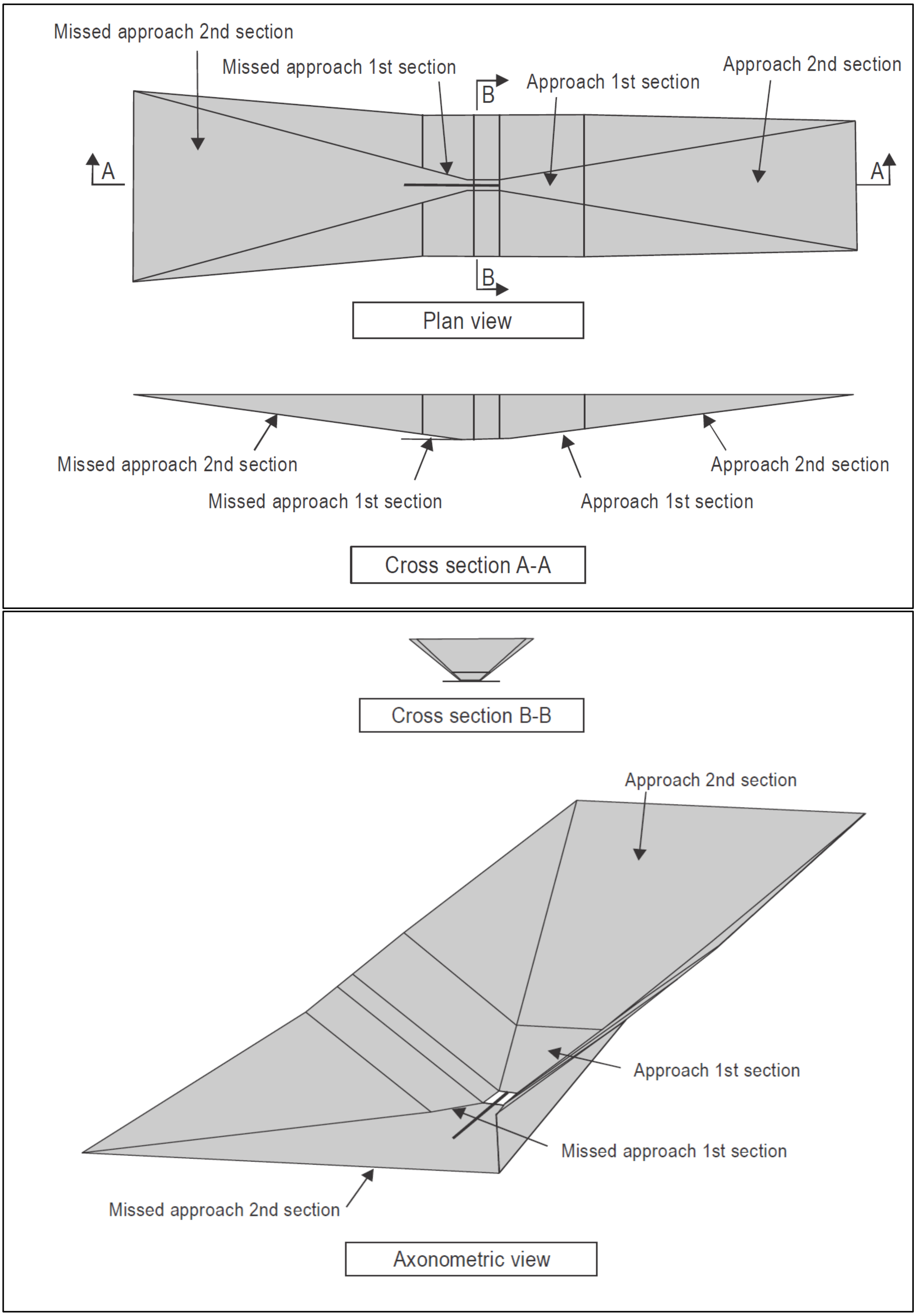


Figure 4-6. Surface for precision approaches

4.3.5 Instrument departure surface

Note: The purpose of the instrument departure surface is to establish the airspace where obstacles may have an impact on aircraft following an omnidirectional instrument departure procedure. The design of the instrument departure surface is consistent with the dimensions provided in ICAO PANS-OPS (Doc 8168, Volume II, Part I, Section 3, Chapter 4).

Description

4.3.5.1 *Instrument departure surface.* An inclined surface, along the runway centre line and its extension after the end of the take-off distance available.

Characteristics

4.3.5.2 The limits of the instrument departure surface should comprise:

(a) an inner edge of specified length, horizontal and perpendicular to the centre line of the runway and located at the end of the take-off distance available;

(b) two sides originating at the ends of the inner edge and diverging uniformly at a specified rate from the extended centre line of the runway to a specified distance and diverging uniformly thereafter at another specified rate for the remainder of the length of the instrument departure surface; and

(c) an outer edge parallel to the inner edge.

4.3.5.3 The elevation of the inner edge shall be 5 m above the elevation of the runway centre line and its extension at the end of the take-off distance available.

4.3.5.4 The slope of the instrument departure surface shall be measured in the vertical plane containing the centre line of the runway and its extension.

4.3.5.5 The slope of the instrument departure surface shall not be greater than, and its other dimensions not less than, those specified in Table4-13.

Table 4-13. Dimensions of instrument departure surface

	Aeroplane design group	**I to V**
	Length of inner edge	300 m
	Slope	2.5 %
First section	**Length**	3 500 m
	Divergence	26.8 %
Second section	**Length**	8 300 m
	Divergence	57.8 %

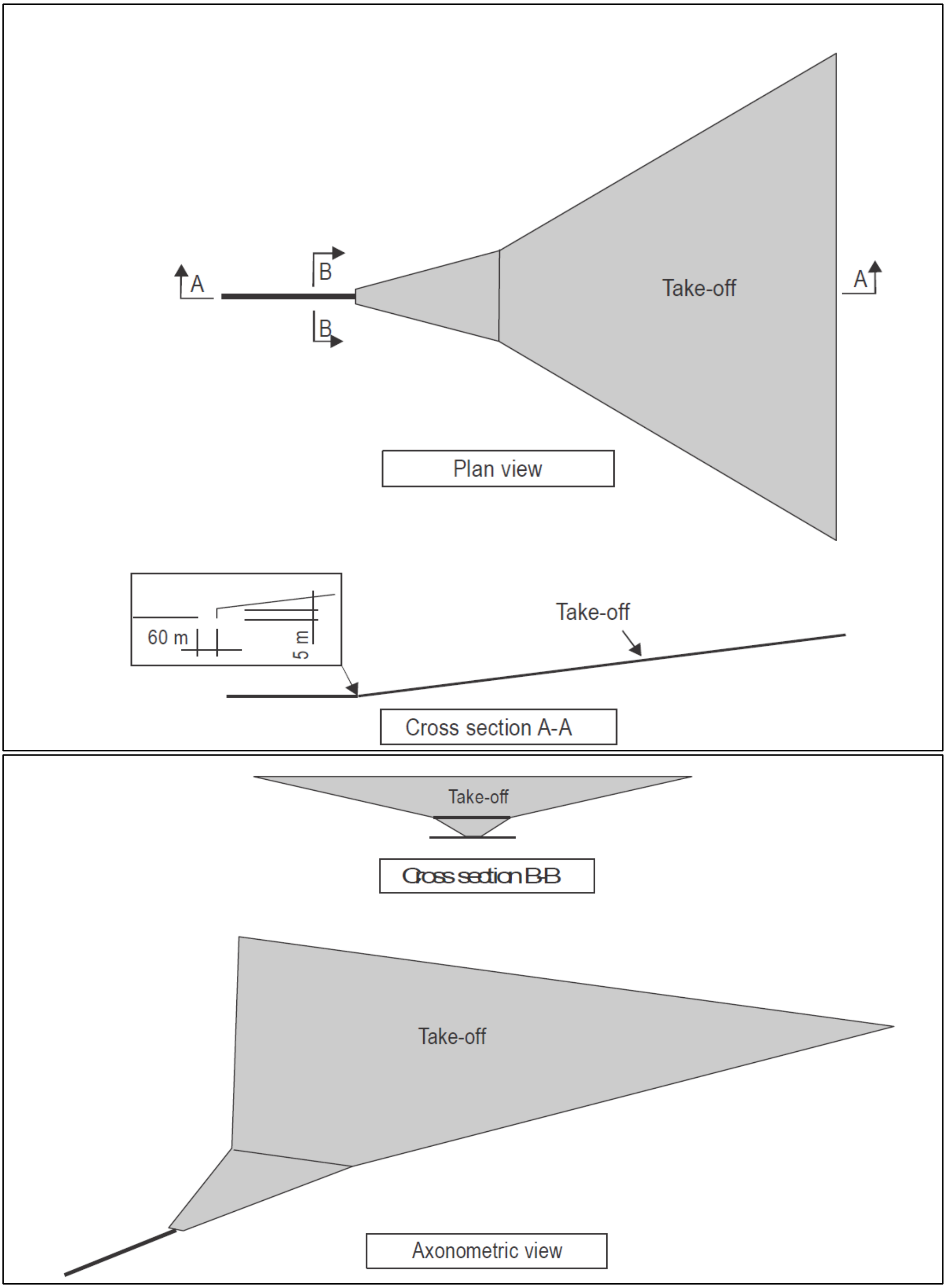


Figure 4-7. Instrument departure surface

4.3.6 Take-off climb surface

Note (1): The purpose of the take-off climb surface is to establish the airspace where obstacles may have an impact on aircraft operating limitations during take-off under non-critical operating conditions. The design of the take-off climb surface is consistent with the take-off obstacle clearance limitations provided in the ICAO Aeroplane Performance Manual *(Doc 10064, Chapter 3), and ICAO Annex 6, Part I.*

Note (2): Obstacles that have no impact on aircraft operating limitations during take-off under non-critical operating conditions could have an impact in case of engine failure or abnormal (e.g. extreme weather conditions) and emergency situations (e.g. system failure).

Description
4.3.6.1 *Take-off climb surface.* An inclined surface beyond the end of the take-off distance available.

Characteristics
4.3.6.2 The limits of the take-off climb surface should comprise:

(a) an inner edge horizontal and perpendicular to the centre line of the runway and located at a specified distance beyond the end of the runway or at the end of the take-off distance available;

(b) two sides originating at the ends of the inner edge, diverging uniformly at a specified rate from the take-off ground track to a specified final width and continuing thereafter at that width for the remainder of the length of the take-off climb surface; and

(c) an outer edge horizontal and perpendicular to the specified take-off track.

4.3.6.3 The above surface shall vary when take-off flight paths involving turns are utilized; two sides originating at the end of the inner edge and diverging uniformly at a specified rate from the extended centre line of the take-off ground track to a specified final width, and extending thereafter parallel to the take-off ground track for the remainder of the length of the take-off climb surface.

4.3.6.4 The elevation of the inner edge shall be equal to the highest point on the extended runway centre line between the end of the take-off run available and the inner edge of the take-off climb surface.

4.3.6.5 The slope of the take-off climb surface shall be measured:

(a) in the vertical plane containing the centre line of the runway and its extension where straight take-off flight path are utilized;

(b) along any straight part of the take-off flight path, in the vertical plane containing the centre line of the take-off flight path or, along any curved part of the take-off flight path, in the vertical plane tangent with the take-off flight path where take-off flight paths involving turns are utilized.

4.3.6.6 On runways intended for operations of aeroplanes with a maximum certificated take-off mass up to 5 700 kg, the slope of the take-off climb surface shall not be greater than, and its other dimensions not less than, those specified in Table 4-14, except that:

(a) a lesser length should be adopted for the take-off climb surface where such lesser length would be consistent with procedural measures adopted to govern the outward flight of aeroplanes; and

(b) a higher slope should be adopted for the take-off climb surface where such slope would be consistent with the operational characteristics of the critical aeroplane operating out of the runway and the local conditions.

4.3.6.7 On runways intended for operations of aeroplanes with a maximum certificated take-off mass greater than 5 700 kg, the slope of the take-off climb surface shall not be greater than, and its other dimensions not less than, those specified in Table 4-15, except that:

(a) a lesser length should be adopted for the take-off climb surface where such lesser length would be consistent with procedural measures adopted to govern the outward flight of aeroplanes; and

(b) a higher slope should be adopted for the take-off climb surface where such slope would be consistent with the operational characteristics of the critical aeroplane operating out of the runway and the local conditions.

4.3.6.8 The slope of the take-off climb surface shall not be increased to facilitate the growth of obstacles.

Note. The slope of the take-off climb surface is intended to adapt to the operations of aeroplanes whose climb performances on take-off climb are such that a slope of 2 per cent is not necessary. However, this slope is not intended to be increased to enable the growth of obstacles. Specifications concerning the increase of the slope of the take-off climb surface are contained in CARC Guidance Material 34-GM-16 PANS-Aerodromes, Part II, Chapter 10.

4.3.6.9 The operational characteristics of aeroplanes for which the runway is intended shall be examined to see if it is desirable to reduce the slope specified in Table 4-14 and Table 4-15 to 1.6 per cent when critical operating conditions are to be catered to. If the specified slope is reduced, corresponding adjustment in the length of the take-off climb surface should be made so as to provide protection to a height equal to that reached with the slopes and lengths in Table 4-14 and 4-15.

Table 4-14. Dimensions of take-off climb surface – runways with operations of aeroplanes with a mass up to 5 700 kg

Aeroplane design group	I	IIA-IIB	IIC[a]	III[a]	IV[a]	V[a]
Distance from runway end[b]	30 m	60 m	-	-	-	-
Length of inner edge	60 m	80 m	-	-	-	-
Divergence (each side)	10%	10%	-	-	-	-
Final width	380 m	580 m	-	-	-	-
Length	1 600 m	2 500 m	-	-	-	-
Slope	5%	4%	-	-	-	-

a. Aeroplanes with a mass up to but not including 5 700 kg generally belong to aeroplane design groups I, IIA and IIB.
b. The take-off climb surface starts at the end of the clearway if the clearway length exceeds the specified distance.

Table 4-15. Dimensions of take-off climb surface – runways with operations of aeroplanes with amass above 5 700 kg

Aeroplane design group	I	IIA-IIB	IIC	III	IV	V
Distance from TODA	-	-	-	-	-	-
Length of inner edge	144 m	156 m	156 m	172 m	180 m	180 m
Divergence (each side)	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%
Final width	1 800 m[a]	1 800 m[a]	1 800 m[a]	1 800 m[a]	1 800 m[a]	1 800 m[a]
Length	10 000 m	10 000 m	10 000 m	10 000 m	10 000 m	10 000 m
Slope	5%	4%	2%	2%	2%	2%

[a] Where given operational conditions and performances are met, the final width can be decreased. Specifications concerning this reduction are contained in the *Airport Services Manual* (Doc 9137), Part 6.

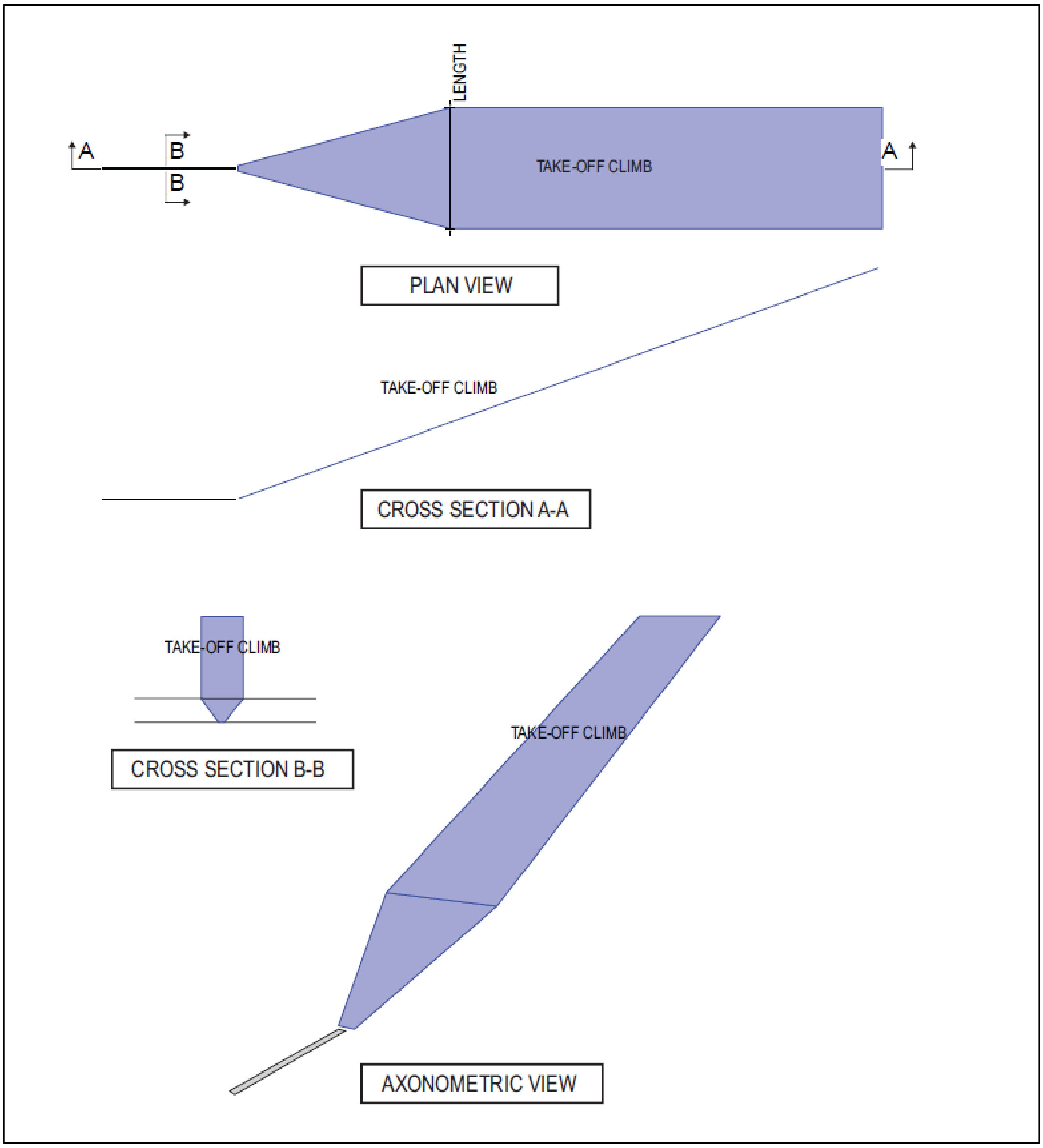


Figure 4-8 Take-off climb surface

4.4 Obstacle limitation requirements

Obstacle free surfaces

4.4.1 Fixed objects shall not be permitted above the inner approach surface, inner transitional surfaces and balked landing surface and that complex surface extending between the lower edges of the inner transitional surfaces. Visual aids required for air navigation purposes or those objects required for aircraft safety purposes, and which must project into the airspace above the inner approach surface, inner transitional surfaces and balked landing surface or that complex surface extending between the lower edges of the inner transitional surfaces are permitted.

Note: Specifications concerning objects required for aircraft safety purposes are provided in the CARC Guidance Material 34-GM-04 Control of Obstacles. Such objects may for example consist of arresting systems, arresting cables, arresting beds, FOD detection systems, wildlife hazard equipment.

4.4.2 Visual aids required for air navigation purposes or those fixed objects required for aircraft safety purposes and which project into the airspace above the inner approach surface, inner transitional surfaces and balked landing surface or that complex surface extending between the lower edges of the inner transitional surfaces shall be frangible and mounted as low as possible.

4.4.3 Mobile objects shall not be permitted above the inner approach surface, inner transitional surfaces, balked landing surface and that complex surface extending between the lower edges of the inner transitional surfaces during the use of the runway for landing.

4.4.4 New objects or extensions of existing objects shall not be permitted above the approach surface and transitional surfaces and the complex surface extending between the lower edges of the transitional surfaces. Equipment and installations required for air navigation or for aircraft safety purposes, and which must project into the airspace above the approach surface and transitional surfaces or that complex surface extending between the lower edges of the transitional surfaces are permitted.

4.4.5 Equipment and installations required for air navigation or for aircraft safety purposes and which must project into the airspace above the approach surface and transitional surfaces or that complex surface extending between the lower edges of the transitional surfaces shall be frangible and mounted as low as possible.

4.4.6 Existing obstacles above the approach surface, and transitional surfaces or that complex surface extending between the lower edges of the transitional surfaces shall as far as practicable be removed.

4.4.7 CARC will ensure that existing terrain and/or obstacles that cannot be removed and penetrate the approach surface and transitional surfaces or that complex surface extending between the lower edges of the transitional surfaces are only permitted when, after aeronautical study, it is determined that the obstacles do not adversely affect the safety or significantly affect the regularity of operations of aeroplanes.

Note. Detailed specifications concerning aeronautical study are provided in CARC Guidance Material 34-GM-16 PANS-Aerodromes, Part II, Chapter 10.

Obstacle evaluation surfaces

4.4.8 CARC will ensure that obstacles penetrating the obstacle evaluation surfaces are only permitted when, after aeronautical study, it is determined that the obstacles do not adversely affect the safety or significantly affect the regularity of the existing and intended operations of aeroplanes.

Note. Detailed specifications concerning aeronautical study is given in CARC Guidance Material 34-GM-16 PANS-Aerodromes, Part II, Chapter 10.

4.5 Obstacle limitation surfaces requirements

Note (1): The requirements for obstacle free surfaces are specified on the basis of the intended use of a runway and are intended to be applied when such use is made of the runway.

Note (2): The requirements for obstacle evaluation surfaces are specified on the basis of the intended use and/or intended operations on the runway. When different obstacle evaluation surfaces overlap each other, each individual surface must be considered as they have specific functions.

4.5.1 Obstacle free surfaces

4.5.1.1 The following obstacle free surfaces shall be established for a non-instrument or non-precision approach runway:

(a) approach surface;

(b) transitional surfaces;

(c) inner approach surface; and

(d) inner transitional surfaces.

4.5.1.2 The following obstacle free surfaces shall be established for a precision approach runway:

(a) Approach surface;

(b) transitional surfaces;

(c) inner approach surface;

(d) inner transitional surfaces; and

(e) balked landing surface.

4.5.2 Obstacle evaluation surfaces

4.5.2.1 The following obstacle evaluation surfaces shall be established:

(a) in case of circling approach and/or visual circuits — the horizontal surface specified in 4.3.2 or a specific OES;

(b) in case of straight-in instrument approaches other than precision approaches, where the horizontal surface is not established — the surface for straight-in instrument approaches specified in 4.3.3 or a specific OES;

(c) in case of precision approach procedure — the surface for precision approaches specified in 4.3.4 or a specific OES;

(d) in case of instrument departure procedure — the instrument departure surface specified in 4.3.5 or a specific OES;

(e) in case of take-off operations — the take-off climb surface specified in 4.3.6 or a specific OES; and

(f) in case of operations different from the above — specific OES.

Note (1): Operations mentioned in f) may include curved approach, VFR circuit patterns, etc.

Note (2): Specifications and further guidance related to specific OES are contained in CARC Guidance Material 34-GM-16 PANS-Aerodromes and in the CARC Guidance Material 34-GM-04 Control of Obstacles."

4.6 Objects outside the obstacle free surfaces and obstacle evaluation surfaces

4.6.1 In areas beyond the limits of the obstacle limitation surfaces, at least those objects which extend to a height of 100 m or more above ground elevation shall be regarded as obstacles, unless an aeronautical study indicates that they do not constitute a hazard to the operations of intended aeroplane.

Chapter (5)
Visual Aids for Navigation

5.1 Indicators and Signaling Devices

5.1.1 Wind direction indicators

Application
5.1.1.1 An aerodrome shall be equipped with at least one wind direction indicator, subjected to conditions established in 5.1.1.2, 5.1.1.3.

Location
5.1.1.2 A wind direction indicator shall be located so as to be visible from aircraft in flight or on the movement area and in such a way as to be free from the effects of air disturbances caused by nearby objects.

Characteristics
5.1.1.3 The wind direction indicator shall be in the form of a truncated cone made of fabric and shall have a length of not less than 3.6 m and a diameter, at the larger end, of not less than 0.9 m. It shall be constructed so that it gives a clear indication of the direction of the surface wind and a general indication of the wind speed. The color or colors shall be so selected as to make the wind direction indicator clearly visible and understandable from a height of at least 300 m, having regard to background. Where practicable, a single color, preferably white or orange, shall be used. Where a combination of two colors is required to give adequate conspicuity against changing backgrounds, they shall preferably be orange and white, red and white, or black and white, and shall be arranged in five alternate bands, the first and last bands being the darker color.

5.1.1.4 The location of all wind direction indicators shall be marked by a circular band 15 m in diameter and 1.2 m wide. The band shall be centered about the wind direction indicator support and shall be in a color chosen to give adequate conspicuity, preferably white.

5.1.1.5 Provision shall be made for illuminating all wind indicators at an aerodrome intended for use at night.

5.1.2 Landing direction indicator

Location
5.1.2.1 A visual aerodrome shall be equipped with a landing direction indicator which shall be located in a conspicuous place on the aerodrome.

Characteristics

5.1.2.2 The landing direction indicator shall be in the form of a “T”.

5.1.2.3 The shape and minimum dimensions of a landing “T” shall be as shown in Figure 5-1. The color of the landing “T” shall be either white or orange, the choice being dependent on the color that contrasts best with the background against which the indicator will be viewed. Where required for use at night the landing “T” shall either be illuminated or outlined by white lights.

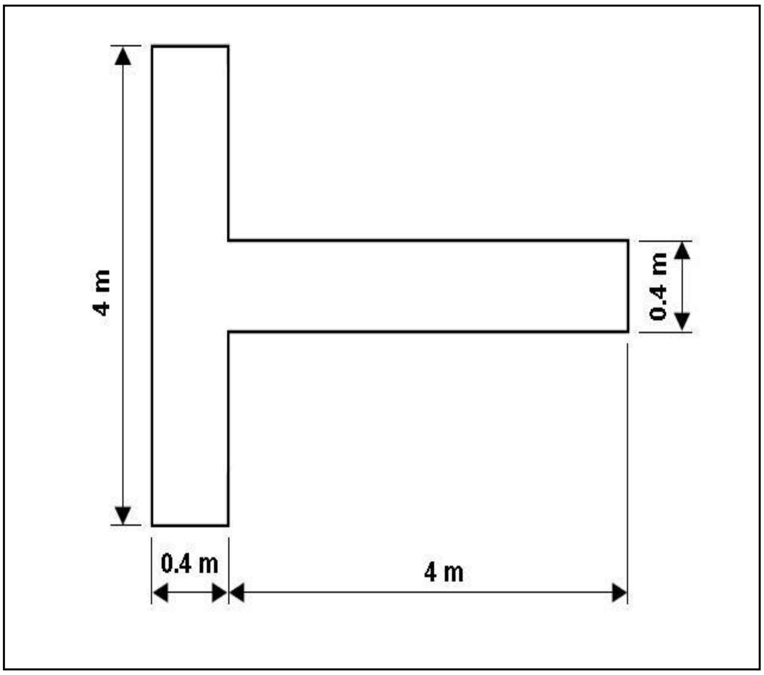


Figure 5-1. Landing direction indicator

5.1.3 Signaling lamp

Application

5.1.3.1 A signaling lamp shall be provided at a controlled aerodrome in the aerodrome control tower.

Characteristics

5.1.3.2 A signaling lamp shall be capable of producing red, green and white signals, and of:

(a) being aimed manually at any target as required;
(b) giving a signal in any one color followed by a signal in either of the two other colors; and
(c) transmitting a message in any one of the three colors by Morse Code up to a speed of at least four words per minute.

When selecting the green light, use shall be made of the restricted boundary of green as specified in Appendix 1 paragraph 2.1.2.

5.1.3.3 The beam spread shall be not less than 1° nor greater than 3°, with negligible light beyond 3°. When the signaling lamp is intended for use in the daytime the intensity of the colored light shall be not less than 6 000 cd.

5.1.4 Signal panels and signal area

Note: The inclusion of detailed specifications for a signal area in this section is not intended to imply that one has to be provided. CARC Guidance Material to Part 14 No. 34 GM-01 provides guidance on the need to provide ground signals. CARC Guidance Material 34-GM-17 Visual Aids for Navigation provides guidance on their design.

Location of signal area *(if provided)*
5.1.4.1 The signal area shall be located so as to be visible for all angles of azimuth above an angle of 10° above the horizontal when viewed from a height of 300 m.

Characteristics of signal area *(if provided)*
5.1.4.2 The signal area shall be an even horizontal surface at least 9 m square.
5.1.4.3 The color of the signal area shall be chosen to contrast with the colors of the signal panels used, and it shall be surrounded by a white border not less than 0.3 m wide.

5.2 Markings

5.2.1 General

Interruption of runway markings
5.2.1.1 At an intersection of two (or more) runways the markings of the more important runway, except for the runway side stripe marking, shall be displayed and the markings of the other runway(s) shall be interrupted. The runway side stripe marking of the more important runway may be either continued across the intersection or interrupted.

5.2.1.2 The order of importance of runways for the display of runway markings shall be as follows:

1st — precision approach runway;
2nd — non-precision approach runway; and
3rd — non-instrument runway

5.2.1.3 At an intersection of a runway and taxiway the markings of the runway shall be displayed and the markings of the taxiway interrupted, except that runway side stripe markings may be interrupted.

Note: Refer to 5.2.8.7 regarding the manner of connecting runway and taxiway center line markings.

Color and conspicuity

5.2.1.4 Runway markings shall be white.

Note (1): It has been found that, on runway surfaces of light color, the conspicuity of white markings can be improved by outlining them in black.

Note (2): It is preferable that the risk of uneven friction characteristics on markings be reduced in so far as practicable by the use of a suitable kind of paint.

Note (3): Markings may consist of solid areas or a series of longitudinal stripes providing an effect equivalent to the solid areas.

5.2.1.5 Taxiway markings, runway turn pad markings and aircraft stand markings shall be yellow.

5.2.1.6 Apron safety lines shall be of a conspicuous color which shall contrast with that used for aircraft stand markings.

5.2.1.7 At aerodromes where operations take place at night, pavement markings shall be made with reflective materials designed to enhance the visibility of the markings.

Note: Guidance on reflective materials is given in CARC Guidance Material 34-GM-17 Visual Aids for Navigation.

Unpaved taxiways

5.2.1.8 An unpaved taxiway should be provided, so far as practicable, with the markings prescribed for paved taxiways.

5.2.2 Runway designation marking

Application

5.2.2.1 A runway designation marking shall be provided at the thresholds of a paved runway.

5.2.2.2 A runway designation marking should be provided, so far as practicable, at the thresholds of an unpaved runway.

Location

5.2.2.3 A runway designation marking shall be located at a threshold as shown in Figure 5-2.

Note: If the runway threshold is displaced from the extremity of the runway, a sign showing the designation of the runway shall be provided for airplanes taking off.

Characteristics

5.2.2.4 A runway designation marking shall consist of a two-digit number and on parallel runways shall be supplemented with a letter. On a single runway, dual parallel runways and triple parallel runways the two-digit number shall be the whole number nearest the one-tenth of the magnetic North when viewed from the direction of approach. On four or more parallel runways, one set of adjacent runways shall be numbered to the nearest one-tenth magnetic azimuth and the other set of adjacent runways numbered to the next nearest one-tenth of the magnetic azimuth. When the above rule would give a single digit number, it shall be preceded by a zero.

5.2.2.5 In the case of parallel runways, each runway designation number shall be supplemented by a letter as follows, in the order shown from left to right when viewed from the direction of approach:

— for two parallel runways: “L” “R”;
— for three parallel runways: “L” “C” “R”;
— for four parallel runways: “L” “R” “L” “R”;
— for five parallel runways: “L” “C” “R” “L” “R” or “L” “R” “L” “C” “R”; and
— for six parallel runways: “L” “C” “R” “L” “C” “R”.

5.2.2.6 The numbers and letters shall be in the form and proportion shown in Figure 5-3. The dimensions shall be not less than those shown in Figure 5-3, but where the numbers are incorporated in the threshold marking, larger dimensions shall be used in order to fill adequately the gap between the stripes of the threshold marking.

5.2.3 Runway center line marking

Application

5.2.3.1 A runway center line marking shall be provided on a paved runway.

Location

5.2.3.2 A runway center line marking shall be located along the center line of the runway between the runway designation markings as shown in Figure 5-2, except when interrupted in compliance with 5.2.1.1.

Characteristics

5.2.3.3 A runway center line marking shall consist of a line of uniformly spaced stripes and gaps. The length of a stripe plus a gap shall be not less than 50 m or more than 75 m. The length of each stripe shall be at least equal to the length of the gap or 30 m, whichever is greater.

5.2.3.4 The width of the stripes shall be not less than:
- — 0.90 m on precision approach category II and III runways;
- — 0.45 m on non-precision approach runways where the code number is 3 or 4, and precision approach category I runways; and
- — 0.30 m on non-precision approach runways where the code number is 1 or 2, and on non-instrument runways.

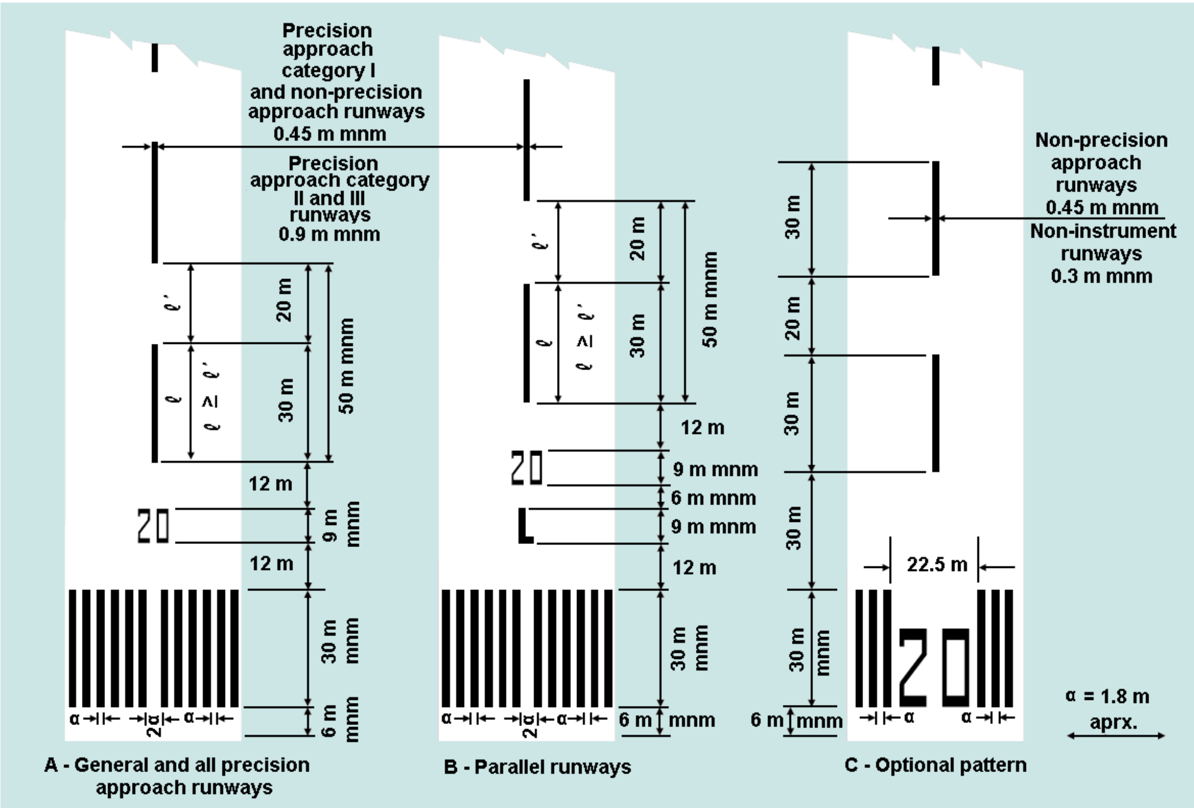


Figure 5-2. Runway designation, center line and threshold markings

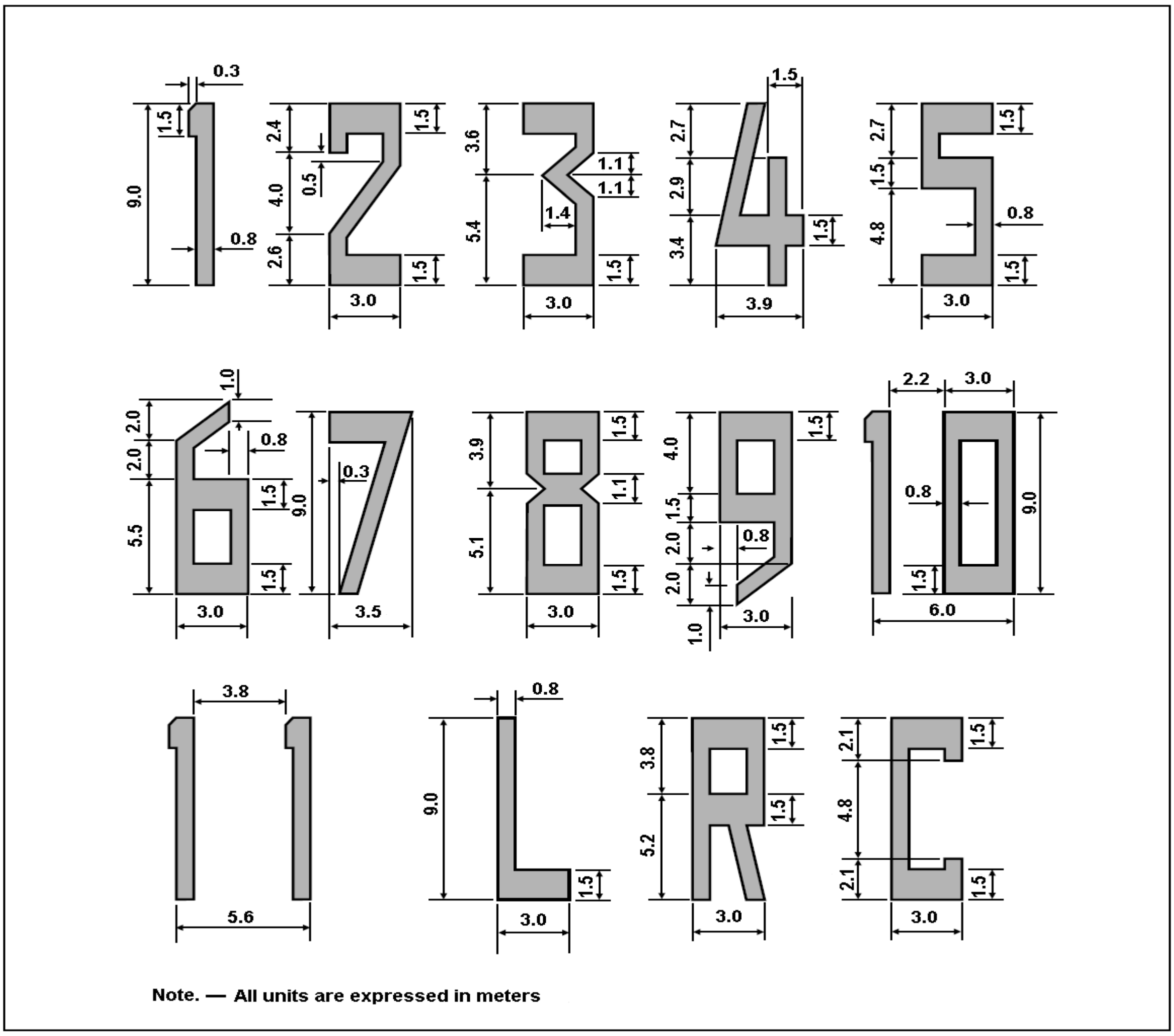


Figure 5-3. Form and proportions of numbers and letters for runway designation markings

5.2.4 Threshold marking

Application

5.2.4.1 A threshold marking shall be provided at the threshold of a paved runway.

5.2.4.2 A threshold marking should be provided, so far as practicable, at the thresholds of an unpaved runway.

Note: CARC Guidance Material 34-GM-17 Visual Aids for Navigation, shows a form of marking which has been found satisfactory for the marking of downward slopes immediately before the threshold.

Location

5.2.4.3 The stripes of the threshold marking shall commence 6 m from the threshold.

Characteristics

5.2.4.4 A runway threshold marking shall consist of a pattern of longitudinal stripes of uniform dimensions disposed symmetrically about the center line of a runway as shown in Figure 5-2 (A) and (B) for a runway width of 45 m. The number of stripes shall be in accordance with the runway width as follows:

5.2.4.5

Runway width	Number of stripes
18 m	4
23 m	6
30 m	8
45 m	12
60 m	16

except that on non-precision approach and non-instrument runways 45 m or greater in width, they may be as shown in Figure 5-2 (C).

5.2.4.6 The stripes shall extend laterally to within 3 m of the edge of a runway or to a distance of 27 m on either side of a runway center line, whichever results in the smaller lateral distance. Where a runway designation marking is placed within a threshold marking there shall be a minimum of three stripes on each side of the center line of the runway. Where a runway designation marking is placed above a threshold marking, the stripes shall be continued across the runway. The stripes shall be at least 30 m long and approximately 1.80 m wide with spacings of approximately 1.80 m between them except that, where the stripes are continued across a runway, a double spacing shall be used to separate the two stripes nearest the center line of the runway, and in the case where the designation marking is included within the threshold marking this spacing shall be 22.5 m.

Transverse stripe

5.2.4.7 Where a threshold is displaced from the extremity of a runway or where the extremity of a runway is not square with the runway center line, a transverse stripe as shown in Figure 5-4 (B) shall be added to the threshold marking.

5.2.4.8 A transverse stripe shall be not less than 1.80 m wide.

Arrows

5.2.4.9 Where a runway threshold is permanently displaced, arrows conforming to Figure 5-4 (B) shall be provided on the portion of the runway before the displaced threshold.

5.2.4.10 When a runway threshold is temporarily displaced from the normal position, it shall be marked as shown in Figure 5-4 (A) or 5-4 (B) and all markings prior to the displaced threshold shall be obscured except the runway center line marking, which shall be converted to arrows.

Note (1): In the case where a threshold is temporarily displaced for only a short period of time, it has been found satisfactory to use markers in the form and color of a displaced threshold marking rather than attempting to paint this marking on the runway.

Note (2): When the runway before a displaced threshold is unfit for the surface movement of aircraft, closed markings, as described in Chapter 7, paragraph 7.1.4, are required to be provided.

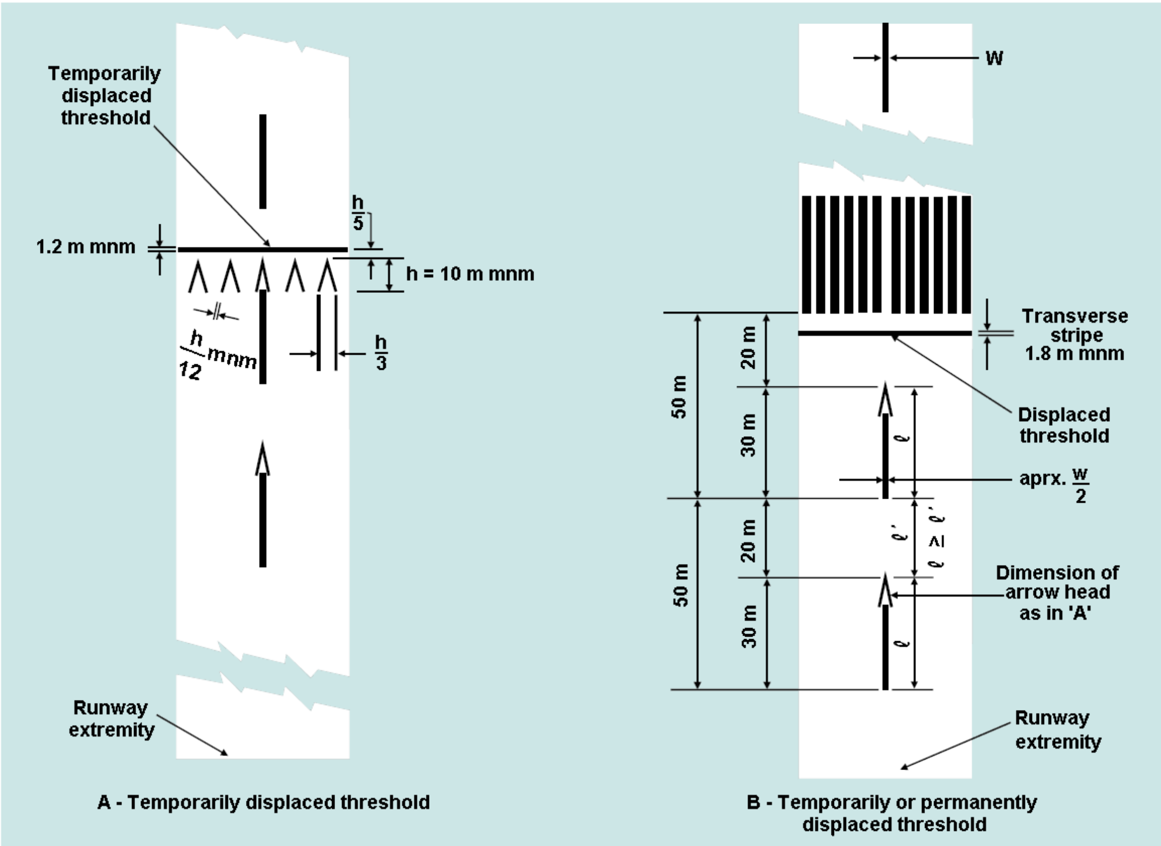


Figure 5-4. Displaced threshold markings

5.2.5 Aiming point marking

Application

5.2.5.1 An aiming point marking shall be provided at each approach end of a paved instrument runway where the code number is 2, 3 or 4.

5.2.5.2 An aiming point marking shall be provided at each approach end of:

a) a paved non-instrument runway where the code number is 3 or 4;
b) a paved instrument runway where the code number is 1.

when additional conspicuity of the aiming point is desirable.

Location

5.2.5.3 The aiming point marking shall commence no closer to the threshold than the distance indicated in the appropriate column of Table 5-1, except that, on a runway equipped with a visual approach slope indicator system, the beginning of the marking shall be coincident with the visual approach slope origin.

5.2.5.4 An aiming point marking shall consist of two conspicuous stripes. The dimensions of the stripes and the lateral spacing between their inner sides shall be in accordance with the provisions of the appropriate column of Table 5-1. Where a touchdown zone marking is provided, the lateral spacing between the markings shall be the same as that of the touchdown zone marking.

Table 5-1. Location and dimensions of aiming point marking

	LANDING DISTANCE AVAILABLE			
Location and dimensions	Less than 800 m	800 m up to but not including 1200 m	1200 m up to but not including 2400 m	2400 m and above
(1)	**(2)**	**(3)**	**(4)**	**(5)**
Distance from threshold to beginning of marking	150 m	250 m	300 m	400 m
Length of stripe [a]	30 - 45 m	30 - 45 m	45 - 60 m	45 - 60 m
Width of stripe	4 m	6 m	6 - 10 m [b]	6 - 10 m [b]
Lateral spacing between inner sides of stripes	6 m [c]	9 m [c]	18 - 22.5 m	18 - 22.5 m

(a) The greater dimensions of the specified ranges are intended to be used where increased conspicuity is required.
(b) The lateral spacing may be varied within these limits to minimize the contamination of the marking by rubber deposits.
(c) These figures were deduced by reference to the outer main gear wheel span which is element 2 of the aerodrome reference code at Chapter 1, Table 1-1.

5.2.6 Touchdown zone marking

Application

5.2.6.1 A touchdown zone marking shall be provided in the touchdown zone of a paved precision approach runway where the code number is 2, 3 or 4.

5.2.6.2 A touchdown zone marking shall be provided in the touchdown zone of a paved non-precision approach or non-instrument runway where the code number is 3 or 4 and additional conspicuity of the touchdown zone is desirable.

Location and characteristics

5.2.6.3 A touchdown zone marking shall consist of pairs of rectangular markings symmetrically disposed about the runway center line with the number of such pairs related to the landing distance available and, where the marking is to be displayed at both the approach directions of a runway, the distance between the thresholds, as follows:

Landing distance available or the distance between thresholds	Pair(s) of markings
less than 900 m	1
900 m up to but not including 1 200 m	2
1 200 m up to but not including 1 500 m	3
1 500 m up to but not including 2 400 m	4
2 400 m or more	6

5.2.6.4 A touchdown zone marking shall conform to either of the two patterns shown in Figure 5-5. For the pattern shown in Figure 5-5 (A), the markings shall be not less than 22.5 m long and 3 m wide. For the pattern shown in Figure 5-5 (B), each stripe of each marking shall be not less than 22.5 m long and 1.8 m wide with a spacing of 1.5 m between adjacent stripes. The lateral spacing between the inner sides of the rectangles shall be equal to that of the aiming point marking where provided. Where an aiming point marking is not provided, the lateral spacing between the inner sides of the rectangles shall correspond to the lateral spacing specified for the aiming point marking in Table 5-1 (columns 2, 3, 4 or 5, as appropriate). The pairs of markings shall be provided at longitudinal spacings of 150 m beginning from the threshold except that pairs of touchdown zone markings coincident with or located within 50 m of an aiming point marking shall be deleted from the pattern.

5.2.6.5 On a non-precision approach runway where the code number is 2, an additional pair of touchdown zone marking stripes shall be provided 150 m beyond the beginning of the aiming point marking.

5.2.7 Runway side stripe marking

Application

5.2.7.1 A runway side stripe marking shall be provided between the thresholds of a paved runway where there is a lack of contrast between the runway edges and the shoulders or the surrounding terrain.

5.2.7.2 A runway side stripe marking shall be provided on a precision approach runway irrespective of the contrast between the runway edges and the shoulders or the surrounding terrain.

Location

5.2.7.3 A runway side stripe marking shall consist of two stripes, one placed along each edge of the runway with the outer edge of each stripe approximately on the edge of the runway, except that, where the runway is greater than 60 m in width, the stripes shall be located 30 m from the runway center line.

5.2.7.4 Where a runway turn pad is provided, the runway side stripe marking shall be continued between the runway and the runway turn pad.

Characteristics

5.2.7.5 A runway side stripe shall have an overall width of at least 0.9 m on runways 30 m or more in width and at least 0.45 m on narrower runways.

5.2.8 Taxiway center line marking

Application

5.2.8.1 Taxiway center line marking shall be provided on a paved taxiway, de-icing/anti-icing facility and apron where the code number is 3 or 4 in such a way as to provide continuous guidance between the runway center line and aircraft stands.

5.2.8.2 Taxiway center line marking shall be provided on a paved taxiway, de-icing/anti-icing facility and apron where the code number is 1 or 2 in such a way as to provide continuous guidance between the runway center line and aircraft stands.

5.2.8.3 Taxiway center line marking shall be provided on a paved runway when the runway is part of a standard taxi-route and:

(a) there is no runway center line marking; or

(b) where the taxiway center line is not coincident with the runway center line.

5.2.8.4 Where it is necessary to denote the proximity of a runway-holding position, enhanced taxiway centre line marking shall be provided.

Note: The provision of enhanced taxiway centre line marking may form part of runway incursion prevention measures.

5.2.8.5 Where provided, enhanced taxiway centre line marking shall be installed at each taxiway/runway intersections.

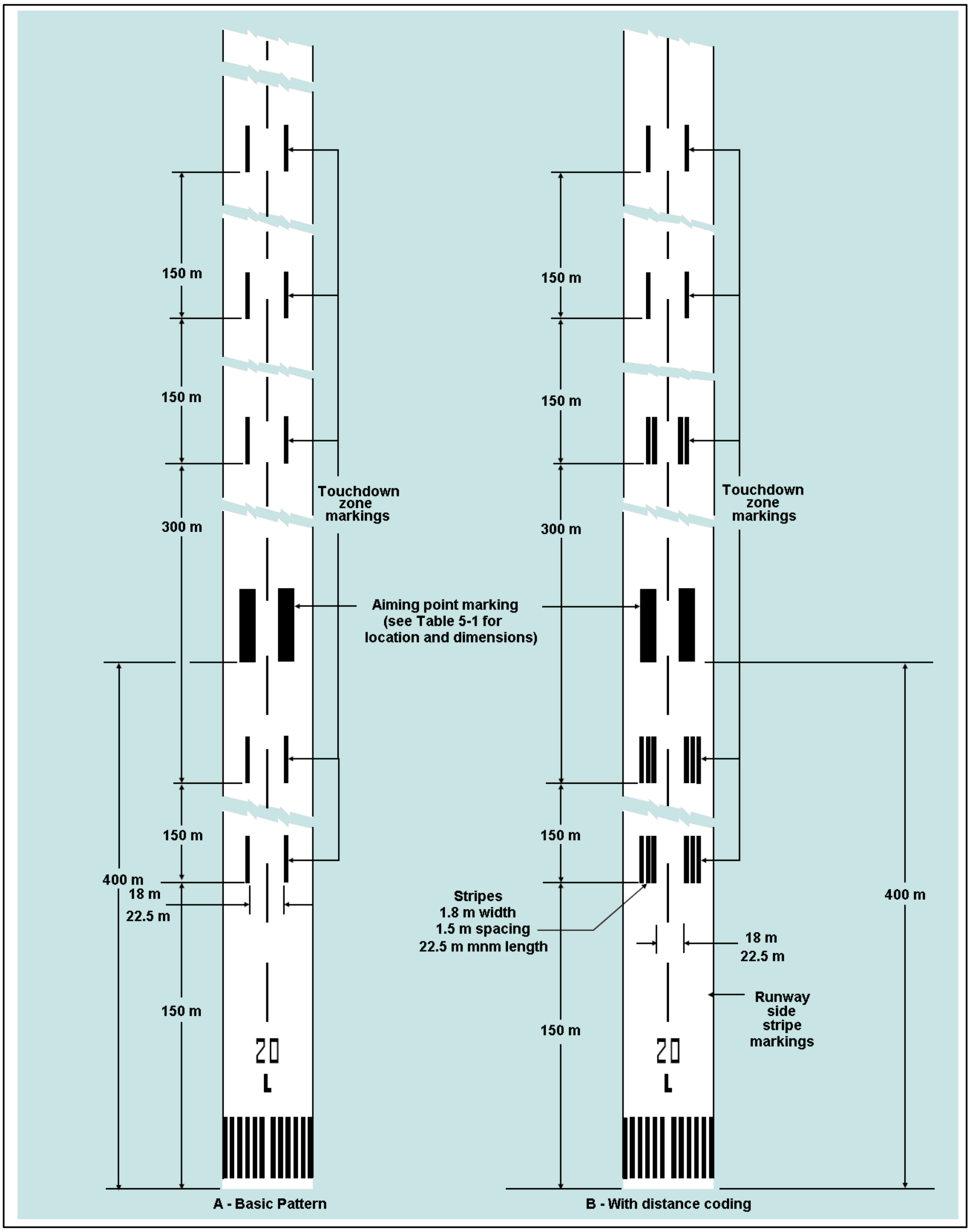


Figure 5-5. Aiming point and touchdown zone markings (illustrated for a runway with a length of 2 400 m or more)

Location

5.2.8.6 On a straight section of a taxiway the taxiway center line marking shall be located along the taxiway center line. On a taxiway curve the marking shall continue from the straight portion of the taxiway at a constant distance from the outside edge of the curve.

Note: Refer to chapter 3 Section 3.9.5 and Figure 3-2.

5.2.8.7 At an intersection of a taxiway with a runway where the taxiway serves as an exit from the runway, the taxiway center line marking shall be curved into the runway center line marking as shown in Figures 5-6 and 5-26. The taxiway center line marking shall be extended parallel to the runway center line marking for a distance of at least 60 m beyond the point of tangency where the code number is 3 or 4, and for a distance of at least 30 m where the code number is 1 or 2.

5.2.8.8 Where taxiway center line marking is provided on a runway in accordance with 5.2.8.3, the marking shall be located on the center line of the designated taxiway.

5.2.8.9 Where provided:

(1) An enhanced taxiway centre line marking shall extend from the runway-holding position Pattern A (as defined in Figure 5-6, Taxiway markings) to a distance of up to 47m in the direction of travel away from the runway. See Figure 5-7 (a).

(2) If the enhanced taxiway centre line marking intersects another runway-holding position marking, such as for a precision approach category II or III runway, that is located within 47m of the first runway-holding position marking, the enhanced taxiway centre line marking shall be interrupted 0.9m prior to and after the intersected runway-holding position marking. The enhanced taxiway centre line marking shall continue beyond the intersected runway-holding position marking for at least 3 dashed line segments or 47m from start to finish, whichever is greater. See Figure 5-7 (b).

(3) If the enhanced taxiway centre line marking continues through a taxiway/taxiway intersection that is located within 47m of the runway-holding position marking, the enhanced taxiway centre line marking shall be interrupted 1.5m prior to and after the point where the intersected taxiway centre line crosses the enhanced taxiway centre line. The enhanced taxiway centre line marking shall continue beyond the taxiway/taxiway intersection for at least 3 dashed line segments or 47m from start to finish, whichever is greater. See Figure 5-7 (c).

(4) Where two taxiway centre lines converge at or before the runway-holding position marking, the inner dashed line shall not be less than 3m in length. See Figure 5-7 (d).

(5) Where there are two opposing runway-holding position markings and the distance between the markings is less than 94m, the enhanced taxiway centre line markings shall extend over this entire distance. The enhanced taxiway centre line markings shall not extend beyond either runway-holding position marking. See Figure 5-7 (e).

Characteristics

5.2.8.10 A taxiway center line marking shall be at least 15 cm in width and continuous in length except where it intersects with a runway-holding position marking or an intermediate holding position marking as shown in Figure 5-6.

5.2.8.11 Enhanced taxiway centre line marking shall be as shown in Figure 5-7.

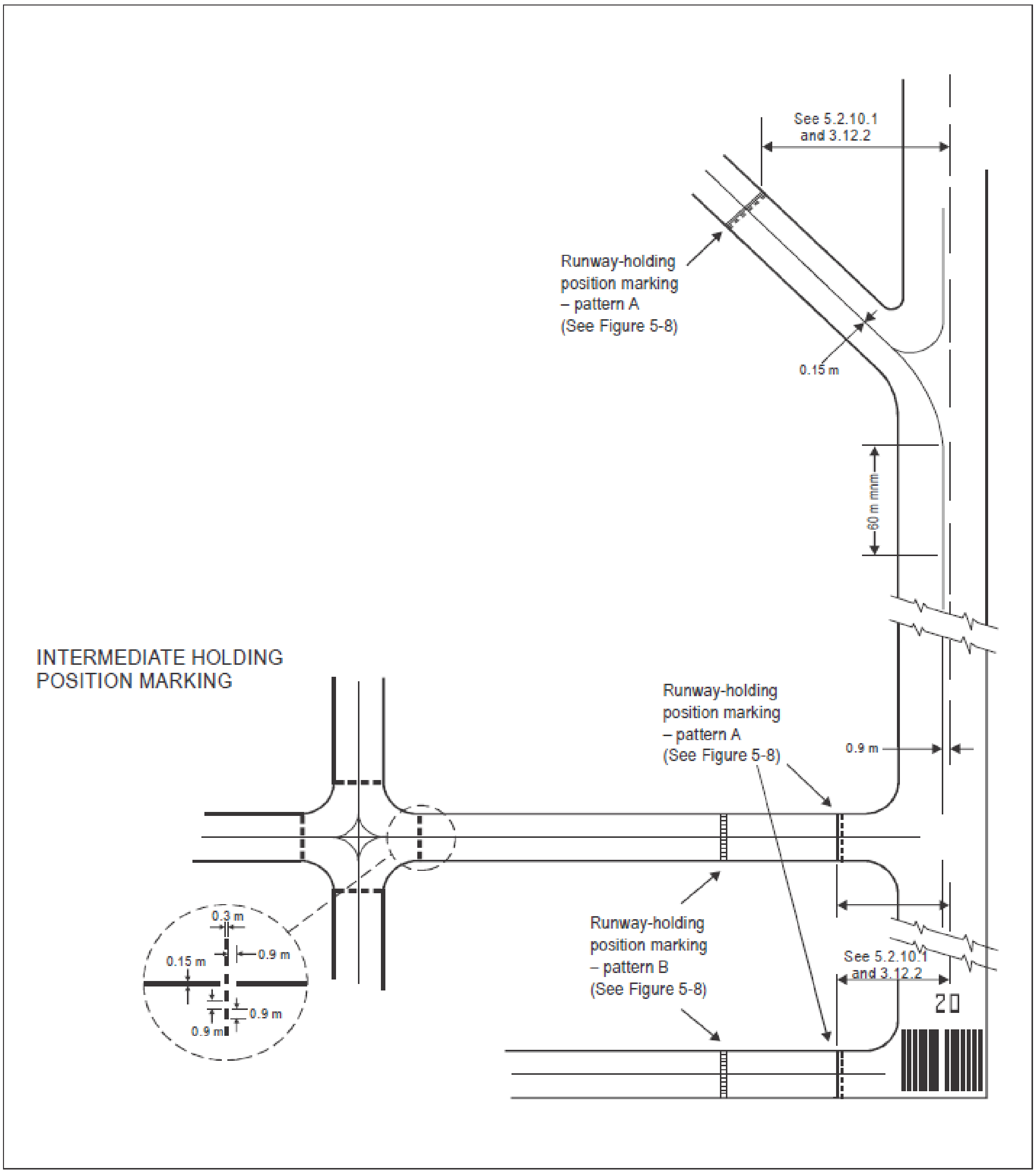


Figure 5-6. Taxiway markings
(shown with basic runway markings)

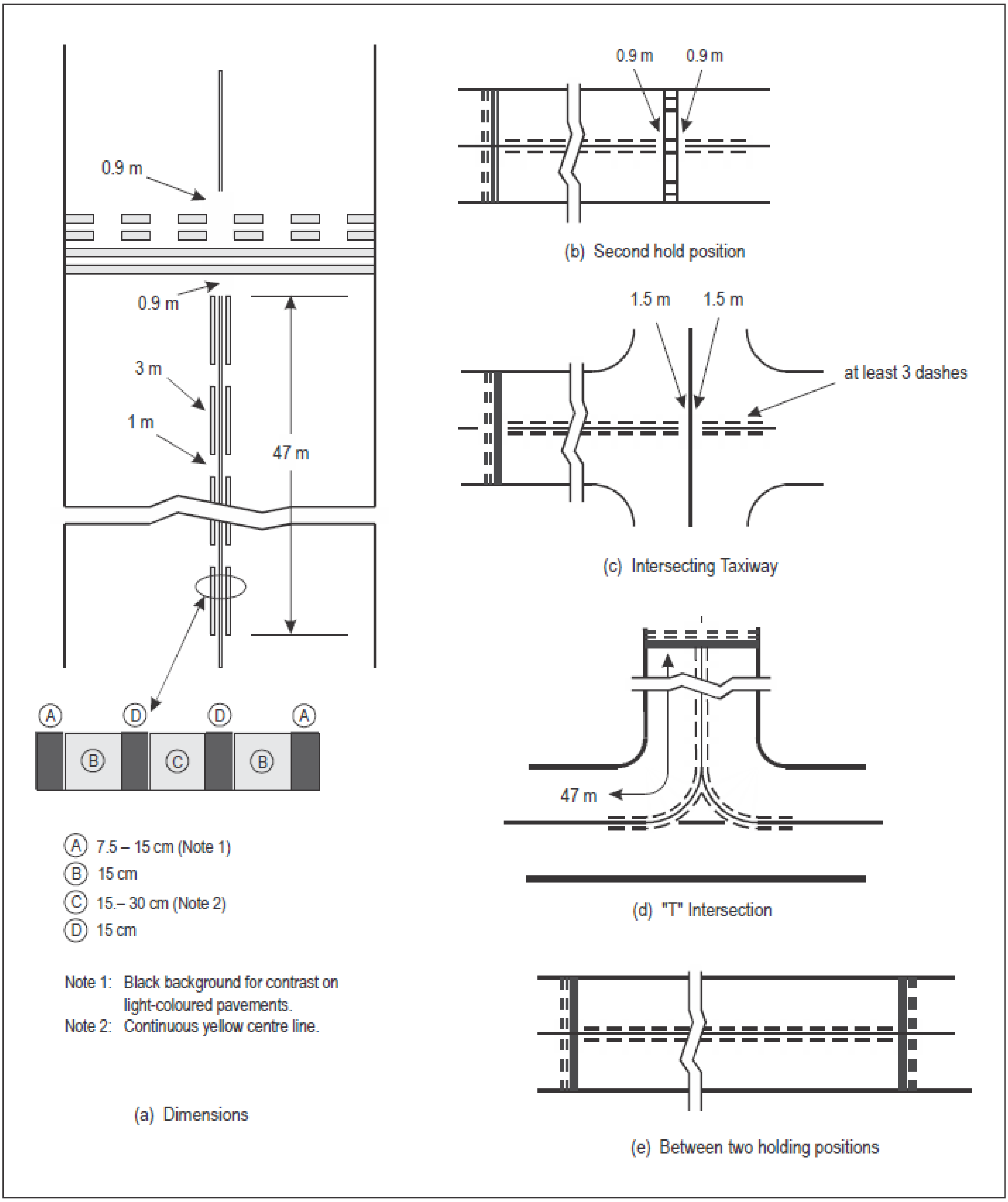


Figure 5-7. Enhanced taxiway center line marking
(shown with basic runway markings)

5.2.9 Runway turn pad marking

Application

5.2.9.1 Where a runway turn pad is provided, a runway turn pad marking shall be provided for continuous guidance to enable an airplane to complete a 180-degree turn and align with the runway center line.

Location

5.2.9.2 The runway turn pad marking shall be curved from the runway center line into the turn pad. The radius of the curve shall be compatible with the maneuvering capability and normal taxiing speeds of the airplanes for which the runway turn pad is intended. The intersection angle of the runway turn pad marking with the runway center line shall not be greater than 30 degrees.

5.2.9.3 The runway turn pad marking shall be extended parallel to the runway center line marking for a distance of at least 60 m beyond the point of tangency where the code number is 3 or 4, and for a distance of at least 30 m where the code number is 1 or 2.

5.2.9.4 A runway turn pad marking shall guide the airplane in such a way as to allow a straight portion of taxiing before the point where a 180-degree turn is to be made. The straight portion of the runway turn pad marking shall be parallel to the outer edge of the runway turn pad.

5.2.9.5 The design of the curve allowing the airplane to negotiate a 180-degree turn shall be based on a nose wheel steering angle not exceeding 45 degrees.

5.2.9.6 The design of the turn pad marking shall be such that, when the cockpit of the airplane remains over the runway turn pad marking, the clearance distance between any wheel of the airplane landing gear and the edge of the runway turn pad shall be not less than those specified in chapter 3 Section 3.3.6.

Note: For ease of maneuvering, consideration shall be given to providing a larger wheel-to-edge clearance for codes E and F airplanes. Refer to chapter 3 Section 3.3.7.

Characteristics

5.2.9.7 A runway turn pad marking shall be at least 15 cm in width and continuous in length.

5.2.10 Runway-holding position marking

Application and location

5.2.10.1 A runway-holding position marking shall be displayed along a runway-holding position.

Note: Refer to 5.4.2 concerning the provision of signs at runway-holding positions.

Characteristics

5.2.10.2 At an intersection of a taxiway and a non-instrument, non-precision approach or take-off runway, the runway-holding position marking shall be as shown in Figure 5-6, pattern A.

5.2.10.3 Where a single runway-holding position is provided at an intersection of a taxiway and a precision approach category I, II or III runway, the runway-holding position marking shall be as shown in Figure 5-6, pattern A. Where two or three runway-holding positions are provided at such an intersection, the runway-holding position marking closer (closest) to the runway shall be as shown in Figure 5-6, pattern A and the markings farther from the runway shall be as shown in Figure 5-6, pattern B.

5.2.10.4 The runway-holding position marking displayed at a runway-holding position established in accordance with chapter 3 section 3.12.3 shall be as shown in Figure 5-6, pattern A.

5.2.10.5 Until 26 November 2026, the dimensions of runway-holding position markings shall be as shown in figure 5-8, pattern A1 (or A2) or pattern B1 (or B2), as appropriate.

5.2.10.6 As of 26 November 2026, the dimensions of runway-holding position marking shall be as shown in Figure 5-8, pattern A2 or pattern B2, as appropriate.

5.2.10.7 Where increased conspicuity of the runway-holding position is required, the dimensions of runway holding position marking shall be as shown in Figure 5-8, pattern A2 or pattern B2, as appropriate.

Note (1): Patterns A1 and B1 are no longer valid after 2026

Note (2): An increased conspicuity of the runway-holding position can be required, notably to avoid incursion risks.

5.2.10.8 Where a pattern B runway-holding position marking is located on an area where it would exceed 60 m in length, the term “CAT II” or “CAT III” as appropriate shall be marked on the surface at the ends of the runway-holding position marking and at equal intervals of 45 m maximum between successive marks. The letters shall be not less than 1.8 m high and shall be placed not more than 0.9 m beyond the holding position marking.

5.2.10.9 The runway-holding position marking displayed at a runway/runway intersection shall be perpendicular to the center line of the runway forming part of the standard taxi-route. The pattern of the marking shall be as shown in Figure 5-8, pattern A2.

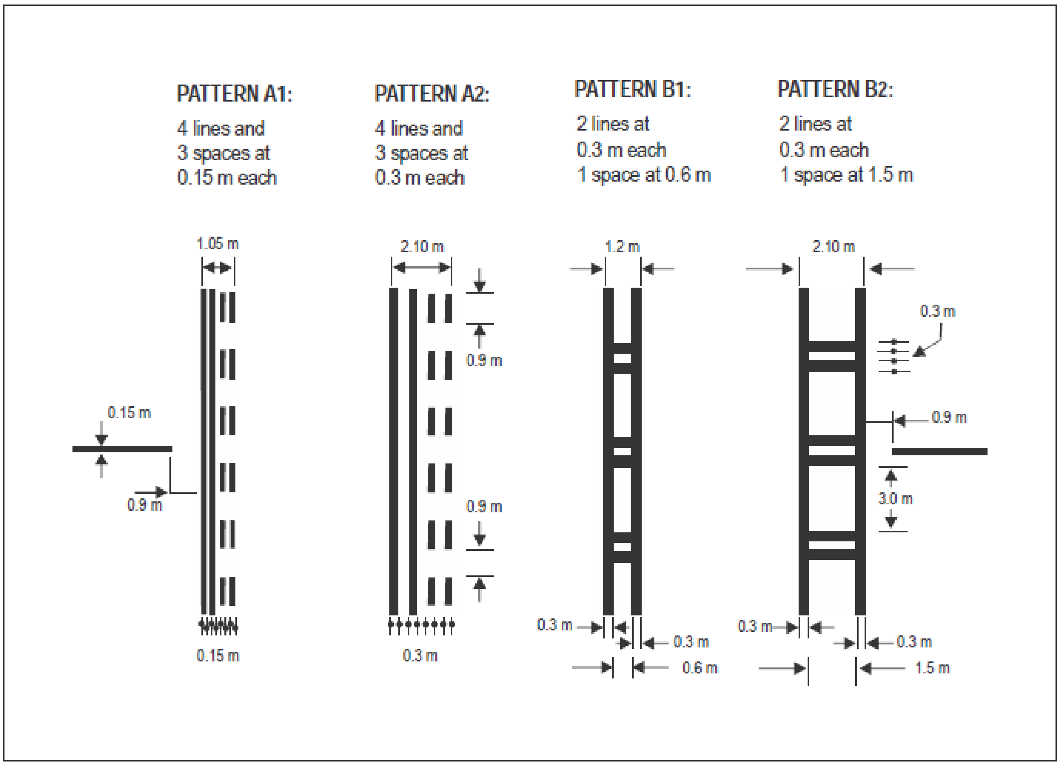


Figure 5-8. Runway- holding position markings

5.2.11 Intermediate holding position marking

Application and location

5.2.11.1 An intermediate holding position marking shall be displayed along an intermediate holding position.

5.2.11.2 An intermediate holding position marking shall be displayed at the exit boundary of a remote de-icing/anti-icing facility adjoining a taxiway.

5.2.11.3 Where an intermediate holding position marking is displayed at an intersection of two paved taxiways, it shall be located across the taxiway at sufficient distance from the near edge of the intersecting taxiway to ensure safe clearance between taxiing aircraft. It shall be coincident with a stop bar or intermediate holding position lights, where provided.

5.2.11.4 The distance between an intermediate holding position marking at the exit boundary of a remote de-icing/ anti-icing facility and the center line of the adjoining taxiway shall not be less than the dimension specified in Table 3-1, column 11.

Characteristics

5.2.11.5 An intermediate holding position marking shall consist of a single broken line as shown in Figure 5-6.

5.2.12 VOR aerodrome check-point marking

Application

5.2.12.1 When a VOR aerodrome check-point is established, it shall be indicated by a VOR aerodrome check-point marking and sign.

Note: Refer to chapter 5, paragraph 5.4.4 for VOR aerodrome check-point sign.

5.2.12.1 Site selection

Note: Guidance on the selection of sites for VOR aerodrome checkpoints is given in Annex 10, Volume I, Attachment E.

Location

5.2.12.2 A VOR aerodrome check-point marking shall be centered on the spot at which an aircraft is to be parked to receive the correct VOR signal.

Characteristics

5.2.12.3 A VOR aerodrome check-point marking shall consist of a circle 6 m in diameter and have a line width of 15 cm (see Figure 5-9 (A)).

5.2.12.4 When it is preferable for an aircraft to be aligned in a specific direction, a line shall be provided that passes through the center of the circle on the desired azimuth. The line shall extend 6 m outside the circle in the desired direction of heading and terminate in an arrowhead. The width of the line shall be 15 cm (see Figure 5-9 (B)).

5.2.12.5 A VOR aerodrome checkpoint marking shall be white in color. To provide contrast, markings may be bordered with black.

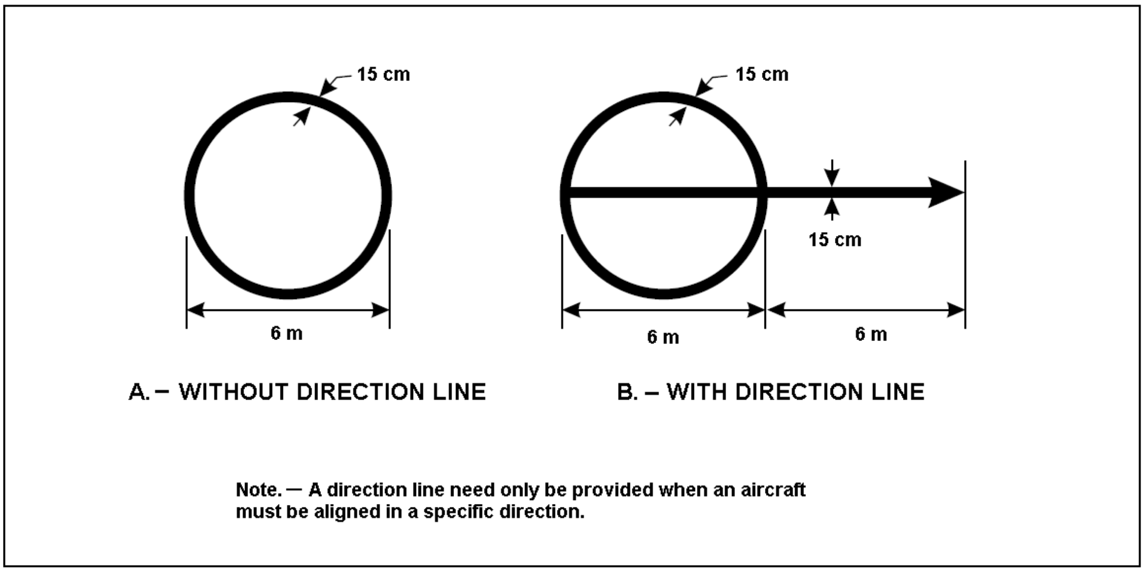


Figure 5-9. VOR aerodrome check- point marking

5.2.13 Aircraft stand markings

Note: Guidance on the layout of aircraft stand markings is contained in CARC Guidance Material 34-GM-17 Visual Aids for Navigation.

Application

5.2.13.1 Aircraft stand markings shall be provided for designated parking positions on a paved apron and on a de-icing/anti-icing facility.

Location

5.2.13.2 Aircraft stand markings on a paved apron and on a de-icing/anti-icing facility shall be located so as to provide the clearances specified in chapter 3 section 3.13.6 and 3.15.9 respectively, when the nose wheel follows the stand marking.

Characteristics

5.2.13.3 Aircraft stand markings shall include such elements as stand identification, lead-in line, turn bar, turning line, alignment bar, stop line and lead-out line, as are required by the parking configuration and to complement other parking aids.

5.2.13.4 An aircraft stand identification (letter and/or number) shall be included in the lead-in line a short distance after the beginning of the lead-in line. The height of the identification shall be adequate to be readable from the cockpit of aircraft using the stand.

5.2.13.5 Where two sets of aircraft stand markings are superimposed on each other in order to permit more flexible use of the apron and it is difficult to identify which stand marking shall be followed, or safety would be impaired if the wrong marking was followed, then identification of the aircraft for which each set of markings is intended shall be added to the stand identification.

Example: 2A-B747, 2B-F28.

5.2.13.6 Lead-in, turning and lead-out lines shall normally be continuous in length and have a width of not less than 15 cm. Where one or more sets of stand markings are superimposed on a stand marking, the lines shall be continuous for the most demanding aircraft and broken for other aircraft.

5.2.13.7 The curved portions of lead-in, turning and lead-out lines shall have radii appropriate to the most demanding aircraft type for which the markings are intended.

5.2.13.8 Where it is intended that an aircraft proceed in one direction only, arrows pointing in the direction to be followed shall be added as part of the lead-in and lead-out lines.

5.2.13.9 A turn bar shall be located at right angles to the lead-in line, abeam the left pilot position at the point of initiation of any intended turn. It shall have a length and width of not less than 6 m and 15 cm, respectively, and include an arrowhead to indicate the direction of turn.

Note: The distances to be maintained between the turn bar and the lead-in line may vary according to different aircraft types, taking into account the pilot's field of view.

5.2.13.10 If more than one turn bar and/or stop line is required, they shall be coded.

5.2.13.11 An alignment bar shall be placed so as to be coincident with the extended center line of the aircraft in the specified parking position and visible to the pilot during the final part of the parking maneuver. It shall have a width of not less than 15 cm.

5.2.13.12 A stop line shall be located at right angles to the alignment bar, abeam the left pilot position at the intended point of stop. It shall have a length and width of not less than 6 m and 15 cm, respectively.

Note: The distances to be maintained between the stop line and the lead-in line may vary according to different aircraft types, taking into account the pilot's field of view.

5.2.14 Apron safety lines

Note: Guidance on apron safety lines is contained in CARC Guidance Material 34-GM-17 Visual Aids for Navigation.

Application

5.2.14.1 Apron safety lines shall be provided on a paved apron as required by the parking configurations and ground facilities.

Location

5.2.14.2 Apron safety lines shall be located so as to define the areas intended for use by ground vehicles and other aircraft servicing equipment, etc., to provide safe separation from aircraft.

Characteristics

5.2.14.3 Apron safety lines shall include such elements as wing tip clearance lines and service road boundary lines as required by the parking configurations and ground facilities.

5.2.14.4 An apron safety line shall be continuous in length and at least 10 cm in width.

5.2.15 Road-holding position marking

Application

5.2.15.1 A road-holding position marking shall be provided at all road entrances to a runway.

Location

5.2.15.2 The road-holding position marking shall be located across the road at the holding position.

Characteristics

5.2.15.3 The road-holding position marking shall be in accordance with the local road traffic regulations.

5.2.16 Mandatory instruction marking

Note: Guidance on mandatory instruction marking is given in CARC Guidance Material 34-GM-17 Visual Aids for Navigation.

Application

5.2.16.1 Where it is impracticable to install a mandatory instruction sign in accordance with chapter 5 paragraph 5.4.2.1, a mandatory instruction marking shall be provided on the surface of the pavement.

5.2.16.2 Where operationally required, such as on taxiways exceeding 60 m in width, or to assist in the prevention of a runway incursion, a mandatory instruction sign shall be supplemented by a mandatory instruction marking.

Location

5.2.16.3 The mandatory instruction marking on taxiways, where the OMGWS is up to but not including 9 m shall be located across the taxiway equally placed about the taxiway centerline marking and on the holding side of the runway-holding position marking as shown in Figure 5-10 (A). The distance between the nearest edge of the marking and the runway holding position marking or the taxiway centre line marking shall be not less than 1 m.

5.2.16.4 The mandatory instruction marking on taxiways, where the OMGWS from 9 m up to but not including 15 m shall be located on both sides of the taxiway center line marking and on the holding side of the runway-holding position marking as shown in Figure 5-10 (B). The distance between the nearest edge of the marking and the runway holding position marking or the taxiway centerline marking shall be not less than 1 m.

5.2.16.5 Except where operationally required, a mandatory instruction marking shall not be located on a runway.

Characteristics

5.2.16.6 A mandatory instruction marking shall consist of an inscription in white on a red background. Except for a NO ENTRY marking, the inscription shall provide information identical to that of the associated mandatory instruction sign.

5.2.16.7 A NO ENTRY marking shall consist of an inscription in white reading NO ENTRY on a red background.

5.2.16.8 Where there is insufficient contrast between the marking and the pavement surface, the mandatory instruction marking shall include an appropriate border, preferably white or black.

5.2.16.9 The character height shall be 4 m. for inscriptions where OMGWS is from 6 m up to but not including 15 m, and 2 m where the OMGWS is up to but not including 6 m. The inscriptions shall be in the form and proportions shown in Appendix 3.

5.2.16.10 The background shall be rectangular and extend a minimum of 0.5 m laterally and vertically beyond the extremities of the inscription.

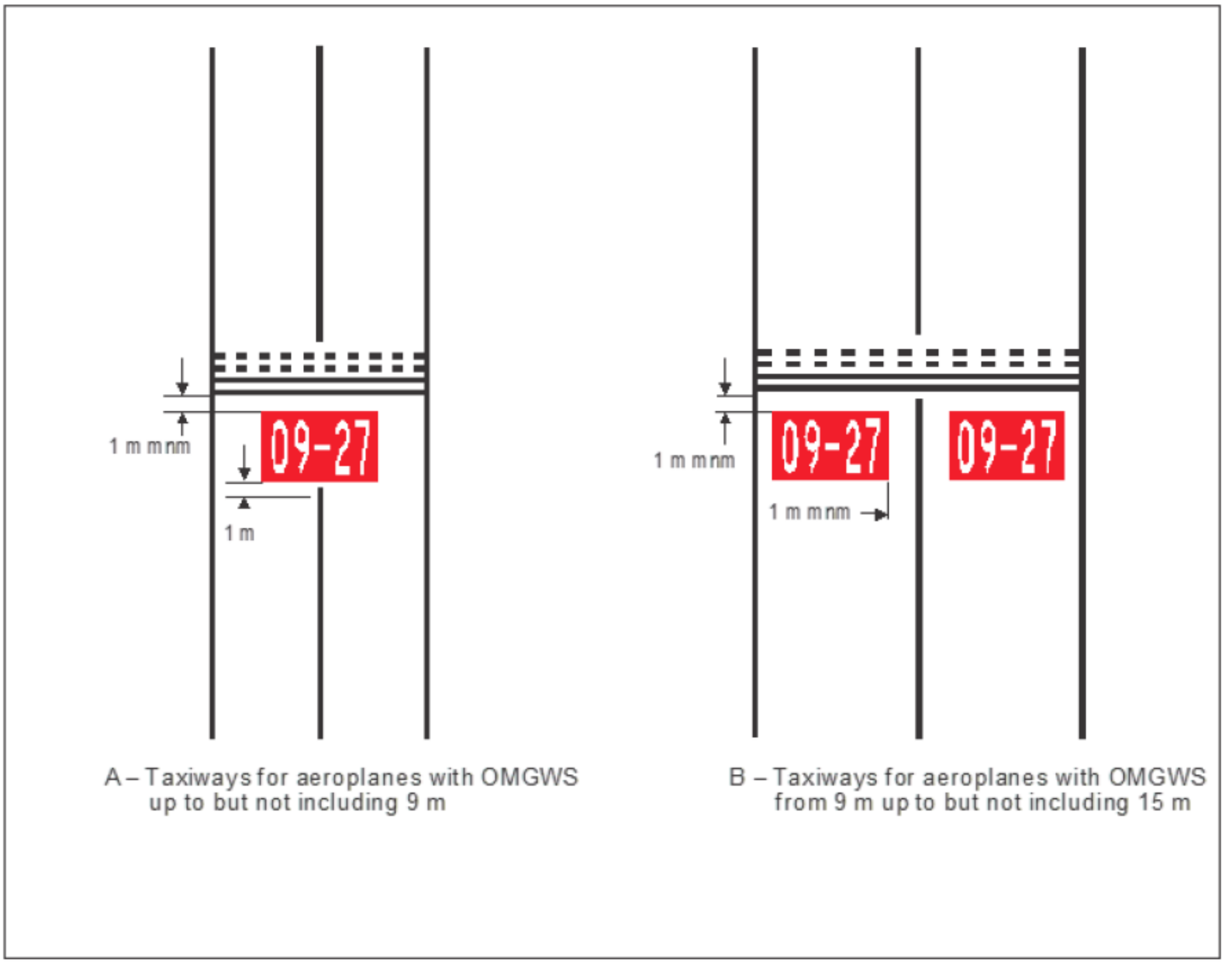


Figure 5-10. Mandatory instruction marking

5.2.17 Information marking

Note: Guidance on information marking is contained in CARC Guidance Material 34-GM-17 Visual Aids for Navigation.

Application

5.2.17.1 Where an information sign would normally be installed and is impractical to install, as determined by CARC, an information marking shall be displayed on the surface of the pavement.

5.2.17.2 Where operationally required an information sign shall be supplemented by an information marking.

5.2.17.3 An information (location/ direction) marking shall be displayed prior to and following complex taxiway intersections and where operational experience has indicated the addition of a taxiway location marking could assist flight crew ground navigation.

5.2.17.4 An information (location) marking shall be displayed on the pavement surface at regular intervals along taxiways of great length.

Location

5.2.17.5 The information marking shall be displayed across the surface of the taxiway or apron where necessary and positioned so as to be legible from the cockpit of an approaching aircraft.

Characteristics

5.2.17.6 An information marking shall consist of:

(a) an inscription in yellow upon a black background, when it replaces or supplements a location sign; and

(b) an inscription in black upon a yellow background, when it replaces or supplements a direction or destination sign

5.2.17.7 Where there is insufficient contrast between the marking background and the pavement surface, the marking shall include:

(a) a black border of 15cm in width where the inscriptions are in black; and

(b) a yellow border of 15cm in width where the inscriptions are in yellow.

5.2.17.8 The character height shall be 4 m. The inscriptions shall be in the form and proportions shown in Appendix 3.

5.3 Lights

5.3.1 General

Lights which may endanger the safety of aircraft

5.3.1.1 A non-aeronautical ground light near an aerodrome which might endanger the safety of aircraft shall be extinguished, screened or otherwise modified so as to eliminate the source of danger.

Laser emissions which may endanger the safety of aircraft

5.3.1.2 To protect the safety of aircraft against the hazardous effects of laser emitters, the following protected zones shall be established around aerodromes:

— a laser-beam free flight zone (LFFZ)

— a laser-beam critical flight zone (LCFZ)

— a laser-beam sensitive flight zone (LSFZ).

Note (1): Figures 5-11, 5-12 and 5-13 may be used to determine the exposure levels and distances that adequately protect flight operations.

Note (2): The restrictions on the use of laser beams in the three protected flight zones, LFFZ, LCFZ and LSFZ, refer to visible laser beams only. Laser emitters operated by authorities in a manner compatible with flight safety are excluded. In all navigable air space, the irradiance level of any laser beam, visible or invisible, is expected to be less than or equal to the maximum permissible exposure (MPE) unless such emission has been notified to CARC and permission obtained.

Note (3): The protected flight zones are established in order to mitigate the risk of operating laser emitters in the vicinity of aerodromes.

Note (4): Further guidance on how to protect flight operations from the hazardous effects of laser emitters is contained in ICAO Manual on Laser Emitters and Flight Safety (Doc 9815).

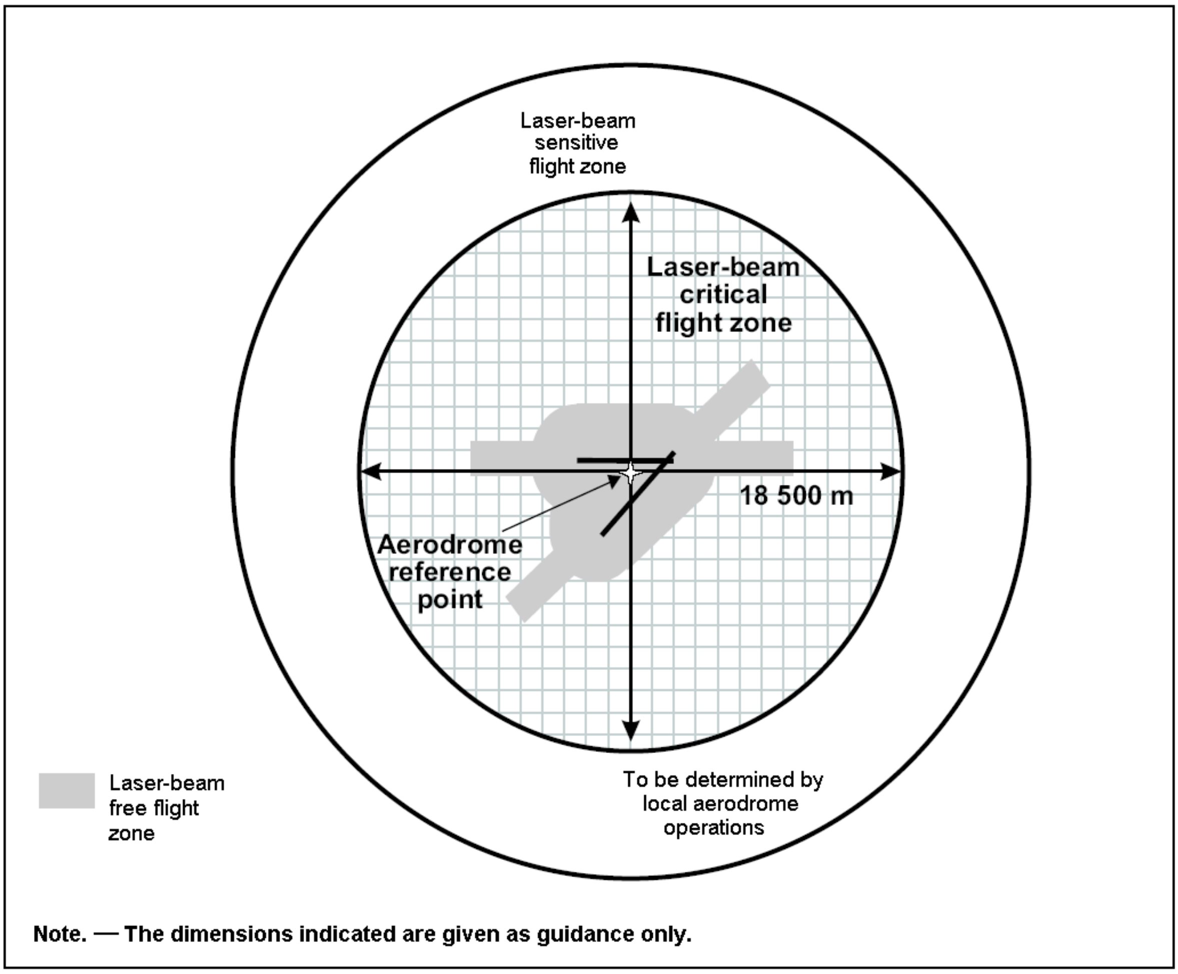


Figure 5-11. Protected flight zones

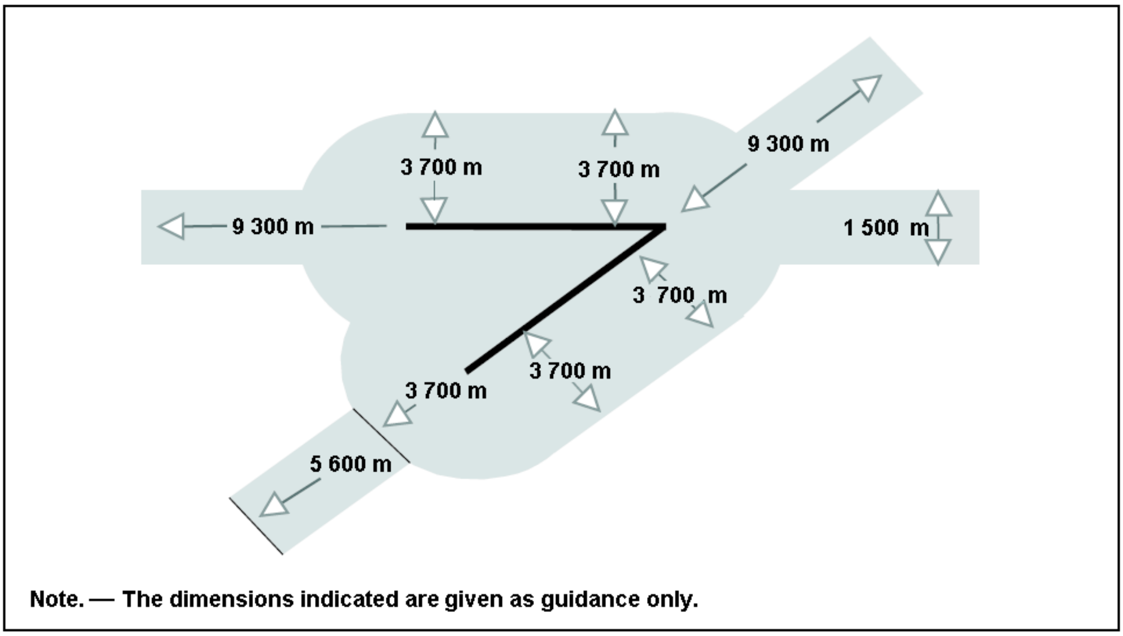


Figure 5-12. Multiple runway laser- beam free flight zone

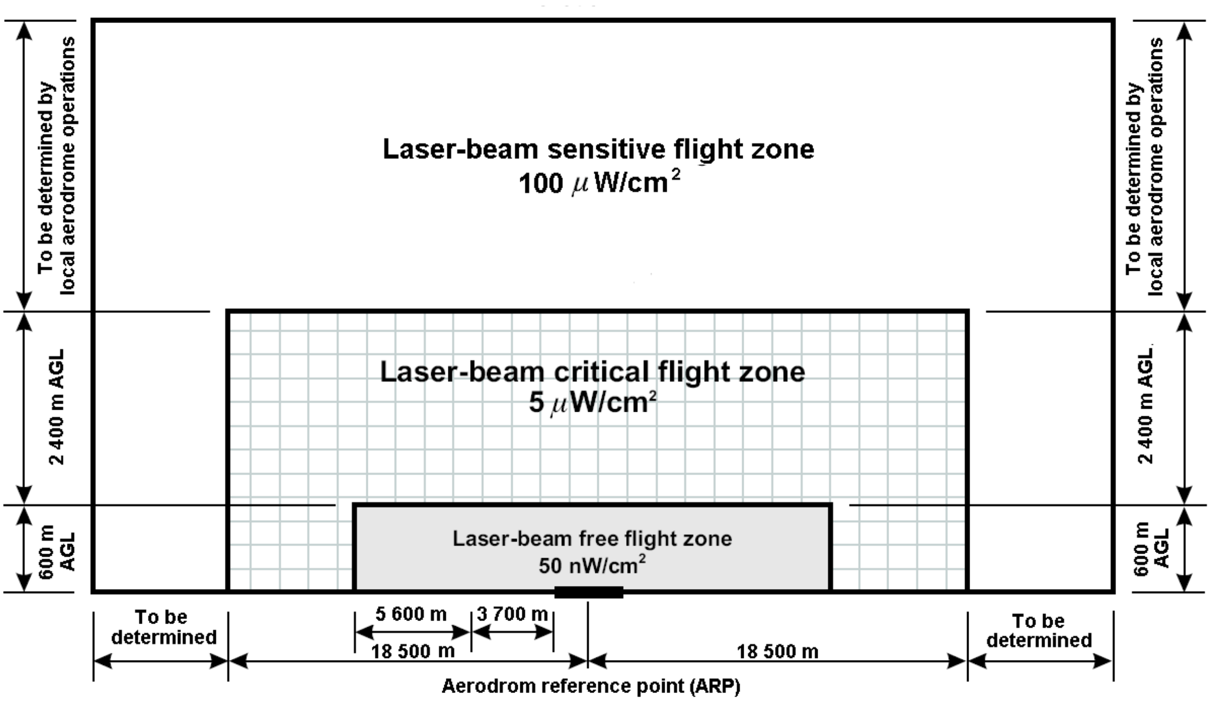


Figure 5-13. Protected flight zones with indication of maximum irradiance levels for visible laser beams

Lights which may cause confusion

5.3.1.3 A non-aeronautical ground light which, by reason of its intensity, configuration or color, might prevent, or cause confusion in, the clear interpretation of aeronautical ground lights shall be extinguished, screened or otherwise modified so as to eliminate such a possibility. In particular, attention shall be directed to a non-aeronautical ground light visible from the air within the areas described hereunder:

(a) Instrument runway — code number 4: within the areas before the threshold and beyond the end of the runway extending at least 4 500 m in length from the threshold and runway end and 750 m either side of the extended runway center line in width.
(b) Instrument runway — code number 2 or 3: as in a), except that the length shall be at least 3 000 m.
(c) Instrument runway — code number 1; and non-instrument runway: within the approach area.

Aeronautical ground lights which may cause confusion to mariners

Note: In the case of aeronautical ground lights near navigable waters, consideration needs to be given to ensuring that the lights do not cause confusion to mariners.

Light fixtures and supporting structures

Note: Refer to chapter 9, paragraph 9.9 for information regarding siting of equipment and installations on operational areas, and ICAO Aerodrome Design Manual, Part 6 — Frangibility (Doc 9157) for guidance on frangibility of light fixtures and supporting structures.

Elevated approach lights

5.3.1.4 Elevated approach lights and their supporting structures shall be frangible except that, in that portion of the approach lighting system beyond 300 m from the threshold:

(a) where the height of a supporting structure exceeds 12 m, the frangibility requirement shall 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 shall be frangible.

5.3.1.5 When an approach light fixture or supporting structure is not in itself sufficiently conspicuous, it shall be suitably marked.

Elevated lights

5.3.1.6 Elevated runway, stopway and taxiway lights shall be frangible. Their height shall be sufficiently low to preserve clearance for propellers and for the engine pods of jet aircraft.

Surface lights

5.3.1.7 Light fixtures inset in the surface of runways, stopways, taxiways and aprons shall be so designed and fitted as to withstand being run over by the wheels of an aircraft without damage either to the aircraft or to the lights themselves.

5.3.1.8 The temperature produced by conduction or radiation at the interface between an installed inset light and an aircraft tire shall not exceed 160°C during a 10-minute period of exposure.

Note: Guidance on measuring the temperature of inset lights is given in CARC Guidance Material 34-GM-17 Visual Aids for Navigation.

Light intensity and control

Note: In dusk or poor visibility conditions by day, lighting can be more effective than marking. For lights to be effective in such conditions or in poor visibility by night, they must be of adequate intensity. To obtain the required intensity, it will usually be necessary to make the light directional, in which case the arcs over which the light shows will have to be adequate and so orientated as to meet the operational requirements. The runway lighting system will have to be considered as a whole, to ensure that the relative light intensities are suitably matched to the same end and are maintained over time. (See CARC Guidance Material to Part 14 No. 34 GM-01, on intensity). Guidance on maintenance criteria for aeronautical ground lights and on the use of a site standard is contained in CARC Guidance Material 34-GM-17 Visual Aids for Navigation.

5.3.1.9 The intensity of runway lighting shall be adequate for the minimum conditions of visibility and ambient light in which use of the runway is intended, and compatible with that of the nearest section of the approach lighting system when provided.

Note: While the lights of an approach lighting system may be of higher intensity than the runway lighting, it is good practice to avoid abrupt changes in intensity as these could give a pilot a false impression that the visibility is changing during approach.

5.3.1.10 Where a high-intensity lighting system is provided, a suitable intensity control shall be incorporated to allow for adjustment of the light intensity to meet the prevailing conditions. Separate intensity controls or other suitable methods shall be provided to ensure that the following systems, when installed, can be operated at compatible intensities:

— approach lighting system;
— runway edge lights;
— runway threshold lights;

— runway end lights;
— runway center line lights;
— runway touchdown zone lights; and
— taxiway center line lights.

5.3.1.11 On the perimeter of and within the ellipse defining the main beam in Appendix 2, Figures A2-1 to A2-10, the maximum light intensity value shall not be greater than three times the minimum light intensity value measured in accordance with Appendix 2, collective notes for Figures A2-1 to A2-11, Note 2.

5.3.1.12 On the perimeter of and within the rectangle defining the main beam in Appendix 2, Figures A2-12 to A2-20, the maximum light intensity value shall not be greater than three times the minimum light intensity value measured in accordance with Appendix 2, collective notes for Figures A2-12 to A2-21, Note (2).

5.3.2 Emergency lighting

Application

5.3.2.1 At an aerodrome provided with runway lighting and without a secondary power supply, sufficient emergency lights shall be conveniently available for installation on at least the primary runway in the event of failure of the normal lighting system.

Note: Emergency lighting may also be useful to mark obstacles or delineate taxiways and apron areas.

Location

5.3.2.2 When installed on a runway the emergency lights shall, as a minimum, conform to the configuration required for a non-instrument runway.

Characteristics

5.3.2.3 The color of the emergency lights shall conform to the color requirements for runway lighting, except that, where the provision of colored lights at the threshold and the runway end is not practicable, all lights may be variable white or as close to variable white as practicable.

5.3.3 Aeronautical beacons

Application

5.3.3.1 Where operationally necessary an aerodrome beacon or an identification beacon shall be provided at each aerodrome intended for use at night.

5.3.3.2 The operational requirement shall be determined having regard to the requirements of the air traffic using the aerodrome, the conspicuity of the aerodrome features in relation to its surroundings and the installation of other visual and non-visual aids useful in locating the aerodrome.

Aerodrome beacon

5.3.3.3 An aerodrome beacon shall be provided at an aerodrome intended for use at night if one or more of the following conditions exist:

(a) aircraft navigate predominantly by visual means;
(b) reduced visibilities are frequent; or
(c) it is difficult to locate the aerodrome from the air due to surrounding lights or terrain.

Location

5.3.3.4 The aerodrome beacon shall be located on or adjacent to the aerodrome in an area of low ambient background lighting.

5.3.3.5 The location of the beacon shall be such that the beacon is not shielded by objects in significant directions and does not dazzle a pilot approaching to land.

Characteristics

5.3.3.6 The aerodrome beacon shall show either colored flashes alternating with white flashes, or white flashes only. The frequency of total flashes shall be from 20 to 30 per minute. Where used, the colored flashes emitted by beacons at land aerodromes shall be green and colored flashes emitted by beacons at water aerodromes shall be yellow. In the case of a combined water and land aerodrome, colored flashes, if used, shall have the color characteristics of whichever section of the aerodrome is designated as the principal facility.

5.3.3.7 The light from the beacon shall show at all angles of azimuth. The vertical light distribution shall extend upwards from an elevation of not more than 1° to an elevation determined by the appropriate authority to be sufficient to provide guidance at the maximum elevation at which the beacon is intended to be used and the effective intensity of the flash shall be not less than 2 000 cd.

Note: At locations where a high ambient background lighting level cannot be avoided, the effective intensity of the flash may be required to be increased by a factor up to a value of 10.

Identification beacon

Application

5.3.3.8 An identification beacon shall be provided at an aerodrome which is intended for use at night and cannot be easily identified from the air by other means.

Location
5.3.3.9 The identification beacon shall be located on the aerodrome in an area of low ambient background lighting.

5.3.3.10 The location of the beacon shall be such that the beacon is not shielded by objects in significant directions and does not dazzle a pilot approaching to land.

Characteristics
5.3.3.11 An identification beacon at a land aerodrome shall show at all angles of azimuth. The vertical light distribution shall extend upwards from an elevation of not more than 1° to an elevation determined by the appropriate authority to be sufficient to provide guidance at the maximum elevation at which the beacon is intended to be used and the effective intensity of the flash shall be not less than 2 000 cd.

Note: At locations where a high ambient background lighting level cannot be avoided, the effective intensity of the flash may be required to be increased by a factor up to a value of 10.

5.3.3.12 An identification beacon shall show flashing green at a land aerodrome and flashing-yellow at a water aerodrome.

5.3.3.13 The identification characters shall be transmitted in the International Morse Code.

5.3.3.14 The speed of transmission shall be between six and eight words per minute, the corresponding range of duration of the Morse dots being from 0.15 to 0.2 seconds per dot.

5.3.4 Approach lighting systems

5.3.4.1 Application

A — Non-instrument runway
Where physically practicable, a simple approach lighting system as specified in Chapter 5 paragraph 5.3.4.2 to 5.3.4.9 should be provided to serve a non-instrument runway where the code number is 3 or 4 and intended for use at night, except when the runway is used only in conditions of good visibility, and sufficient guidance is provided by other visual aids.

A simple approach lighting system can also provide visual guidance by day.

B — Non- precision approach runway

Where physically practicable, a simple approach lighting system as specified in chapter 5 paragraph 5.3.4.2 to 5.3.4.9 shall be provided to serve a non-precision approach runway, except when the runway is used only in conditions of good visibility or sufficient guidance is provided by other visual aids.

Note: It is advisable to give consideration to the installation of a precision approach category I lighting system or to the addition of a runway lead-in lighting system.

C — Precision approach runway category I

Where physically practicable, a precision approach category I lighting system as specified in chapter 5 section 5.3.4.10 to 5.3.4.21 shall be provided to serve a precision approach runway category I.

D — Precision approach runway categories II and III

A precision approach category II and III lighting system as specified in chapter 5 paragraph 5.3.4.22 to 5.3.4.39 shall be provided to serve a precision approach runway category II or III.

Simple approach lighting system

Location

5.3.4.2 A simple approach lighting system shall consist of a row of lights on the extended center line of the runway extending, whenever possible, over a distance of not less than 420 m from the threshold with a row of lights forming a crossbar 18 m or 30 m in length at a distance of 300 m from the threshold.

5.3.4.3 The lights forming the crossbar shall be as nearly as practicable in a horizontal straight line at right angles to, and bisected by, the line of the center line lights. The lights of the crossbar shall be spaced so as to produce a linear effect, except that, when a crossbar of 30 m is used, gaps may be left on each side of the center line. These gaps shall be kept to a minimum to meet local requirements and each shall not exceed 6 m.

Note (1): Spacing for the crossbar lights between 1 m and 4 m are in use. Gaps on each side of the center line may improve directional guidance when approaches are made with a lateral error, and facilitate the movement of rescue and fire fighting vehicles.

Note (2): See CARC Guidance Material to Part 14 No. 34 GM-01for guidance on installation tolerances.

5.3.4.4 The lights forming the center line shall be placed at longitudinal intervals of 60 m, except that, when it is desired to improve the guidance, an interval of 30 m may be used. The innermost light shall be located either 60 m or 30 m from the threshold, depending on the longitudinal interval selected for the center line lights.

5.3.4.5 If it is not physically possible to provide a center line extending for a distance of 420 m from the threshold, it shall be extended to 300 m so as to include the crossbar. If this is not possible, the center line lights shall be extended as far as practicable, and each center line light shall then consist of a barrette at least 3 m in length. Subject to the approach system having a crossbar at 300 m from the threshold, an additional crossbar shall be provided at 150 m from the threshold.

5.3.4.6 The system shall lie as nearly as practicable in the horizontal plane passing through the threshold, provided that:

(a) no object other than an ILS or MLS azimuth antenna shall protrude through the plane of the approach lights within a distance of 60 m from the center line of the system; and

(b) no light other than a light located within the central part of a crossbar or a center line barrette (not their extremities) shall be screened from an approaching aircraft.

Any ILS or MLS azimuth antenna protruding through the plane of the lights shall be treated as an obstacle and marked and lighted accordingly.

Characteristics

5.3.4.7 The lights of a simple approach lighting system shall be fixed lights and the color of the lights shall be such as to ensure that the system is readily distinguishable from other aeronautical ground lights, and from extraneous lighting if present. Each center line light shall consist of either:

(a) a single source; or

(b) a barrette at least 3 m in length.

Note (1): When the barrette as in b) is composed of lights approximating to point sources, a spacing of 1.5 m between adjacent lights in the barrette has been found satisfactory.

Note (2): It may be advisable to use barrettes 4 m in length if it is anticipated that the simple approach lighting system will be developed into a precision approach lighting system.

Note (3): At locations where identification of the simple approach lighting system is difficult at night due to surrounding lights, sequence flashing lights installed in the outer portion of the system may resolve this problem.

5.3.4.8 Where provided for a non-instrument runway, the lights shall show at all angles in azimuth necessary to a pilot on base leg and final approach. The intensity of the lights shall be adequate for all conditions of visibility and ambient light for which the system has been provided.

5.3.4.9 Where provided for a non-precision approach runway, the lights shall show at all angles in azimuth necessary to the pilot of an aircraft which on final approach does not deviate by an abnormal amount from the path defined by the non-visual aid. The lights shall be designed to provide guidance during both day and night in the most adverse conditions of visibility and ambient light for which it is intended that the system shall remain usable.

Precision approach category I lighting system

Location

5.3.4.10 A precision approach category I lighting system shall consist of a row of lights on the extended center line of the runway extending, wherever possible, over a distance of 900 m from the runway threshold with a row of lights forming a crossbar 30 m in length at a distance of 300 m from the runway threshold.

Note: 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. See CARC Guidance Material to Part 14 No. 34 GM-01.

5.3.4.11 The lights forming the crossbar shall be as nearly as practicable in a horizontal straight line at right angles to, and bisected by, the line of the center line lights. The lights of the crossbar shall be spaced so as to produce a linear effect, except that gaps may be left on each side of the center line. These gaps shall be kept to a minimum to meet local requirements and each shall not exceed 6 m.

Note (1): Spacing for the crossbar lights between 1 m and 4 m are in use. Gaps on each side of the center line may improve directional guidance when approaches are made with a lateral error, and facilitate the movement of rescue and fire fighting vehicles.

Note (2): See CARC Guidance Material to Part 14 No. 34 GM-01 for guidance on installation tolerances.

5.3.4.12 The lights forming the center line shall be placed at longitudinal intervals of 30 m with the innermost light located 30 m from the threshold.

5.3.4.13 The system shall lie as nearly as practicable in the horizontal plane passing through the threshold, provided that:

(a) no object other than an ILS or MLS azimuth antenna shall protrude through the plane of the approach lights within a distance of 60 m from the center line of the system; and
(b) no light other than a light located within the central part of a crossbar or a center line barrette (not their extremities) shall be screened from an approaching aircraft. Any ILS or MLS azimuth antenna protruding through the plane of the lights shall be treated as an obstacle and marked and lighted accordingly.

Characteristics

5.3.4.14 The center line and crossbar lights of a precision approach category I lighting system shall be fixed lights showing variable white. Each center line light position shall consist of either:

(a) a single light source in the innermost 300 m of the center line, two light sources in the central 300 m of the center line and three light sources in the outer 300 m of the center line to provide distance information; or
(b) a barrette.

5.3.4.15 Where the serviceability level of the approach lights specified as a maintenance objective in Chapter 10 paragraph 10.5.10 can be demonstrated, each center line light position may consist of either:

(a) a single light source; or
(b) a barrette.

5.3.4.16 The barrettes shall be at least 4 m in length. When barrettes are composed of lights approximating to point sources, the lights shall be uniformly spaced at intervals of not more than 1.5 m.

5.3.4.17 If the center line consists of barrettes, as described in Chapter 5 paragraph 5.3.4.14 b or 5.3.4.15 b, each barrette shall be supplemented by a flashing light, except where such lighting is considered unnecessary taking into account the characteristics of the system and the nature of the meteorological conditions.

5.3.4.18 Each flashing light, as described in Chapter 5 paragraph 5.3.4.17, shall be flashed twice a second in sequence, beginning with the outermost light and progressing toward the threshold to the innermost light of the system. The design of the electrical circuit shall be such that these lights can be operated independently of the other lights of the approach lighting system.

5.3.4.19 If the center line consists of lights, as described in Chapter 5 paragraph 5.3.4.14 a or 5.3.4.15 a, additional crossbars of lights to the crossbar provided at 300 m from the threshold shall be provided at 150 m, 450 m, 600 m and 750 m from the threshold. The lights forming each crossbar shall be as nearly as practicable in a horizontal straight line at right angles to, and bisected by, the line of the center line lights. The lights shall be spaced so as to produce a linear effect, except that gaps may be left on each side of the center line. These gaps shall be kept to a minimum to meet local requirements and each shall not exceed 6 m.

Note: See CARC Guidance Material to Part 14 No. 34 GM-01 for detailed configuration.

5.3.4.20 Where the additional crossbars described in Chapter 5 paragraph 5.3.4.19 are incorporated in the system, the outer ends of the crossbars shall lie on two straight lines that either are parallel to the line of the center line lights or converge to meet the runway center line 300 m from threshold.

5.3.4.21 The lights shall be in accordance with the specifications of Appendix 2, Figure A2-1.

Note: The flight path envelopes used in the design of these lights are given in CARC Guidance Material to Part 14 No. 34 GM-01.

Precision approach category II and III lighting system

Location

5.3.4.22 The approach lighting system shall consist of a row of lights on the extended center line of the runway, extending, wherever possible, over a distance of 900 m from the runway threshold. In addition, the system shall have two side rows of lights, extending 270 m from the threshold, and two crossbars, one at 150 m and one at 300 m from the threshold, all as shown in Figure 5-14. Where the serviceability level of the approach lights specified as maintenance objectives in Chapter 10 paragraph 10.5.7 can be demonstrated, the system may have two side rows of lights, extending 240 m from the threshold, and two crossbars, one at 150 m and one at 300 m from the threshold, all as shown in Figure 5-15.

Note: The length of 900 m is based on providing guidance for operations under category I, II and III conditions. Reduced lengths may support category II and III operations but may impose limitations on category I operations. See CARC Guidance Material to Part 14 No. 34 GM-01.

5.3.4.23 The lights forming the center line shall be placed at longitudinal intervals of 30 m with the innermost lights located 30 m from the threshold.

5.3.4.24 The lights forming the side rows shall be placed on each side of the center line, at a longitudinal spacing equal to that of the center line lights and with the first light located 30 m from the threshold. Where the serviceability level of the approach lights specified as maintenance objectives in 10.5.7 can be demonstrated, lights forming the side rows may be placed on each side of the center line, at a longitudinal spacing of 60 m with the first light located 60 m from the threshold. The lateral spacing (or gauge) between the innermost lights of the side rows shall be not less than 18 m nor more than 22.5 m, and preferably 18 m, but in any event shall be equal to that of the touchdown zone lights.

5.3.4.25 The crossbar provided at 150 m from the threshold shall fill in the gaps between the center line and side row lights.

5.3.4.26 The crossbar provided at 300 m from the threshold shall extend on both sides of the center line lights to a distance of 15 m from the center line.

5.3.4.27 If the center line beyond a distance of 300 m from the threshold consists of lights as described in 3.4.31 (b) or 3.4.32 (b), additional crossbars of lights shall be provided at 450 m, 600 m and 750 m from the threshold.

5.3.4.28 Where the additional crossbars described in 5.3.4.27 are incorporated in the system, the outer ends of these crossbars shall lie on two straight lines that either are parallel to the center line or converge to meet the runway center line 300 m from the threshold.

5.3.4.29 The system shall lie as nearly as practicable in the horizontal plane passing through the threshold, provided that:

(a) no object other than an ILS or MLS azimuth antenna shall protrude through the plane of the approach lights within a distance of 60 m from the center line of the system; and

(b) no light other than a light located within the central part of a crossbar or a center line barrette (not their extremities) shall be screened from an approaching aircraft.

Any ILS or MLS azimuth antenna protruding through the plane of the lights shall be treated as an obstacle and marked and lighted accordingly.

Characteristics

5.3.4.30 The center line of a precision approach category II and III lighting system for the first 300 m from the threshold shall consist of barrettes showing variable white, except that, where the threshold is displaced 300 m or more, the center line may consist of single light sources showing variable white. Where the serviceability level of the approach lights specified as maintenance objectives in Chapter 10 paragraph 10.5.7 can be demonstrated, the center line of a precision approach category II and III lighting system for the first 300 m from the threshold may consist of either:

(a) barrettes, where the center line beyond 300 m from the threshold consists of barrettes as described in 5.3.4.32 (a); or
(b) alternate single light sources and barrettes, where the center line beyond 300 m from the threshold consists of single light sources as described in 5.3.4.32 (b), with the innermost single light source located 30 m and the innermost barrette located 60 m from the threshold; or
(c) single light sources where the threshold is displaced 300 m or more;

all of which shall show variable white.

5.3.4.31 Beyond 300 m from the threshold each center line light position shall consist of either:
(a) a barrette as used on the inner 300 m; or
(b) two light sources in the central 300 m of the center line and three light sources in the outer 300 m of the center line;

all of which shall show variable white.

5.3.4.32 Where the serviceability level of the approach lights specified as maintenance objectives in Chapter 10 paragraph 10.5.7 can be demonstrated, beyond 300 m from the threshold each center line light position may consist of either:
(a) a barrette; or
(b) a single light source;

all of which shall show variable white.

5.3.4.33 The barrettes shall be at least 4 m in length. When barrettes are composed of lights approximating to point sources, the lights shall be uniformly spaced at intervals of not more than 1.5 m.

5.3.4.34 If the center line beyond 300 m from the threshold consists of barrettes, as described in 5.3.4.31 a or 5.3.4.32 a, each barrette beyond 300 m shall be supplemented by a flashing light, except where such lighting is considered unnecessary taking into account the characteristics of the system and the nature of the meteorological conditions.

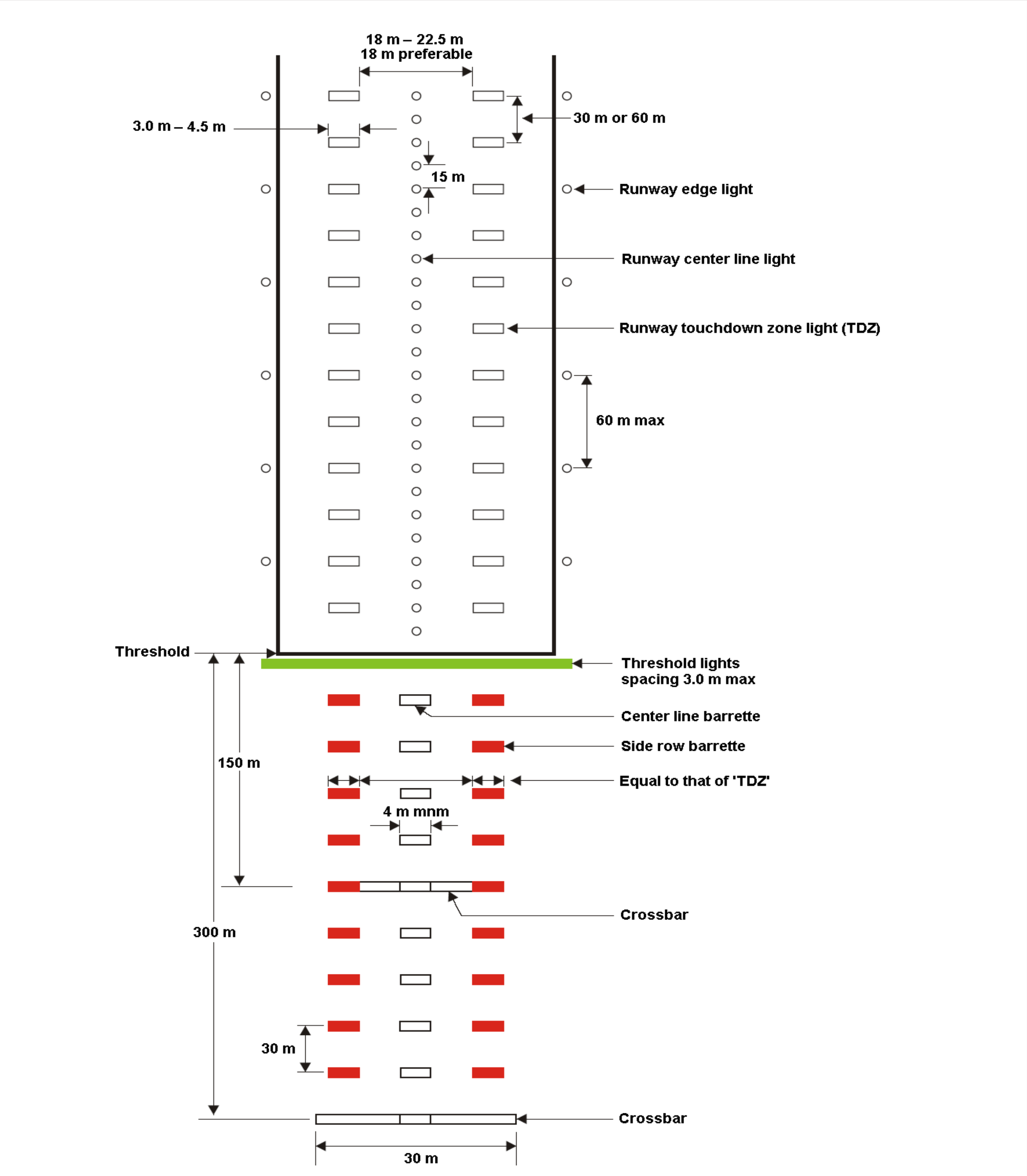


Figure 5-14. Inner 300 m approach and runway lighting for precision approach runways categories II and III

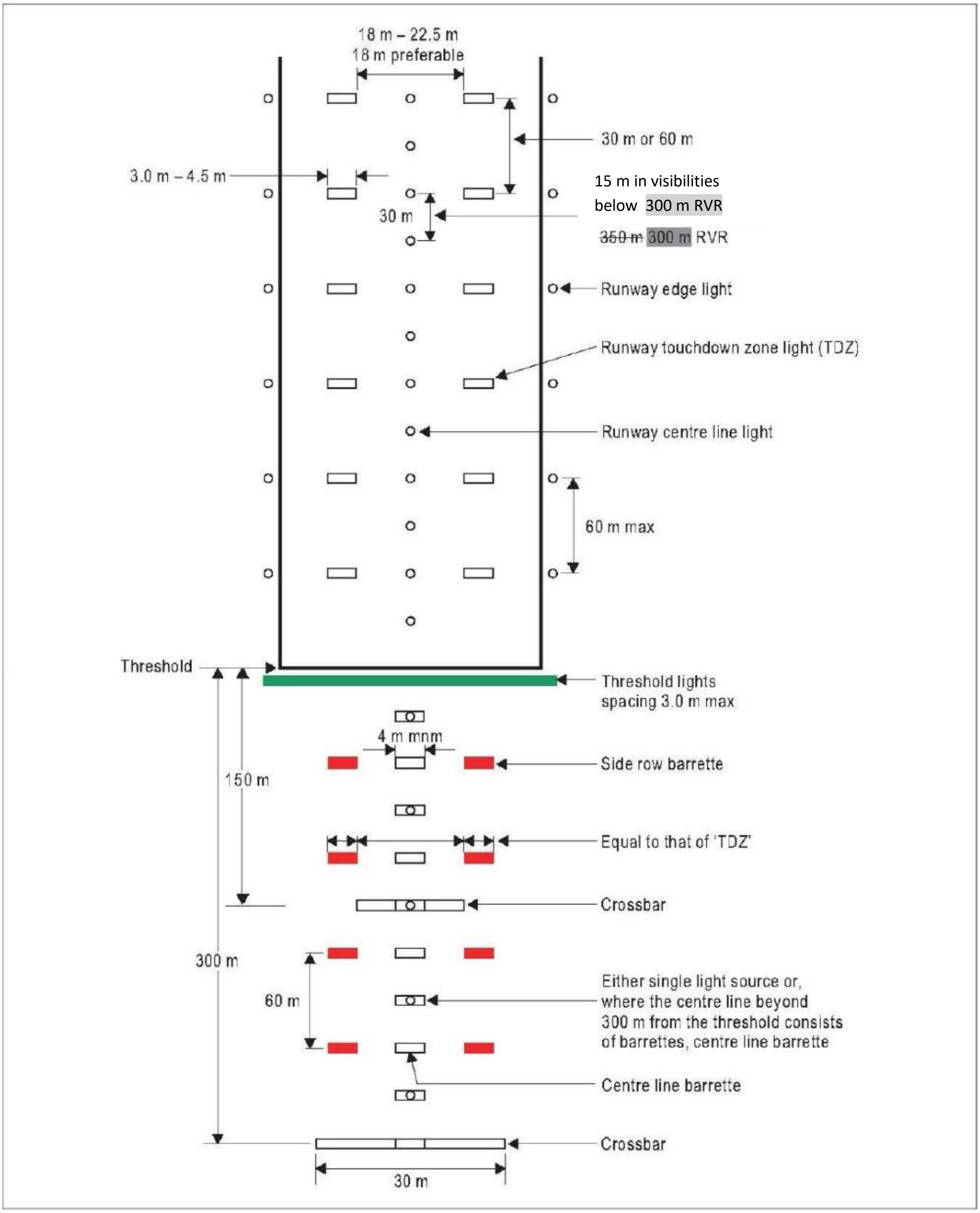


Figure 5-15. Inner 300 m approach and runway lighting for precision approach runways categories II and III where the serviceability levels of the lights specified as maintenance objectives in Chapter 10 can be demonstrated

5.3.4.35 Each flashing light as described in 5.3.4.34 shall be flashed twice a second in sequence, beginning with the outermost light and progressing toward the threshold to the innermost light of the system. The design of the electrical circuit shall be such that these lights can be operated independently of the other lights of the approach lighting system.

5.3.4.36 The side row shall consist of barrettes showing red. The length of a side row barrette and the spacing of its lights shall be equal to those of the touchdown zone light barrettes.

5.3.4.37 The lights forming the crossbars shall be fixed lights showing variable white. The lights shall be uniformly spaced at intervals of not more than 2.7 m.

5.3.4.38 The intensity of the red lights shall be compatible with the intensity of the white lights.

5.3.4.39 The lights shall be in accordance with the specifications of Appendix 2, Figures A2-1 and A2-2.

The flight path envelopes used in the design of these lights are given in CARC Guidance Material to Part 14 No. 34 GM-01.

5.3.5 Visual approach slope indicator systems

Application

5.3.5.1 A visual approach slope indicator system shall be provided to serve the approach to a runway whether or not the runway is served by other visual approach aids or by non-visual aids, where one or more of the following conditions exist:

(a) the runway is used by turbojet or other airplanes with similar approach guidance requirements;

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

(1) 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, or

(2) misleading information such as is produced by deceptive surrounding terrain or runway slopes;

(c) the presence of objects in the approach area may involve serious hazard if an airplane 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 airplane undershooting or overrunning the runway; and

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

Note: Guidance on the priority of installation of visual approach slope indicator systems is contained in CARC Guidance Material to Part 14 No. 34 GM-01.

5.3.5.2 The standard visual approach slope indicator systems shall consist of the following:

(a) T-VASIS and AT-VASIS conforming to the specifications contained in 5.3.5.7 to 5.3.5.23 inclusive;

(b) PAPI and APAPI systems conforming to the specifications contained in 5.3.5.24 to 5.3.5.41 inclusive; as shown in Figure 5-16.

5.3.5.3 PAPI, T-VASIS or AT-VASIS shall be provided where the code number is 3 or 4 when one or more of the conditions specified in 5.3.5.1 exist.

5.3.5.4 As of 1 January 2020, the use of T-VASIS and AT-VASIS as standard visual approach slope indicator systems shall be discontinued

5.3.5.5 PAPI or APAPI shall be provided where the code number is 1 or 2 when one or more of the conditions specified in 5.3.5.1 exist.

5.3.5.6 Where a runway threshold is temporarily displaced from the normal position and one or more of the conditions specified in 5.3.5.1 exist, a PAPI shall be provided except that where the code number is 1 or 2 an APAPI shall be provided.

T-VASIS and AT-VASIS

Description

5.3.5.7 The T-VASIS shall consist of twenty light units symmetrically disposed about the runway center line in the form of two wing bars of four light units each, with bisecting longitudinal lines of six lights, as shown in Figure 5-17.

5.3.5.8 The AT-VASIS shall 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.

5.3.5.9 The light units shall be constructed and arranged in such a manner that the pilot of an airplane during an approach will:

(a) when above the approach slope, see the wing bar(s) white, and one, two or three fly-down lights, the more fly-down lights being visible the higher the pilot is above the approach slope;

(b) when on the approach slope, see the wing bar(s) white; and
(c) when below the approach slope, see the wing bar(s) and one, two or three fly-up lights white, the more fly-up lights being visible the lower the pilot is below the approach slope; and when well below the approach slope, see the wing bar(s) and the three fly-up lights red.

When on or above the approach slope, no light shall be visible from the fly-up light units; when on or below the approach slope, no light shall be visible from the fly-down light units.

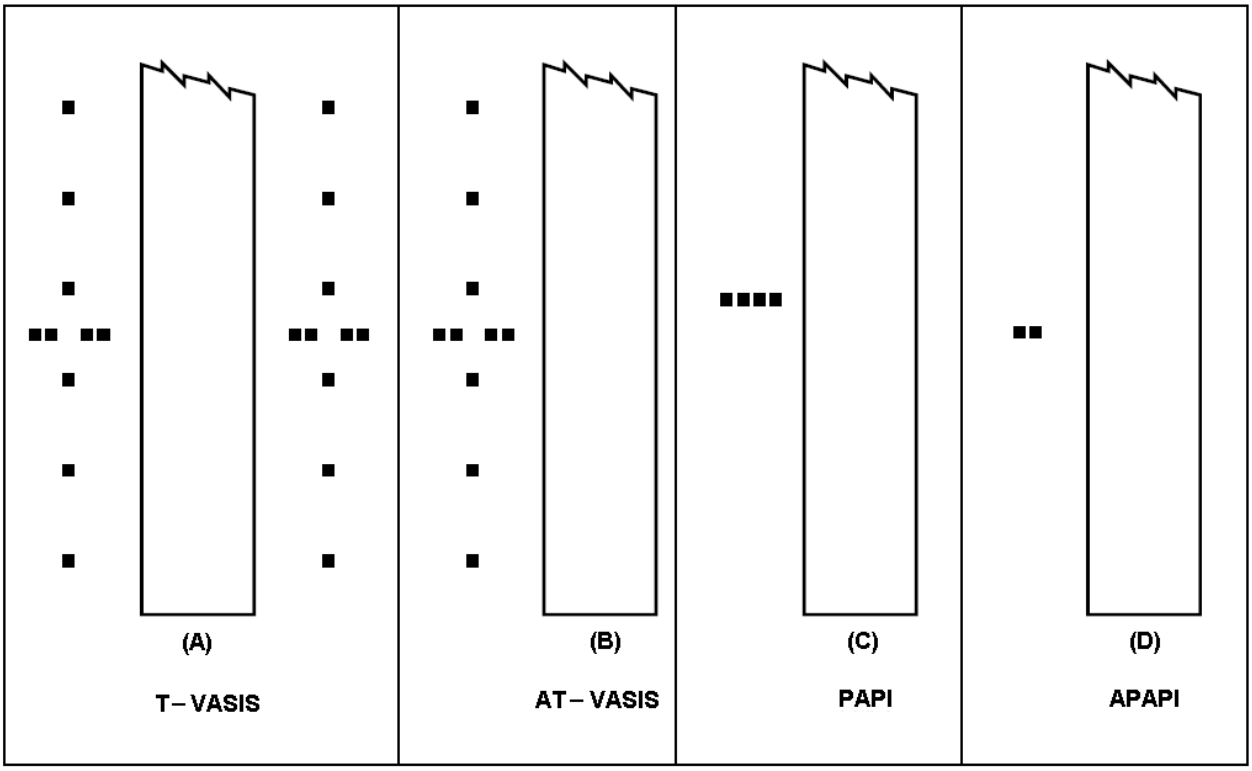


Figure 5-16. Visual approach slope indicator systems

Siting

5.3.5.10 The light units shall be located as shown in Figure 5-17, subject to the installation tolerances given therein.

The siting of T-VASIS will provide, for a 3° slope and a nominal eye height over the threshold of 15 m (see 5.3.5.7 and 5.3.5.20), a pilot’s eye height over threshold of 13 m to 17 m when only the wing bar lights are visible. If increased eye height at the threshold is required (to provide adequate wheel clearance), then the approaches may be flown with one or more fly-down lights visible. The pilot’s eye height over the threshold is then of the following order:

— Wing bar lights and one fly-down light visible	— 17 m to 22 m
— Wing bar lights and two fly-down lights visible	— 22 m to 28 m
— Wing bar lights and three fly-down lights visible	— 28 m to 54 m

Characteristics of the light units

5.3.5.11 The systems shall be suitable for both day and night operations.

5.3.5.12 The light distribution of the beam of each light unit shall 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 shall produce a white beam extending from an elevation of 6° down to approximately the approach slope, where it shall have a sharp cut-off. The fly-up light units shall produce a white beam from approximately the approach slope down to 1°54′ vertical angle and a red beam below a 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 comply with 5.3.5.22.

5.3.5.13 The light intensity distribution of the fly-down, wing bar and fly-up light units shall be as shown in Appendix 2, Figure A2-22.

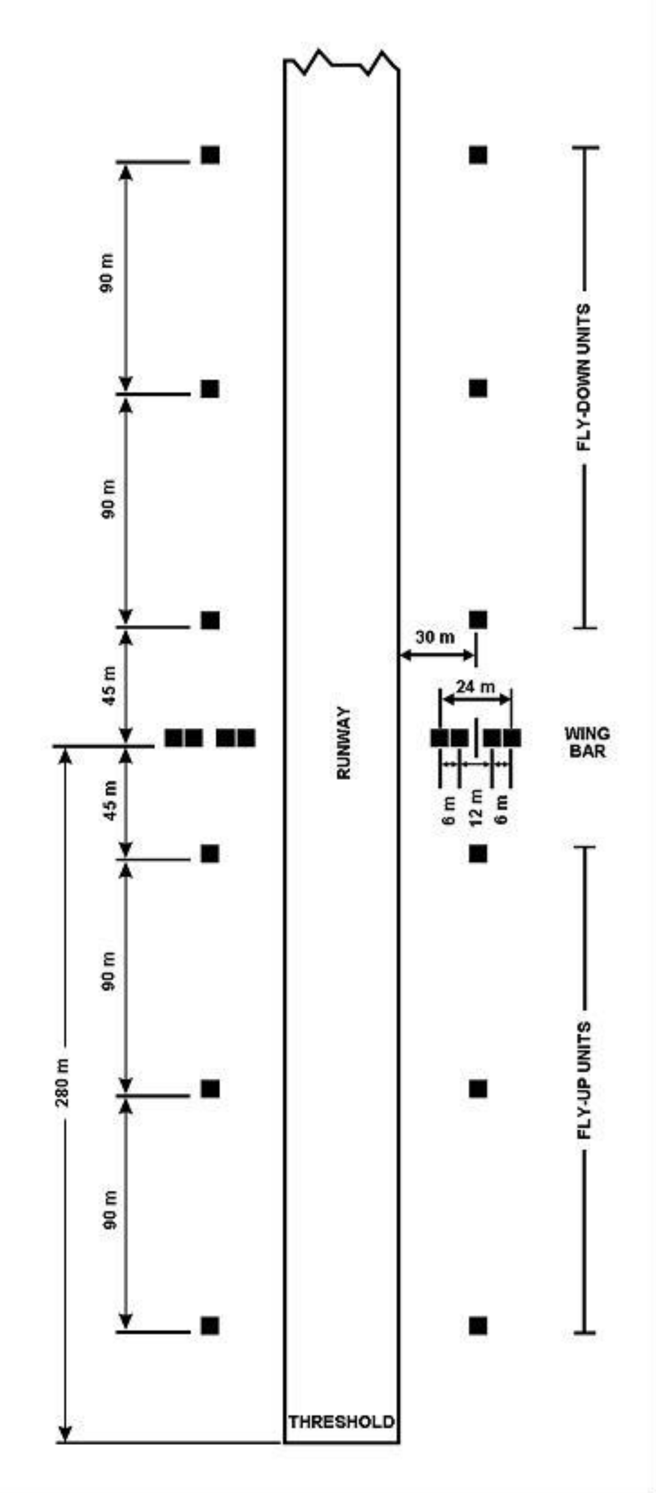
5.3.5.14 The color transition from red to white in the vertical plane shall be such as to appear to an observer, at a distance of not less than 300 m, to occur over a vertical angle of not more than 15′.

5.3.5.15 At full intensity the red light shall have a Y coordinate not exceeding 0.320.

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

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

5.3.5.18 A suitable intensity control shall be provided to allow adjustments to meet the prevailing conditions and to avoid dazzling the pilot during approach and landing.



INSTALLATION TOLERANCES

The appropriate authority may:

(a) vary the nominal eye height over the threshold of the on-slope signal between the limits of 12 m and 16 m, except in cases where a standard ILS glide path and/or MLS minimum glide path is available; the height over threshold should be varied to avoid any conflict between the visual approach slope indications and the usable portion of the ILS glide path and/or MLS minimum glide path indications;

(b) vary the longitudinal distance between individual light units or the overall length of the system by not more than 10 per cent;

(c) vary the lateral displacement of the system from the runway edge by not more than ±3 m;

Note: The system must be symmetrically displaced about the runway centre line.

(d) where there is a longitudinal slope of the ground, adjust the longitudinal distance of a light unit to compensate for its difference in level from that of the threshold; and

(e) where there is a transverse slope in the ground, adjust the longitudinal distance of two light units or two wing bars to compensate for the difference in level between them as necessary to meet the requirements of 5.3.5.16.

The distance between the wing bar and the threshold is based on an approach slope of 3° to a level runway with a nominal eye height over the threshold of 15 m. In practice, the threshold to wing bar distance is determined by:

(a) the selected approach slope;

(b) the longitudinal slope of the runway; and

(c) the selected nominal eye height over the threshold.

Figure 5-17. Siting of light units for T-VASIS

Approach slope and elevation setting of light beams

5.3.5.19 The approach slope shall be appropriate for use by the airplanes using the approach.

5.3.5.20 When the runway on which a T-VASIS is provided is equipped with an ILS and/or MLS, the siting and elevations of the light units shall be such that the visual approach slope conforms as closely as possible with the glide path of the ILS and/or the minimum glide path of the MLS, as appropriate.

5.3.5.21 The elevation of the beams of the wing bar light units on both sides of the runway shall be the same. The elevation of the top of the beam of the fly-up light unit nearest to each wing bar, and that of the bottom of the beam of the fly-down light unit nearest to each wing bar, shall be equal and shall correspond to the approach slope. The cut-off angle of the top of the beams of successive fly-up light units shall decrease by 5′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 shall increase by 7′ of arc at each successive unit away from the wing bar (see Figure 5-18).

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

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

Note: Refer to 5.3.5.42 to 5.3.5.46 concerning the related obstacle protection surface.

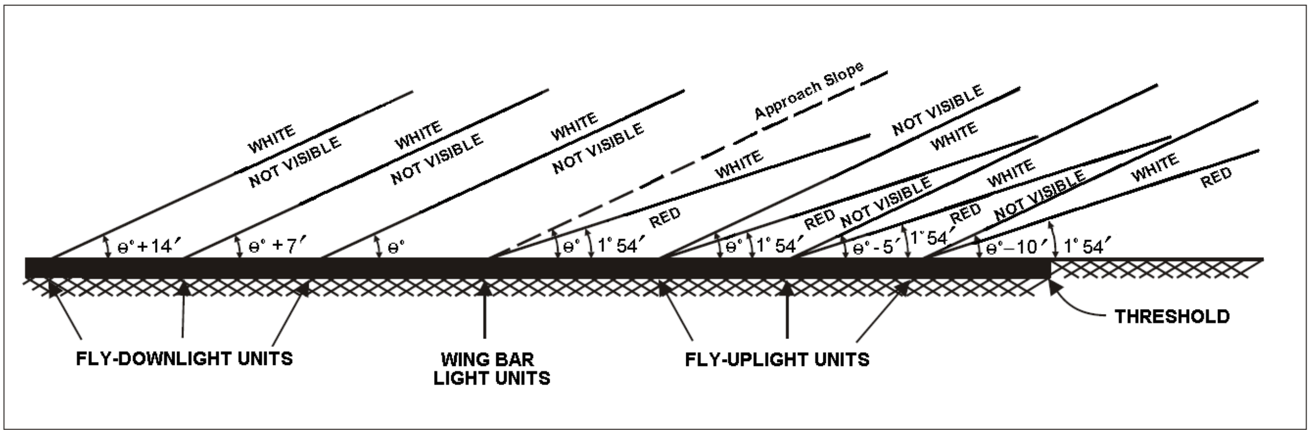


Figure 5-18. Light beams and elevation settings of T-VASIS and AT-VASIS

PAPI and APAPI

Description

5.3.5.24 The PAPI system shall consist of a wing bar of 4 sharp transition multi-lamp (or paired single lamp) units equally spaced. The system shall be located on the left side of the runway unless it is physically impracticable to do so.

Note: Where a runway is used by aircraft requiring visual roll guidance which is not provided by other external means, then a second wing bar may be provided on the opposite side of the runway.

5.3.5.25 The APAPI system shall consist of a wing bar of 2 sharp transition multi-lamp (or paired single lamp) units. The system shall be located on the left side of the runway unless it is physically impracticable to do so.

Note: Where a runway is used by aircraft requiring visual roll guidance which is not provided by other external means, then a second wing bar may be provided on the opposite side of the runway.

5.3.5.26 The wing bar of a PAPI shall be constructed and arranged in such a manner 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; and

(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.

5.3.5.27 The wing bar of an APAPI shall be constructed and arranged in such a manner that a pilot making an approach will:

(a) when on or close to the approach slope, see the unit nearer the runway as red and the unit farther from the runway as white;

(b) when above the approach slope, see both the units as white; and

(c) when below the approach slope, see both the units as red.

Siting

5.3.5.28 The light units shall be located as in the basic configuration illustrated in Figure 5-19, subject to the installation tolerances given therein. The units forming a wing bar shall be mounted so as to appear to the pilot of an approaching airplane to be substantially in a horizontal line. The light units shall be mounted as low as possible and shall be frangible.

Characteristics of the light units

5.3.5.29 The system shall be suitable for both day and night operations.

5.3.5.30 The color transition from red to white in the vertical plane shall be such 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′.

5.3.5.31 At full intensity the red light shall have a Y coordinate not exceeding 0.320.

5.3.5.32 The light intensity distribution of the light units shall be as shown in Appendix 2, Figure A2-23.

Note: Refer to CARC Guidance Material 34-GM-17 Visual Aids for Navigation for additional guidance on the characteristics of light units.

5.3.5.33 Suitable intensity control shall be provided so as to allow adjustment to meet the prevailing conditions and to avoid dazzling the pilot during approach and landing.

5.3.5.34 Each light unit shall 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.

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

Approach slope and elevation setting of light units

5.3.5.36 The approach slope as defined in Figure 5-20 shall be appropriate for use by the airplanes using the approach.

5.3.5.37 When the runway is equipped with an ILS and/or MLS, the siting and the angle of elevation of the light units shall be such that the visual approach slope conforms as closely as possible with the glide path of the ILS and/or the minimum glide path of the MLS, as appropriate.

5.3.5.38 The angle of elevation settings of the light units in a PAPI wing bar shall be such that, during an approach, the pilot of an airplane observing a signal of one white and three reds will clear all objects in the approach area by a safe margin (See Table 5-2).

5.3.5.39 The angle of elevation settings of the light units in an APAPI wing bar shall be such that, during an approach, the pilot of an airplane observing the lowest on slope signal, i.e. one white and one red, will clear all objects in the approach area by a safe margin (See Table 5-2).

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

Note: Refer to 5.3.5.42 to 5.3.5.46 concerning the related obstacle protection surface.

5.3.5.41 Where wing bars are installed on each side of the runway to provide roll guidance, corresponding units shall be set at the same angle so that the signals of each wing bar change symmetrically at the same time.

Table 5-2. Wheel clearance over threshold for PAPI and APAPI

Eye-to-wheel height of airplane in the approach configuration [a] (1)	Desired wheel clearance (meters) [b, c] (2)	Minimum wheel clearance (meters) [d] (3)
Up to but not including 3 m	6	3 [e]
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 airplanes meant to use the system on a regular basis shall be considered. The most demanding amongst such airplanes shall determine the eye-to-wheel height group.
(b) Where practicable the desired wheel clearances shown in column (2) shall be provided.
(c) The wheel clearances in column (2) may be reduced to no less than those in column (3) where an aeronautical study indicates that such reduced wheel clearances are acceptable.
(d) When a reduced wheel clearance is provided at a displaced threshold it shall be ensured that the corresponding desired wheel clearance specified in column (2) will be available when an airplane at the top end of the eye-to-wheel height group chosen over-flies the extremity of the runway.
(e) This wheel clearance may be reduced to 1.5 m on runways used mainly by light-weight non-turbo-jet airplanes.

Obstacle protection surface

The following specifications apply to T-VASIS, AT-VASIS, PAPI and APAPI.

5.3.5.42 An obstacle protection surface shall be established when it is intended to provide a visual approach slope indicator system.

5.3.5.43 The characteristics of the obstacle protection surface, i.e. origin, divergence, length and slope shall correspond to those specified in the relevant column of Table 5-3 and in Figure 5-21.

5.3.5.44 New objects or extensions of existing objects shall not be permitted above an obstacle protection surface except when, in the opinion of the appropriate authority, the new object or extension would be shielded by an existing immovable object.

Note: Circumstances in which the shielding principle may reasonably be applied are described in ICAO Aerodrome Design Manual, Part 6 — Frangibility (Doc 9157).

5.3.5.45 Existing objects above an obstacle protection surface shall be removed except when, in the opinion of the appropriate authority, the object is shielded by an existing immovable object, or after aeronautical study it is determined that the object would not adversely affect the safety of operations of airplanes.

5.3.5.46 Where an aeronautical study indicates that an existing object extending above an obstacle protection surface could adversely affect the safety of operations of airplanes one or more of the following measures shall be taken:

(a) remove the object;

(b) suitably raise the approach slope of the system;

(c) reduce the azimuth spread of the system so that the object is outside the confines of the beam;

(d) displace the axis of the system and its associated obstacle protection surface by no more than 5°; and

(e) suitably displace the system upwind of the threshold such that the object no longer penetrates the OPS.

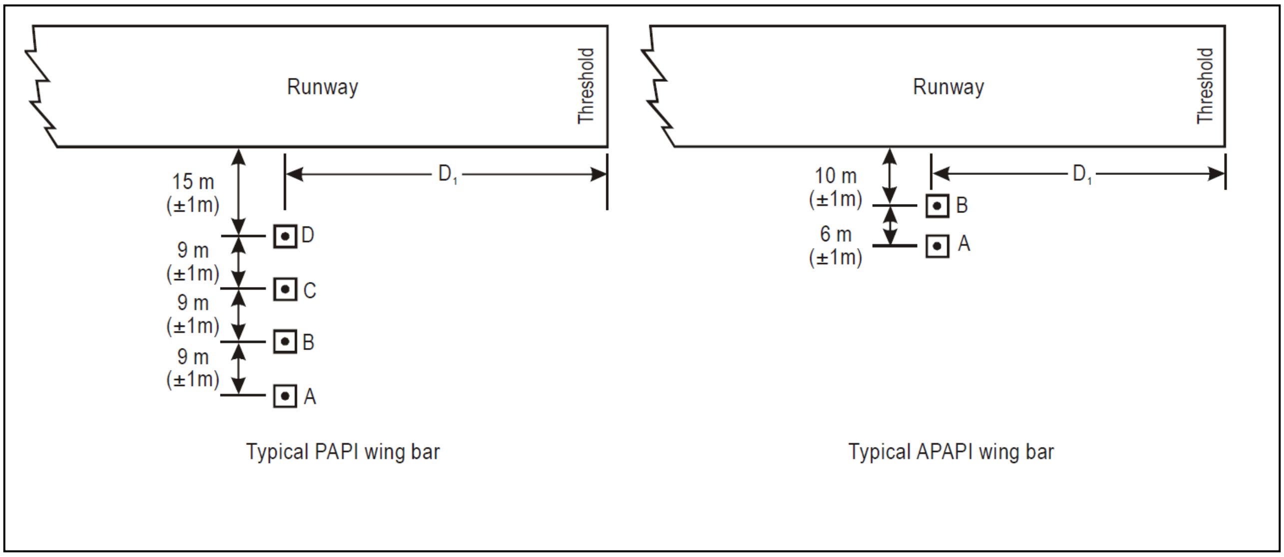
Note (1): Guidance on this issue is contained in CARC Guidance Material 34-GM-17 Visual Aids for Navigation.

Note (2): The displacement of the system upwind of the threshold reduces the operational landing distance.

Table 5-3. Dimensions and slopes of the obstacle protection surface

	Runway type / code number							
	Non-instrument Code number				**Instrument Code number**			
Surface dimensions	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Length of inner edge	60 m	80 m [a]	150 m	150 m	150 m	150 m	300 m	300 m
Distance from the visual approach slope indicator system (e)	D1+30m	D1+60m	D1+60m	D1+60m	D1+60m	D1+60m	D1+60m	D1+60m
Divergence (each side)	10 %	10 %	10 %	10 %	15 %	15 %	15 %	15 %
Total length	7 500 m	7500 m [b]	15 000 m	15 000 m	7 500 m	7500 m [b]	15 000 m	15 000 m
Slope								
(a) T-VASIS and AT-VASIS	— [c]	1.9°	1.9°	1.9°	—	1.9°	1.9°	1.9°
(b) PAPI [d]	—	A—0.57	A—0.57	A—0.57	A—0.57	A—0.57	A—0.57	A—0.57
(c) APAPI [d]	A—0.9°	A—0.9°	—	—	A—0.9°	A—0.9°	—	—

(a) This length is to be increased to 150 m for a T-VASIS or AT-VASIS.
(b) This length is to be increased to 15 000 m for a T-VASIS or AT-VASIS.
(c) No slope has been specified if a system is unlikely to be used on runway type/code number indicated.
(d) Angles as indicated in Figure 5-19.
(e) D1 is the distance of the visual approach slope indicator system from threshold prior to any displacement to remedy object penetration of the OPS (refer Figure 5-19). The start of the OPS is fixed to the visual approach slope indicator system location, such that displacement of the PAPI results in an equal displacement of the start of the OPS. See 5.3.5.45(e)



INSTALLATION TOLERANCES

(a) Where a PAPI or APAPI is installed on a runway not equipped with an ILS or MLS, the distance D1 shall be calculated to ensure that the lowest height at which a pilot will see a correct approach path indication (Figure 5-20, angle B for a PAPI and angle A for an APAPI) provides the wheel clearance over the threshold specified in Table 5-2 for the most demanding amongst aeroplanes regularly using the runway.

(b) Where a PAPI or APAPI is installed on a runway equipped with an ILS and/or MLS, the distance D1 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 aer planes regularly using the runway. The distance shall be equal to that between the threshold and the effective origin of the ILS glide path or MLS minimum glide path, as appropriate, plus a correction factor for the variation of eyeto- antenna heights of the aeroplanes concerned. The correction factor is obtained by multiplying the average eyeto-antenna height of those aeroplanes by the cotangent of the approach angle. However, the distance shall be such that in no case will the wheel clearance over the threshold be lower than that specified in column (3) of Table 5-2.

Note. See Section 5.2.5 for specifications on aiming point marking. Guidance on the harmonization of PAPI, ILS and/or MLS signals is contained in the CARC Guidance Material 34-GM-17 Visual Aids for Navigation.

(c) If a wheel clearance, greater than that specified in a) above is required for specific aircraft, this can be achieved by increasing D1.

(d) Distance D1 shall be adjusted to compensate for differences in elevation between the lens centres of the light units and the threshold.

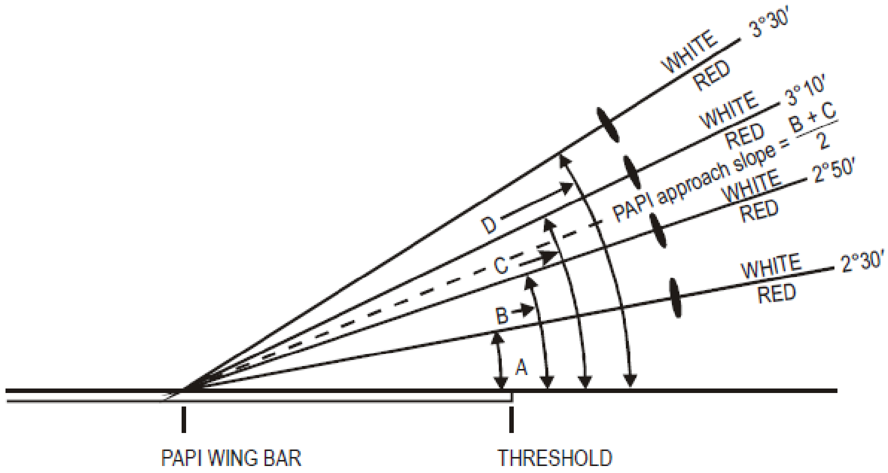
(e) To ensure that units are mounted as low as possible and to allow for any transverse slope, small height adjustments of up to 5 cm between units are acceptable. A lateral gradient not greater than 1.25 per cent can be accepted provided it is uniformly applied across the units.

(f) A spacing of 6 m (±1 m) between PAPI units should be used on code numbers 1 and 2. In such an event, the inner PAPI unit shall be located not less than 10 m (±1 m) from the runway edge.

Note. Reducing the spacing between light units results in a reduction in usable range of the system.

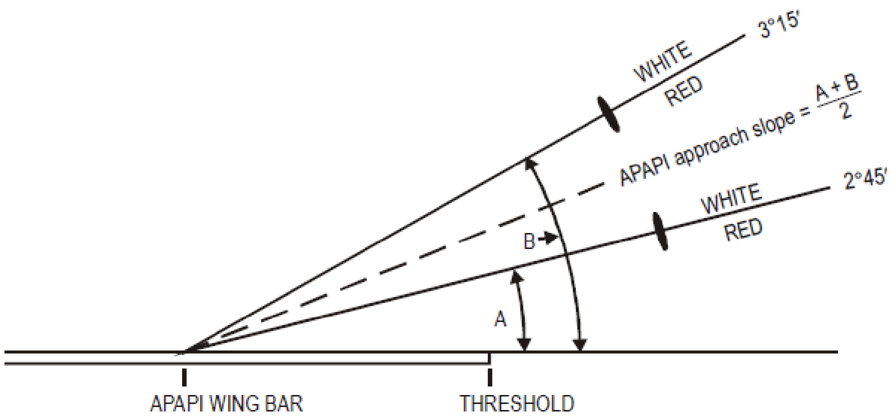
(g) The lateral spacing between APAPI units may be increased to 9 m (±1 m) if greater range is required or later conversion to a full PAPI is anticipated. In the latter case, the inner APAPI unit shall be located 15 m (±1 m) from the runway edge.

Figure 5-19. Siting of PAPI and APAPI



The height of the pilot's eye above the aircraft's ILS glide path/MLS antenna varies with the type of aeroplane and approach attitude. Harmonization of the PAPI signal and ILS glide path and/or MLS minimum glide path to a point closer to the threshold may be achieved by increasing the on-course sector from 20′ to 30′. The setting angles for a 3° glide slope would then be 2°25′, 2°45′, 3°15′ and 3°35′.

A — 3° PAPI ILLUSTRATED



B — 3° APAPI ILLUSTRATED

Figure 5-20. Light beams and angle of elevation setting of PAPI and APAPI

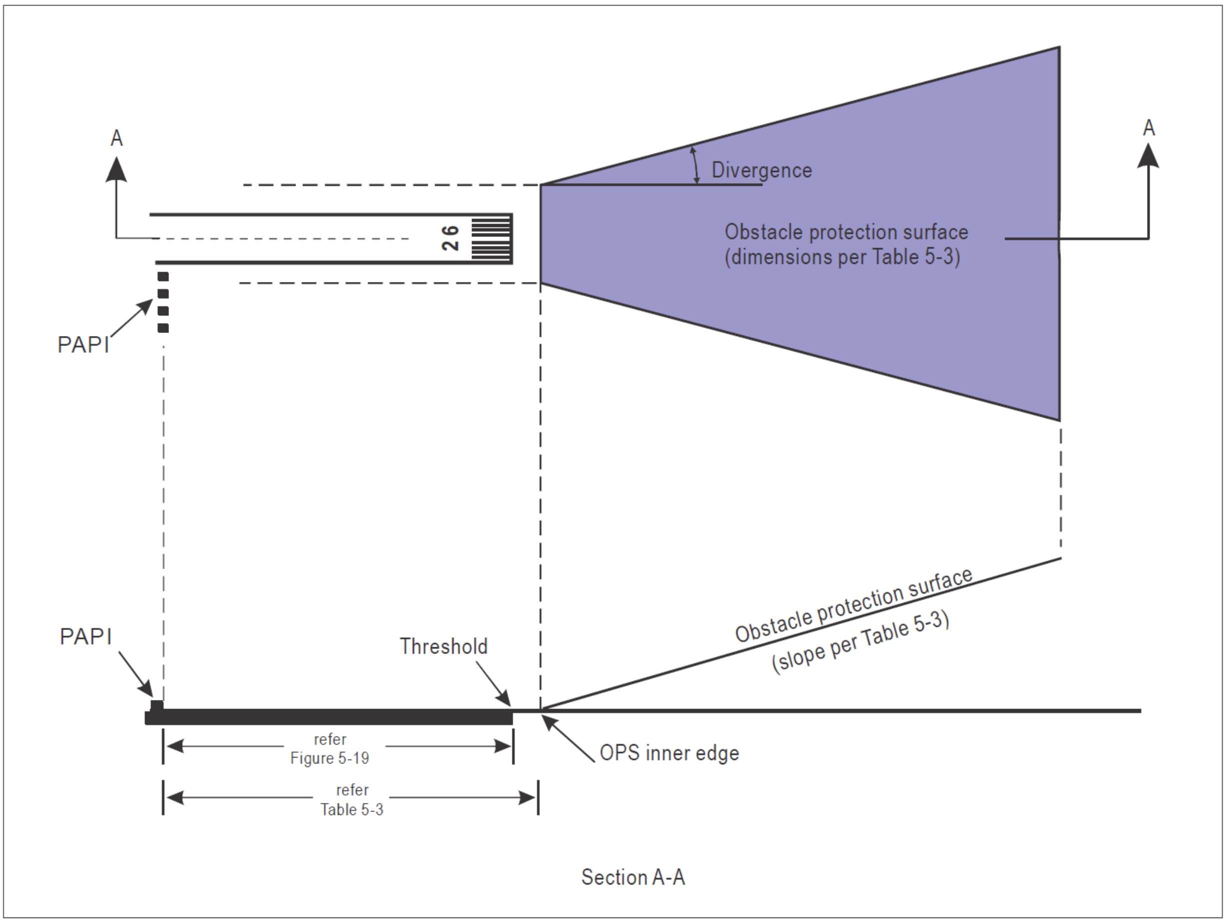


Figure 5-21. Obstacle protection surface for visual approach slope indicator systems

5.3.6 Circling guidance lights

Application

5.3.6.1 Circling guidance lights shall be provided when existing approach and runway lighting systems do not satisfactorily permit identification of the runway and/or approach area to a circling aircraft in the conditions for which it is intended the runway be used for circling approaches.

Location

5.3.6.2 The location and number of circling guidance lights shall be adequate to enable a pilot, as appropriate, to:

(a) join the downwind leg or align and adjust the aircraft's track to the runway at a required distance from it and to distinguish the threshold in passing; and

(b) keep in sight the runway threshold and/or other features which will make it possible to judge the turn on to base leg and final approach, taking into account the guidance provided by other visual aids.

5.3.6.3 Circling guidance lights shall consist of:

(a) lights indicating the extended center line of the runway and/or parts of any approach lighting system; or

(b) lights indicating the position of the runway threshold; or

(c) lights indicating the direction or location of the runway;

or a combination of such lights as is appropriate to the runway under consideration.

Note: Guidance on installation of circling guidance lights is given in CARC Guidance Material 34-GM-17 Visual Aids for Navigation.

Characteristics

5.3.6.4 Circling guidance lights shall be fixed or flashing lights of an intensity and beam spread adequate for the conditions of visibility and ambient light in which it is intended to make visual circling approaches. The flashing lights shall be white, and the steady lights either white or gaseous discharge lights.

5.3.6.5 The lights shall be designed and be installed in such a manner that they will not dazzle or confuse a pilot when approaching to land, taking off or taxiing.

5.3.7 Runway lead-in lighting systems

Application

5.3.7.1 A runway lead-in lighting system shall be provided where it is desired to provide visual guidance along a specific approach path, for reasons such as avoiding hazardous terrain or for purposes of noise abatement.

Note: Guidance on providing lead-in lighting systems is given in CARC Guidance Material 34-GM-17 Visual Aids for Navigation.

Location

5.3.7.2 A runway lead-in lighting system shall consist of groups of lights positioned so as to define the desired approach path and so that one group shall be sighted from the preceding group. The interval between adjacent groups shall not exceed approximately 1 600 m.

Note: Runway lead-in lighting systems shall be curved, straight or a combination thereof.

5.3.7.3 A runway lead-in lighting system shall extend from a point as determined by the appropriate authority, up to a point where the approach lighting system, if provided, or the runway or the runway lighting system is in view.

Characteristics

5.3.7.4 Each group of lights of a runway lead-in lighting system shall consist of at least three flashing lights in a linear or cluster configuration. The system shall be augmented by steady burning lights where such lights would assist in identifying the system.

5.3.7.5 The flashing lights and the steady burning lights shall be white.

5.3.7.6 Where practicable, the flashing lights in each group shall flash in sequence towards the runway.

5.3.8 Runway threshold identification lights

Application

5.3.8.1 Runway threshold identification lights shall be installed:

(a) at the threshold of a non-precision approach runway when additional threshold conspicuity is necessary or where it is not practicable to provide other approach lighting aids; and

(b) where a runway threshold is permanently displaced from the runway extremity or temporarily displaced from the normal position and additional threshold conspicuity is necessary.

Location

5.3.8.2 Runway threshold identification lights shall be located symmetrically about the runway center line, in line with the threshold and approximately 10 m outside each line of runway edge lights.

Characteristics

5.3.8.3 Runway threshold identification lights shall be flashing white lights with a flash frequency between 60 and 120 per minute.

5.3.8.4 The lights shall be visible only in the direction of approach to the runway.

5.3.9 Runway edge lights

Application

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

5.3.9.2 Runway edge lights shall be provided on a runway intended for take-off with an operating minimum below an RVR of the order of 800 m by day.

Location

5.3.9.3 Runway edge lights shall be placed along the full length of the runway and shall be in two parallel rows equidistant from the center line.

5.3.9.4 Runway edge lights shall 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.

5.3.9.5 Where the width of the area which could be declared as runway exceeds 60 m, the distance between the rows of lights shall be determined taking into account the nature of the operations, the light distribution characteristics of the runway edge lights, and other visual aids serving the runway.

5.3.9.6 The lights shall be uniformly spaced in rows at intervals of not more than 60 m for an instrument runway, and at intervals of not more than 100 m for a non-instrument runway. The lights on opposite sides of the runway axis shall be on lines at right angles to that axis. At intersections of runways, lights may be spaced irregularly or omitted, provided that adequate guidance remains available to the pilot.

Characteristics

5.3.9.7 Runway edge lights shall be fixed lights showing variable white, except that:

(a) in the case of a displaced threshold, the lights between the beginning of the runway and the displaced threshold shall show red in the approach direction; and

(b) a section of the lights 600 m or one-third of the runway length, whichever is the less, at the remote end of the runway from the end at which the take-off run is started, may show yellow.

5.3.9.8 The runway edge lights shall show at all angles in azimuth necessary to provide guidance to a pilot landing or taking off in either direction. When the runway edge lights are intended to provide circling guidance, they shall show at all angles in azimuth (see 5.3.6.1).

5.3.9.9 In all angles of azimuth required in 5.3.9.8, runway edge lights shall show at angles up to 15° above the horizontal with an intensity adequate for the conditions of visibility and ambient light in which use of the runway for take-off or landing is intended. In any case, the intensity shall be at least 50 cd except that at an aerodrome without extraneous lighting the intensity of the lights may be reduced to not less than 25 cd to avoid dazzling the pilot.

5.3.9.10 Runway edge lights on a precision approach runway shall be in accordance with the specifications of Appendix 2, Figure A2-9 or A2-10.

5.3.10 Runway threshold and wing bar lights

Application of runway threshold lights

5.3.10.1 Runway threshold lights shall be provided for a runway equipped with runway edge lights except on a non-instrument or non-precision approach runway where the threshold is displaced and wing bar lights are provided.

Location of runway threshold lights

5.3.10.2 When a threshold is at the extremity of a runway, the threshold lights shall be placed in a row at right angles to the runway axis as near to the extremity of the runway as possible and, in any case, not more than 3 m outside the extremity.

5.3.10.3 When a threshold is displaced from the extremity of a runway, threshold lights shall be placed in a row at right angles to the runway axis at the displaced threshold.

5.3.10.4 Threshold lighting shall consist of:

(a) on a non-instrument or non-precision approach runway, at least six lights;

(b) on a precision approach runway category I, at least the number of lights that would be required if the lights were uniformly spaced at intervals of 3 m between the rows of runway edge lights; and

(c) on a precision approach runway category II or III, lights uniformly spaced between the rows of runway edge lights at intervals of not more than 3 m.

5.3.10.5 The lights prescribed in 5.3.10.4 (a) and (b) shall be either:

(a) equally spaced between the rows of runway edge lights, or

(b) symmetrically disposed about the runway center line in two groups, with the lights uniformly spaced in each group and with a gap between the groups equal to the gauge of the touchdown zone marking or lighting, where such is provided, or otherwise not more than half the distance between the rows of runway edge lights.

Application of wing bar lights

5.3.10.6 Wing bar lights shall be provided on a precision approach runway when additional conspicuity is considered desirable.

5.3.10.7 Wing bar lights shall be provided on a non-instrument or non-precision approach runway where the threshold is displaced and runway threshold lights are required, but are not provided.

Location of wing bar lights

5.3.10.8 Wing bar lights shall be symmetrically disposed about the runway center line at the threshold in two groups, i.e. wing bars. Each wing bar shall be formed by at least five lights extending at least 10 m outward from, and at right angles to, the line of the runway edge lights, with the innermost light of each wing bar in the line of the runway edge lights.

Characteristics of runway threshold and wing bar lights

5.3.10.9 Runway threshold and wing bar lights shall be fixed unidirectional lights showing green in the direction of approach to the runway. The intensity and beam spread of the lights shall be adequate for the conditions of visibility and ambient light in which use of the runway is intended.

5.3.10.10 Runway threshold lights on a precision approach runway shall be in accordance with the specifications of Appendix 2, Figure A2-3.

5.3.10.11 Threshold wing bar lights on a precision approach runway shall be in accordance with the specifications of Appendix 2, Figure A2-4.

5.3.11 Runway end lights

(See Figure 5-22)

Application

5.3.11.1 Runway end lights shall be provided for a runway equipped with runway edge lights.

Note: When the threshold is at the runway extremity, fittings serving as threshold lights may be used as runway end lights.

Location

5.3.11.2 Runway end lights shall be placed on a line at right angles to the runway axis as near to the end of the runway as possible and, in any case, not more than 3 m outside the end.

5.3.11.3 Runway end lighting shall consist of at least six lights. The lights shall be either:

(a) equally spaced between the rows of runway edge lights, or

(b) symmetrically disposed about the runway center line in two groups with the lights uniformly spaced in each group and with a gap between the groups of not more than half the distance between the rows of runway edge lights. For a precision approach runway category III, the spacing between runway end lights, except between the two innermost lights if a gap is used, shall not exceed 6 m.

Characteristics

5.3.11.4 Runway end lights shall be fixed unidirectional lights showing red in the direction of the runway. The intensity and beam spread of the lights shall be adequate for the conditions of visibility and ambient light in which use of the runway is intended.

5.3.11.5 Runway end lights on a precision approach runway shall be in accordance with the specifications of Appendix 2, Figure A2-8.

5.3.12 Runway center line lights

Application

5.3.12.1 Runway center line lights shall be provided on a precision approach runway category II or III.

5.3.12.2 Runway center line lights shall be provided on a precision approach runway category I, particularly when the runway is used by aircraft with high landing speeds or where the width between the runway edge lights is greater than 50 m.

5.3.12.3 Runway center line lights shall be provided on a runway intended to be used for take-off with an operating minimum below an RVR of the order of 400 m.

5.3.12.4 Runway center line lights shall be provided on a runway intended to be used for take-off with an operating minimum of an RVR of the order of 400 m or higher when used by airplanes with a very high take-off speed, particularly where the width between the runway edge lights is greater than 50 m.

5.3.12.5 Runway center line lights shall be located along the center line of the runway, except that the lights may be uniformly offset to the same side of the runway center line by not more than 60 cm where it is not practicable to locate them along the center line. The lights shall be located from the threshold to the end at longitudinal spacing of approximately 15 m. Where the serviceability level of the runway center line lights specified as maintenance objectives in Chapter 10 paragraph 10.4.7 or 10.4.11, as appropriate, can be demonstrated and the runway is intended for use in runway visual range conditions of 300 m or greater, the longitudinal spacing may be approximately 30 m.

Note: Existing center line lighting where lights are spaced at 7.5 m need not be replaced.

5.3.12.6 Center line guidance for take-off from the beginning of a runway to a displaced threshold shall be provided by:

(a) an approach lighting system if its characteristics and intensity settings afford the guidance required during take-off and it does not dazzle the pilot of an aircraft taking off; or
(b) runway center line lights; or
(c) barrettes of at least 3 m length and spaced at uniform intervals of 30 m, as shown in Figure 5-23, designed so that their photometric characteristics and intensity setting afford the guidance required during take-off without dazzling the pilot of an aircraft taking off.

Where necessary, provision shall be made to extinguish those center line lights specified in b) or reset the intensity of the approach lighting system or barrettes when the runway is being used for landing. In no case shall only the single source runway center line lights show from the beginning of the runway to a displaced threshold when the runway is being used for landing.

Characteristics

5.3.12.7 Runway center line lights shall be fixed lights showing variable white from the threshold to the point 900 m from the runway end; alternate red and variable white from 900 m to 300 m from the runway end; and red from 300 m to the runway end, except that for runways less than 1 800 m in length, the alternate red and variable white lights shall extend from the mid-point of the runway usable for landing to 300 m from the runway end.

Note: Care is required in the design of the electrical system to ensure that failure of part of the electrical system will not result in a false indication of the runway distance remaining.

5.3.12.8 Runway center line lights shall be in accordance with the specifications of Appendix 2, Figure A2-6 or A2-7.

5.3.13 Runway touchdown zone lights

Application

5.3.13.1 Touchdown zone (TDZ) lights shall be provided in the touchdown zone of a precision approach runway category II or III.

Location

5.3.13.2 Touchdown zone lights shall extend from the threshold for a longitudinal distance of 900 m, except that, on runways less than 1 800 m in length, the system shall be shortened so that it does not extend beyond the midpoint of the runway. The pattern shall be formed by pairs of barrettes symmetrically located about the runway centre line. The lateral spacing between the innermost lights of a pair of barrettes shall be equal to the lateral spacing selected for the touchdown zone marking. The longitudinal spacing between pairs of barrettes shall be either 30 m or 60 m.

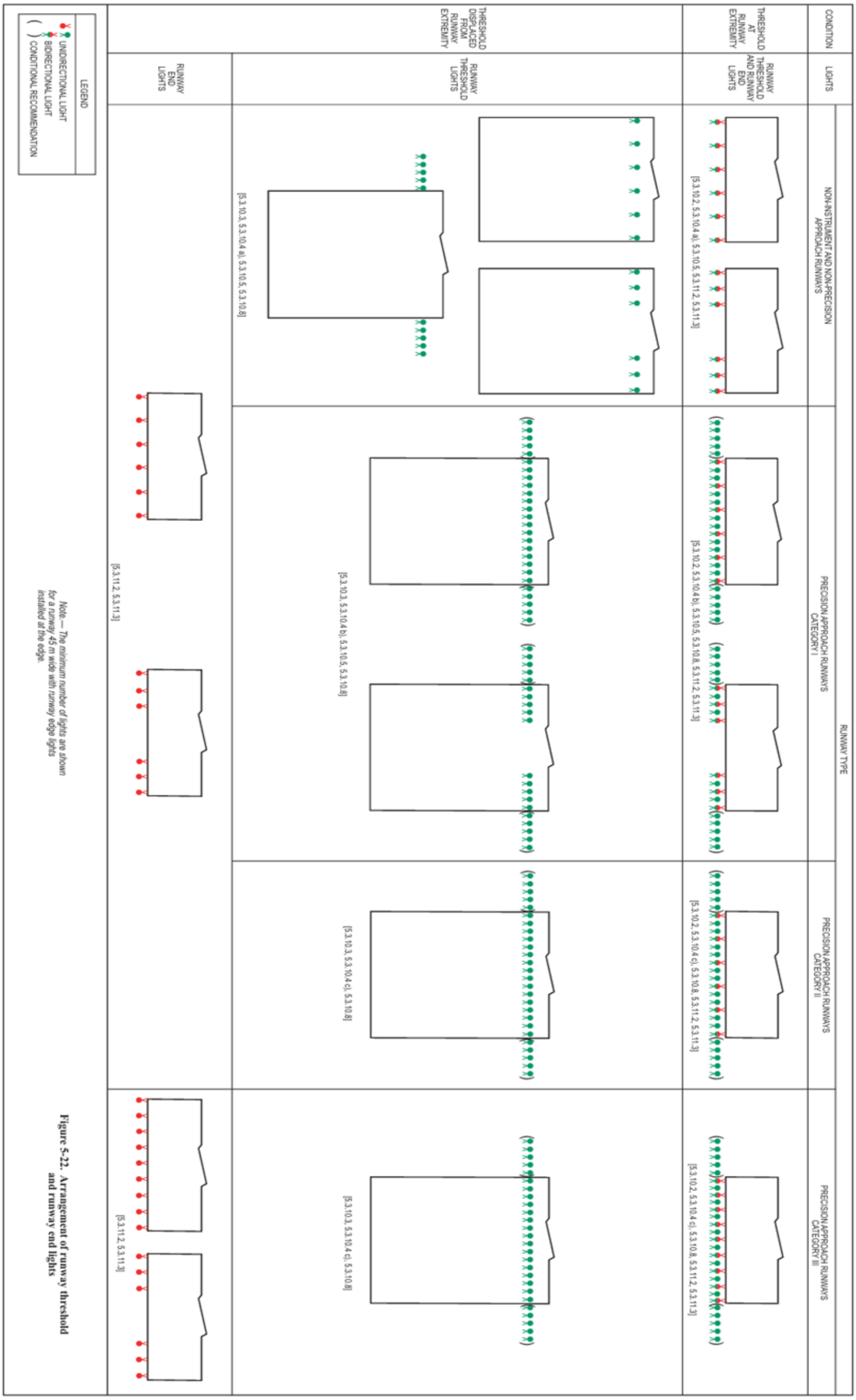


Figure 5-22 Arrangement of runway threshold 2 and runway end lights

Location

Note: To allow for operations at lower visibility minima, it may be advisable to use a 30 m longitudinal spacing between barrettes.

Characteristics

5.3.13.3 A barrette shall be composed of at least three lights with a spacing between the lights of not more than 1.5 m.

5.3.13.4 A barrette should be not less than 3 m nor more than 4.5 m in length.

5.3.13.5 Touchdown zone lights shall be fixed unidirectional lights showing variable white.

5.3.13.6 Touchdown zone lights shall be in accordance with the specifications of Appendix 2, Figure A2-5.

5.3.14 Simple Touchdown Zone Lights

Note: The purpose of Simple Touchdown Zone Lights is to provide pilots with enhanced situational awareness in all visibility conditions and to help enable pilots to decide whether to commence a go around if the aircraft has not landed by a certain point on the runway. It is essential that pilots operating at aerodromes with Simple Touchdown Zone Lights be familiar with the purpose of these lights.

Application

5.3.14.1 Except where TDZ lights are provided in accordance with paragraph 5.3.13, at an aerodrome where the approach angle is greater than 3.5 degrees and/or the Landing Distance Available combined with other factors increases the risk of an overrun, Simple Touchdown Zone Lights shall be provided.

Location

5.3.14.2 Simple Touchdown Zone Lights shall be a pair of lights located on each side of the runway centreline 0.3 metres beyond the upwind edge of the final Touchdown Zone Marking. The lateral spacing between the inner lights of the two pairs of lights shall be equal to the lateral spacing selected for the Touchdown Zone Marking. The spacing between the lights of the same pair shall not be more than 1.5 m or half the width of the touchdown zone marking, whichever is greater. (See Figure 5-24)

5.3.14.3 Where provided on a runway without TDZ markings, Simple Touchdown Zone lights shall be installed in such a position that provides the equivalent TDZ information.

Characteristics

5.3.14.4 Simple Touchdown Zone Lights shall be fixed unidirectional lights showing variable white, aligned so as to be visible to the pilot of a landing aeroplane in the direction of approach to the runway.

5.3.14.5 Simple Touchdown Zone Lights shall be in accordance with the specifications in Appendix 2, Figure A2-5.

Note: As a good operating practice, Simple Touchdown Zone Lights are supplied with power on a separate circuit to other runway lighting so that they may be used when other lighting is switched off.

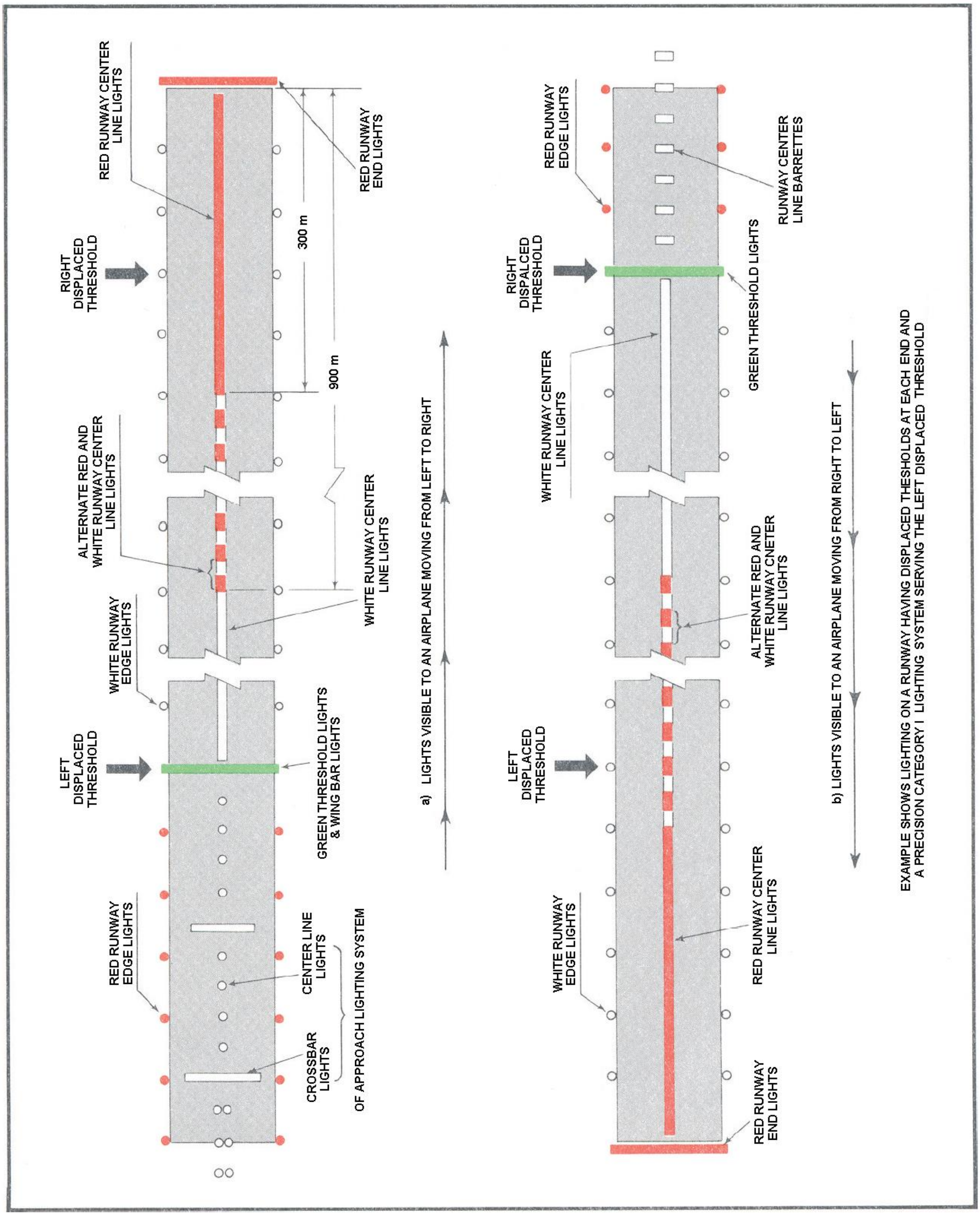


Figure 5-23. Example of approach and runway lighting for runway with displaced thresholds

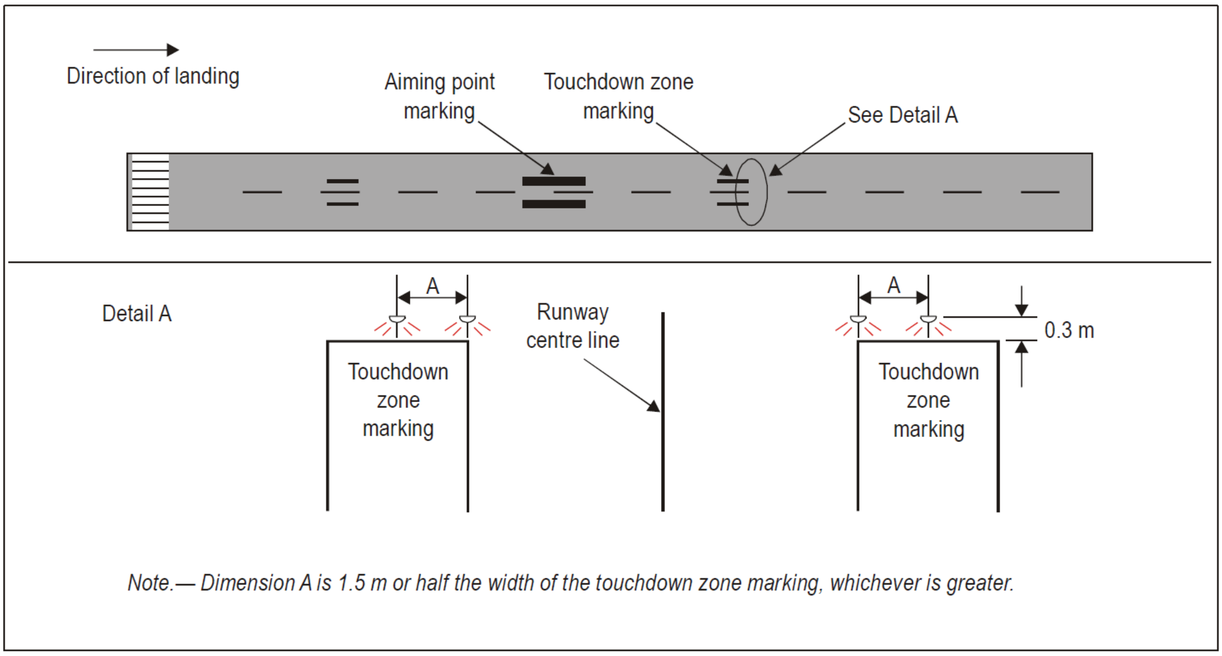


Figure 5-24. Simple touchdown zone lighting

5.3.15 Rapid exit taxiway indicator lights

Note: The purpose of rapid exit taxiway indicator lights (RETILs) is to provide pilots with distance-to-go information to the nearest rapid exit taxiway on the runway, to enhance situational awareness in low visibility conditions and enable pilots to apply braking action for more efficient roll-out and runway exit speeds. It is essential that pilots operating at aerodromes with runway(s) displaying rapid exit taxiway indicator lights be familiar with the purpose of these lights.

Application

5.3.15.1 Rapid exit taxiway indicator lights shall be provided on a runway intended for use in runway visual range conditions less than a value of 300 m and/or where the traffic density is heavy.

Note: See CARC Guidance Material to Part 14 No. 34 GM-01.

5.3.15.2 Rapid exit taxiway indicator lights shall not be displayed in the event of any lamp failure or other failure that prevents the display of the light pattern depicted in Figure 5-25, in full.

Location

5.3.15.3 A set of rapid exit taxiway indicator lights shall be located on the runway on the same side of the runway center line as the associated rapid exit taxiway, in the configuration shown in Figure 5-25. In each set, the lights shall be located 2 m apart and the light nearest to the runway center line shall be displaced 2 m from the runway center line.

5.3.15.4 Where more than one rapid exit taxiway exists on a runway, the set of rapid exit taxiway indicator lights for each exit shall not overlap when displayed.

Characteristics

5.3.15.5 Rapid exit taxiway indicator lights shall be fixed unidirectional yellow lights, aligned so as to be visible to the pilot of a landing airplane in the direction of approach to the runway.

5.3.15.6 Rapid exit taxiway indicator lights shall be in accordance with the specifications in Appendix 2, Figure A2-6 or Figure A2-7, as appropriate.

5.3.15.7 Rapid exit taxiway indicator lights shall be supplied with power on a separate circuit to other runway lighting so that they may be used when other lighting is switched off.

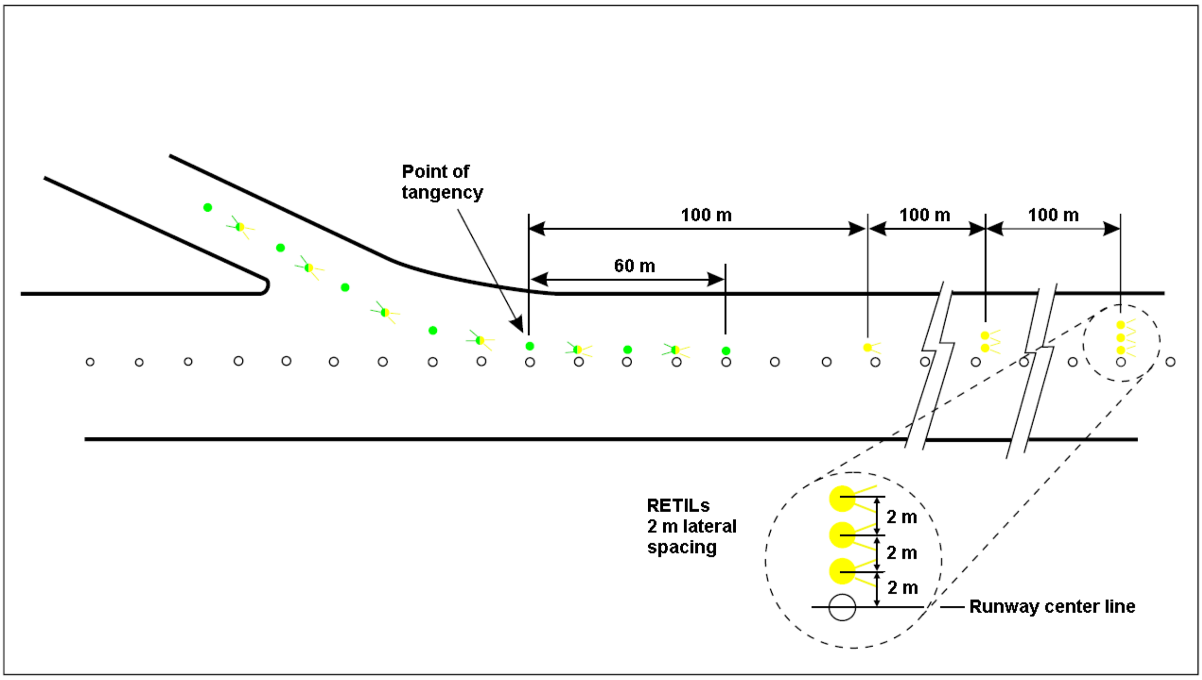


Figure 5-25. Rapid exit taxiway indicator lights (RETILS)

5.3.16 Stopway lights

Application
5.3.16.1 Stopway lights shall be provided for a stopway intended for use at night.

Location
5.3.16.2 Stopway lights shall be placed along the full length of the stopway and shall be in two parallel rows that are equidistant from the center line and coincident with the rows of the runway edge lights. Stopway lights shall also be provided across the end of a stopway on a line at right angles to the stopway axis as near to the end of the stopway as possible and, in any case, not more than 3 m outside the end.

Characteristics
5.3.16.3 Stopway lights shall be fixed unidirectional lights showing red in the direction of the runway.

5.3.17 Taxiway center line lights

Application
5.3.17.1 Taxiway center line lights shall be provided on an exit taxiway, taxiway, de-icing/anti-icing facility and apron intended for use in runway visual range conditions less than a value of 300 m in such a manner as to provide continuous guidance between the runway center line and aircraft stands, except that these lights need not be provided where the traffic density is light and taxiway edge lights and center line marking provide adequate guidance.

5.3.17.2 Taxiway center line lights shall be provided on a taxiway intended for use at night in runway visual range conditions of 300 m or greater, and particularly on complex taxiway intersections and exit taxiways, except that these lights need not be provided where the traffic density is light and taxiway edge lights and center line marking provide adequate guidance.

Note: Where there may be a need to delineate the edges of a taxiway, e.g. on a rapid exit taxiway, narrow taxiway or in snow conditions, this may be done with taxiway edge lights or markers.

5.3.17.3 Taxiway center line lights shall be provided on an exit taxiway, taxiway, de-icing/anti-icing facility and apron in all visibility conditions where specified as components of an advanced surface movement guidance and control system in such a manner as to provide continuous guidance between the runway center line and aircraft stands.

5.3.17.4 Taxiway center line lights shall be provided on a runway forming part of a standard taxi-route and intended for taxiing in runway visual range conditions less than a value of 300 m, except that these lights need not be provided where the traffic density is light and taxiway edge lights and center line marking provide adequate guidance.

Note: Refer to Chapter 8, paragraph 8.2.3 for provisions concerning the interlocking of runway and taxiway lighting systems.

5.3.17.5 Taxiway center line lights shall be provided in all visibility conditions on a runway forming part of a standard taxi-route where specified as components of an advanced surface movement guidance and control system.

Characteristics

5.3.17.6 Except as provided for in 5.3.17.8, taxiway center line lights on a taxiway other than an exit taxiway and on a runway forming part of a standard taxi-route shall be fixed lights showing green with beam dimensions such that the light is visible only from airplanes on or in the vicinity of the taxiway.

5.3.17.7 Taxiway center line lights on an exit taxiway shall be fixed lights. Alternate taxiway center line lights shall show green and yellow from their beginning near the runway center line to the perimeter of the ILS/MLS critical/sensitive area or the lower edge of the inner transitional surface, whichever is farthest from the runway; and thereafter all lights shall show green (Figure 5-26). The first light in the exit centre line shall always show green and the light nearest to the perimeter shall always show yellow.

Note (1): Care is necessary to limit the light distribution of green lights on or near a runway so as to avoid possible confusion with threshold lights.

Note (2): For yellow filter characteristics see Appendix 1, Paragraph 2.2.

Note (3): The size of the ILS/MLS critical/sensitive area depends on the characteristics of the associated ILS/MLS and other factors.

Note (4): Refer to 5.4.3 for specifications on runway vacated signs.

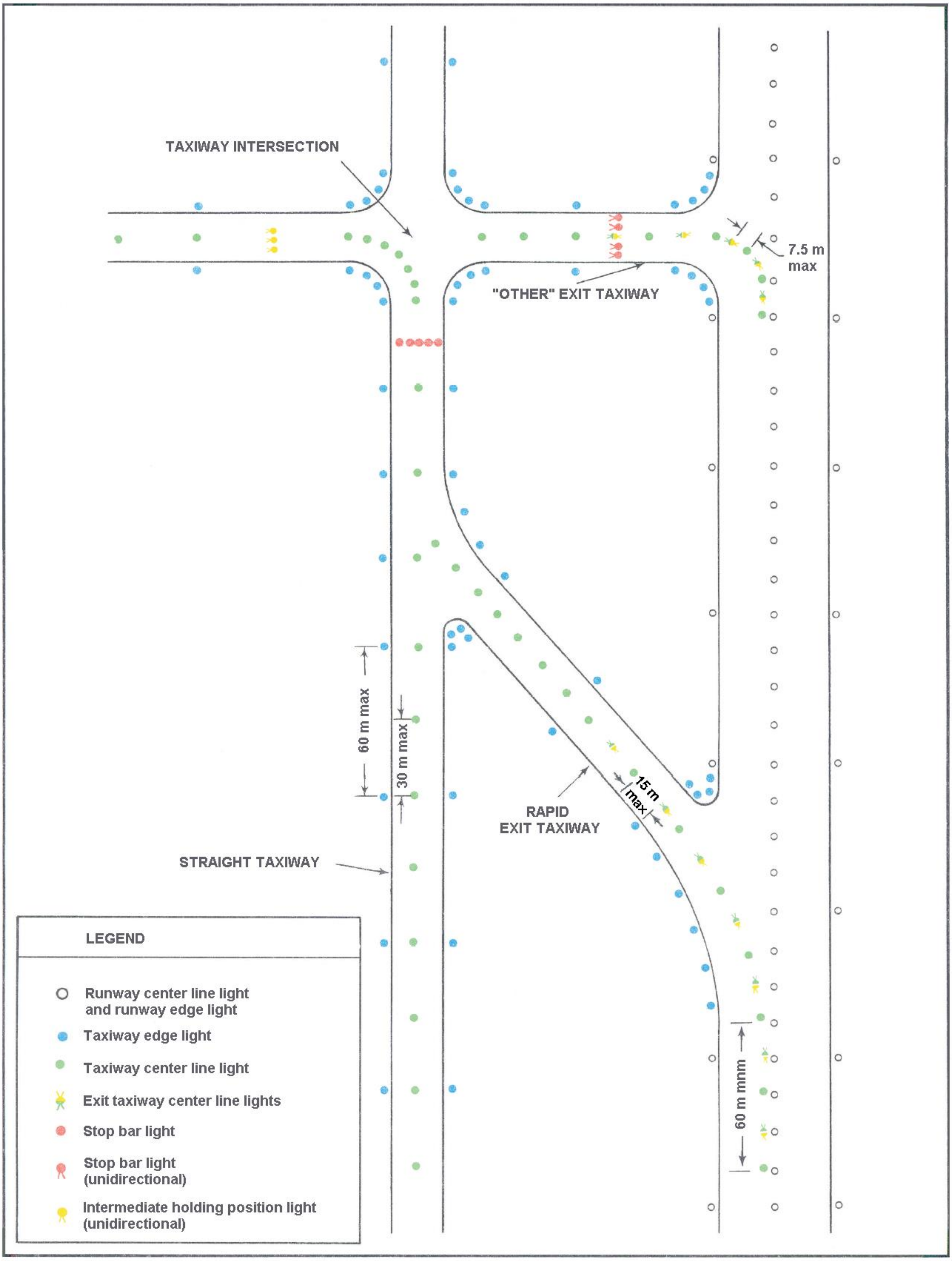


Figure 5-26. Taxiway lighting

5.3.17.8 Where it is necessary to denote the proximity to a runway, taxiway centre line lights shall be fixed lights showing alternating green and yellow from the perimeter of the ILS/MLS critical/sensitive area or the lower edge of the inner transitional surface, whichever is farthest from the runway, to the runway and continue alternating green and yellow until:

(a) their end point near the runway centre line; or

(b) in the case of the taxiway centre line lights crossing the runway, to the opposite perimeter of the ILS/MLS critical/sensitive area or the lower edge of the inner transitional surface, whichever is farthest from the runway.

Note (1): Care is necessary to limit the light distribution of green lights on or near a runway so as to avoid possible confusion with threshold lights.

Note (2): The provisions of 5.3.17.8 can form part of effective runway incursion prevention measures.

5.3.17.9 Taxiway center line lights shall be in accordance with the specifications of:

(a) Appendix 2, Figure A2-12, A2-13, or A2-14 for taxiways intended for use in runway visual range conditions of less than a value of 300 m; and

(b) Appendix 2, Figure A2-15 or A2-16 for other taxiways.

5.3.17.10 Where higher intensities are required, from an operational point of view, taxiway center line lights on rapid exit taxiways intended for use in runway visual range conditions less than a value of 300 m shall be in accordance with the specifications of Appendix 2, Figure A2-12. The number of levels of brilliancy settings for these lights shall be the same as that for the runway center line lights.

5.3.17.11 Where taxiway center line lights are specified as components of an advanced surface movement guidance and control system and where, from an operational point of view, higher intensities are required to maintain ground movements at a certain speed in very low visibilities or in bright daytime conditions, taxiway center line lights shall be in accordance with the specifications of Appendix 2, Figure A2-17, A2-18 or A2-19.

Note: High-intensity center line lights shall only be used in case of an absolute necessity and following a specific study.

Location

5.3.17.12 Taxiway center line lights shall normally be located on the taxiway center line marking, except that they may be offset by not more than 30 cm where it is not practicable to locate them on the marking.

Taxiway center line lights on taxiways

Location

5.3.17.13 Taxiway center line lights on a straight section of a taxiway shall be spaced at longitudinal intervals of not more than 30 m, except that:

(a) larger intervals not exceeding 60 m shall be used where, because of the prevailing meteorological conditions, adequate guidance is provided by such spacing;
(b) intervals less than 30 m shall be provided on short straight sections; and
(c) on a taxiway intended for use in RVR conditions of less than a value of 300 m, the longitudinal spacing shall not exceed 15 m.

5.3.17.14 Taxiway center line lights on a taxiway curve shall continue from the straight portion of the taxiway at a constant distance from the outside edge of the taxiway curve. The lights shall be spaced at intervals such that a clear indication of the curve is provided.

5.3.17.15 On a taxiway intended for use in RVR conditions of less than a value of 300 m, the lights on a curve shall not exceed a spacing of 15 m and on a curve of less than 400 m radius the lights shall be spaced at intervals of not greater than 7.5 m. This spacing shall extend for 60 m before and after the curve.

Note (1): Spacing on curves that have been found suitable for a taxiway intended for use in RVR conditions of 300 m *or greater are:*

Note (2): Refer to Chapter 3 Paragraph 3.9.5 and Figure 3-2

Curve radius	Light spacing
up to 400 m	7.5 m
401 m to 899 m	15 m
900 m or greater	30 m

Taxiway center line lights on rapid exit taxiways

Location

5.3.17.16 Taxiway center line lights on a rapid exit taxiway shall commence at a point at least 60 m before the beginning of the taxiway center line curve and continue beyond the end of the curve to a point on the center line of the taxiway where an airplane can be expected to reach normal taxiing speed. The lights on that portion parallel to the runway center line shall always be at least 60 cm from any row of runway center line lights, as shown in Figure 5-27.

5.3.17.17 The lights shall be spaced at longitudinal intervals of not more than 15 m, except that, where runway center line lights are not provided, a greater interval not exceeding 30 m may be used.

Taxiway center line lights on other exit taxiways

Location
5.3.17.18 Taxiway center line lights on exit taxiways other than rapid exit taxiways shall commence at the point where the taxiway center line marking begins to curve from the runway center line, and follow the curved taxiway center line marking at least to the point where the marking leaves the runway. The first light shall be at least 60 cm from any row of runway center line lights, as shown in Figure 5-27.

5.3.17.19 The lights shall be spaced at longitudinal intervals of not more than 7.5 m.

Taxiway center line lights on runways

Location
5.3.17.20 Taxiway center line lights on a runway forming part of a standard taxi-route and intended for taxiing in runway visual range conditions less than a value of 300 m shall be spaced at longitudinal intervals not exceeding 15 m.

5.3.18 Taxiway edge lights

Application
5.3.18.1 Taxiway edge lights shall be provided at the edges of a runway turn pad, holding bay, de-icing/anti-icing facility, apron, etc. intended for use at night and on a taxiway not provided with taxiway center line lights and intended for use at night, except that taxiway edge lights need not be provided where, considering the nature of the operations, adequate guidance can be achieved by surface illumination or other means.

Note: Refer to 5.5.5 for taxiway edge markers.

5.3.18.2 Taxiway edge lights shall be provided on a runway forming part of a standard taxi-route and intended for taxiing at night where the runway is not provided with taxiway center line lights.

Note: Refer to Chapter 8, paragraph 8.2.3 for provisions concerning the inter-locking of runway and taxiway lighting systems.

Location

5.3.18.3 Taxiway edge lights on a straight section of a taxiway and on a runway forming part of a standard taxi-route shall be spaced at uniform longitudinal intervals of not more than 60 m. The lights on a curve shall be spaced at intervals less than 60 m so that a clear indication of the curve is provided.

Note: Guidance on the spacing of taxiway edge lights on curves is given in CARC Guidance Material 34-GM-17 Visual Aids for Navigation.

5.3.18.4 Taxiway edge lights on a holding bay, de-icing/anti-icing facility, apron, etc. shall be spaced at uniform longitudinal intervals of not more than 60 m.

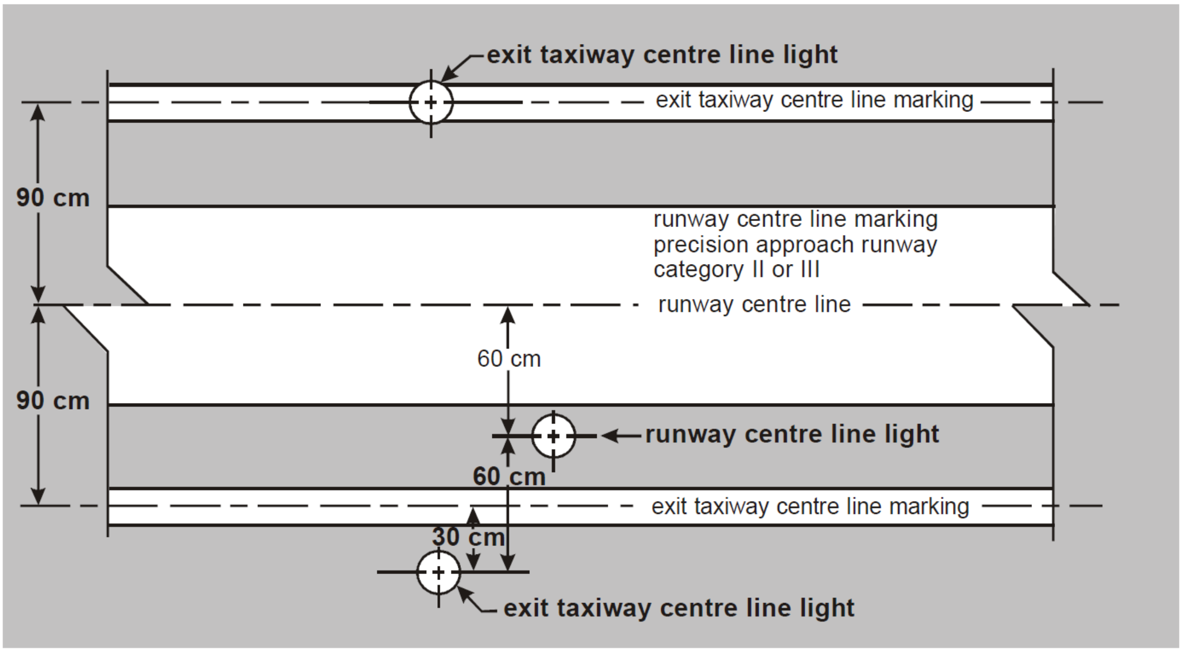
5.3.18.5 Taxiway edge lights on a runway turn pad shall be spaced at uniform longitudinal intervals of not more than 30 m.

5.3.18.6 The lights shall be located as near as practicable to the edges of the taxiway, runway turn pad, holding bay, de-icing/anti-icing facility, apron or runway, etc. or outside the edges at a distance of not more than 3 m.

Characteristics

5.3.18.7 Taxiway edge lights shall be fixed lights showing blue. The lights shall show up to at least 75° above the horizontal and at all angles in azimuth necessary to provide guidance to a pilot taxiing in either direction. At an intersection, exit or curve the lights shall be shielded as far as practicable so that they cannot be seen in angles of azimuth in which they may be confused with other lights.

5.3.18.8 The intensity of taxiway edge lights shall be at least 2 cd from 0° to 6° vertical, and 0.2 cd at any vertical angles between 6° and 75°.



Tolerances for offset runway centre line lights and taxiway centre line lights to maintain 60 cm separation.

Figure 5-27. Offset runway and taxiway center line lights

5.3.19 Runway turn pad lights

Application

5.3.19.1 Runway turn pad lights shall be provided for continuous guidance on a runway turn pad intended for use in runway visual range conditions less than a value of 300 m, to enable an airplane to complete a 180-degree turn and align with the runway center line.

5.3.19.2 Runway turn pad lights shall be provided on a runway turn pad intended for use at night.

Location

5.3.19.3 Runway turn pad lights shall normally be located on the runway turn pad marking, except that they may be offset by not more than 30 cm where it is not practicable to locate them on the marking.

5.3.19.4 Runway turn pad lights on a straight section of the runway turn pad marking shall be spaced at longitudinal intervals of not more than 15 m.

5.3.19.5 Runway turn pad lights on a curved section of the runway turn pad marking shall not exceed a spacing of 7.5 m.

Characteristics
5.3.19.6 Runway turn pad lights shall be unidirectional fixed lights showing green with beam dimensions such that the light is visible only from airplanes on or approaching the runway turn pad.

5.3.19.7 Runway turn pad lights shall be in accordance with the specifications of Appendix 2, Figure A2-13, A2-14 or A2-15, as appropriate.

5.3.20 Stop bars

Application
Note (1): The provision of stop bars requires their control either manually or automatically by air traffic services.

Note (2): Runway incursions may take place in all visibility or weather conditions. The provision of stop bars at runway holding positions and their use at night and in visibility conditions greater than 550 m runway visual range can form part of effective runway incursion prevention measures.

5.3.20.1 A stop bar shall be provided at every runway-holding position serving a runway when it is intended that the runway will be used in runway visual range conditions less than a value of 350 m, except where:

a) appropriate aids and procedures are available to assist in preventing inadvertent incursions of traffic onto the runway; or
b) operational procedures exist to limit, in runway visual range conditions less than a value of 550 m, the number of:
    1) aircraft on the maneuvering area to one at a time; and
    2) vehicles on the maneuvering area to the essential minimum.

5.3.20.2 Where there is more than one stop bar associated with a taxiway/runway intersection, only one shall be illuminated at any given time.

5.3.20.3 A stop bar shall be provided at an intermediate holding position when it is desired to supplement markings with lights and to provide traffic control by visual means.

Location
5.3.20.4 Stop bars shall be located across the taxiway at the point where it is desired that traffic stop. Where the additional lights specified in 5.3.20.6 are provided, these lights shall be located not less than 3 m from the taxiway edge.

Characteristics

5.3.20.5 Stop bars shall consist of lights spaced at uniform intervals of no more than 3 m across the taxiway, showing red in the intended direction(s) of approach to the intersection or runway-holding position.

Note: Where necessary to enhance conspicuity of an existing stop bar, extra lights are installed uniformly.

5.3.20.6 A pair of elevated lights should be added to each end of the stop bar where the in-pavement stop bar lights might be obscured from a pilot’s view, for example, by snow or rain, or 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.

5.3.20.7 Stop bars installed at a runway-holding position shall be unidirectional and shall show red in the direction of approach to the runway.

5.3.20.8 Where the additional lights specified in 5.3.20.6 are provided, these lights shall have the same characteristics as the lights in the stop bar, but shall be visible to approaching aircraft up to the stop bar position.

5.3.20.9 The intensity in red light and beam spreads of stop bar lights shall be in accordance with the specifications in Appendix 2, Figures A2-12 through A2-16, as appropriate.

5.3.20.10 Where stop bars are specified as components of an advanced surface movement guidance and control system and where, from an operational point of view, higher intensities are required to maintain ground movements at a certain speed in very low visibilities or in bright daytime conditions, the intensity in red light and beam spreads of stop bar lights shall be in accordance with the specifications of Appendix 2, Figure A2-17, A2-18 or A2-19.

Note: High-intensity stop bars shall only be used in case of an absolute necessity and following a specific study.

5.3.20.11 Where a wide beam fixture is required, the intensity in red light and beam spreads of stop bar lights shall be in accordance with the specifications of Appendix 2, Figure A2-17 or A2-19.

5.3.20.12 The lighting circuit shall be designed so that:

(a) stop bars located across entrance taxiways are selectively switchable;

(b) stop bars located across taxiways intended to be used only as exit taxiways are switchable selectively or in groups;

(c) when a stop bar is illuminated, any taxiway center line lights installed beyond the stop bar shall be extinguished for a distance of at least 90 m; and
(d) stop bars are interlocked with the taxiway center line lights so that when the center line lights beyond the stop bar are illuminated the stop bar is extinguished and vice versa.

Note (1): A stop bar is switched on to indicate that traffic stop and switched off to indicate that traffic proceed.

Note (2): Care is required in the design of the electrical system to ensure that all of the lights of a stop bar will not fail at the same time. Guidance on this issue is given in CARC Guidance Material 34-GM-05 Aerodrome Electrical System.

5.3.21 Intermediate holding position lights

Note: Refer to 5.2.11 for specifications on intermediate holding position marking.

Application
5.3.21.1 Except where a stop bar has been installed, intermediate holding position lights shall be provided at an intermediate holding position intended for use in runway visual range conditions less than a value of 300 m.

5.3.21.2 Intermediate holding position lights shall be provided at an intermediate holding position where there is no need for stop-and-go signals as provided by a stop bar.

Location
5.3.21.3 Intermediate holding position lights shall be located along the intermediate holding position marking at a distance of 0.3 m prior to the marking.

Characteristics
5.3.21.4 Intermediate holding position lights shall consist of three fixed unidirectional lights showing yellow in the direction of approach to the intermediate holding position with a light distribution similar to taxiway center line lights if provided. The lights shall be disposed symmetrically about and at right angle to the taxiway center line, with individual lights spaced 1.5 m apart.

5.3.22 De-icing/anti-icing facility exit lights

Application
5.3.22.1 De-icing/anti-icing facility exit lights shall be provided at the exit boundary of a remote de-icing/anti-icing facility adjoining a taxiway.

Location
5.3.22.2 De-icing/anti-icing facility exit lights shall be located 0.3 m inward of the intermediate holding position marking displayed at the exit boundary of a remote de-icing/ anti-icing facility.

Characteristics
5.3.22.3 De-icing/anti-icing facility exit lights shall consist of in-pavement fixed unidirectional lights spaced at intervals of 6 m showing yellow in the direction of the approach to the exit boundary with a light distribution similar to taxiway center line lights (see Figure 5-28).

5.3.23 Runway guard lights

Note: Runway incursions may take place in all visibility or weather conditions. The use of runway guard lights at runway-holding positions can form part of effective runway incursion prevention measures. Runway guard lights warn pilots, and drivers of vehicles when they are operating on taxiways, that they are about to enter an active runway. There are two standard configurations of runway guard lights as illustrated in Figure 5-29.

Application
5.3.23.1 Runway guard lights, Configuration A, shall be provided at each taxiway/runway intersection associated with a runway intended for use in:

a) runway visual range conditions less than a value of 550 m where a stop bar is not installed; and
b) runway visual range conditions of values between 550 m and 1 200 m where the traffic density is heavy.

Note (1): Runway guard lights, Configuration B may supplement Configuration A when deemed necessary.

Note (2): Guidance on the design, operation and the location of runway guard lights Configuration B is given in CARC Guidance Material 34-GM-17 Visual Aids for Navigation.

5.3.23.2 As part of runway incursion, runway guard lights, Configuration A or B, shall be provided at each taxiway/runway intersection, where runway incursion hot spots have been identified, and used under all weather conditions during day and night.

5.3.23.3 Configuration B runway guard lights should not be collocated with a stop bar.

5.3.23.4 Where more than one runway-holding positions exist at a runway/taxiway intersection, only the set of runway guard lights associated with the operational runway-holding position shall be illuminated.

Location

5.3.23.5 Runway guard lights, Configuration A, shall be located at each side of the taxiway on the holding side of the runway- holding position marking.

5.3.23.6 Runway guard lights, Configuration B, shall be located across the taxiway on the holding side of the runway – holding position marking.

Characteristics

5.3.23.7 Runway guard lights, Configuration A, shall consist of two pairs of yellow lights.

5.3.23.8 Where there is a need to enhance the contrast between the on and off state of runway guard lights, Configuration A, intended for use during the day, a visor of sufficient size to prevent sunlight from entering the lens without interfering with the function of the fixture shall be located above each lamp.

Note: Some other device or design, e.g. specially designed optics, may be used in lieu of the visor.

5.3.23.9 Runway guard lights, Configuration B, shall consist of yellow lights spaced at intervals of 3 m across the taxiway.

5.3.23.10 The light beam shall be unidirectional and shall show yellow in the direction in approach to aligned so as to the runway-holding position.

Note: For guidance on orientation and aiming of runway guard lights, see CARC Guidance Material 34-GM-17 Visual Aids for Navigation.

5.3.23.11 The intensity in yellow light and beam spreads of lights of Configuration A shall be in accordance with the specifications in Appendix 2, Figure A2-24.

5.3.23.12 Where runway guard lights are intended for use during the day, the intensity in yellow light and beam spreads of lights of Configuration A shall be in accordance with the specifications in Appendix 2, Figure A2-25.

5.3.23.13 Where runway guard lights are specified as components of an advanced surface movement guidance and control system where higher light intensities are required, the intensity in yellow light and beam spreads of lights of Configuration A shall be in accordance with the specifications in Appendix 2, Figure A2-25.

Note: Higher light intensities may be required to maintain ground movement at a certain speed in low visibilities.

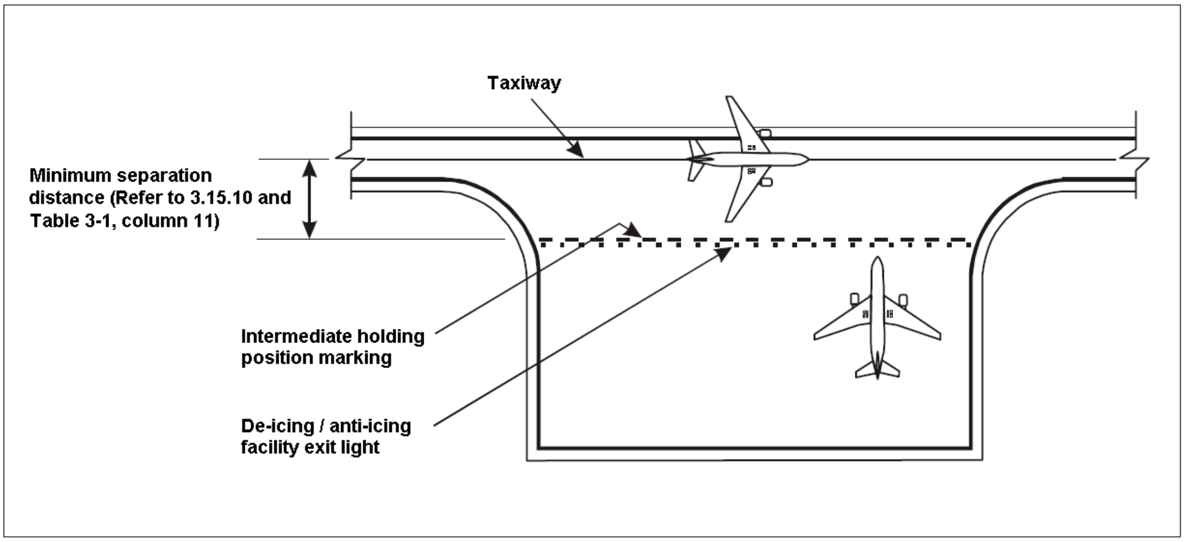


Figure 5-28. Typical remote de- icing/anti- icing facility

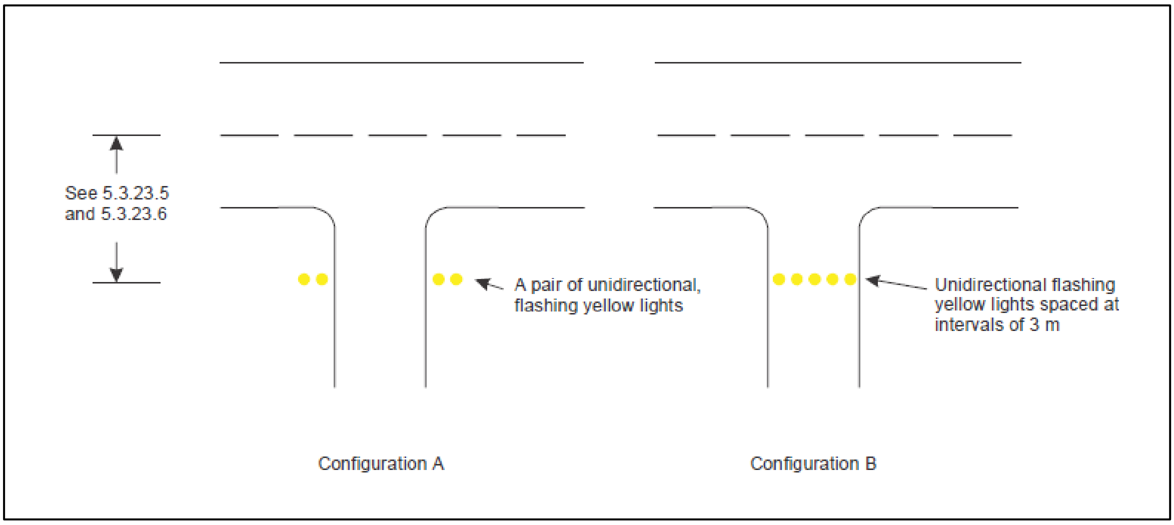


Figure 5-29. Runway guard lights

5.3.23.14 The intensity in yellow light and beam spreads of lights of Configuration B shall be in accordance with the specifications in Appendix 2, Figure A2-12.

5.3.23.15 Where runway guard lights are intended for use during the day, the intensity in yellow light and beam spreads of lights of Configuration B shall be in accordance with the specifications in Appendix 2, Figure A2-20.

5.3.23.16 Where runway guard lights are specified as components of an advanced surface movement guidance and control system where higher light intensities are required, the intensity in yellow light and beam spreads of lights of Configuration B shall be in accordance with the specifications in Appendix 2, Figure A2-20.

5.3.23.17 The lights in each unit of Configuration A shall be illuminated alternately.

5.3.23.18 For Configuration B, adjacent lights shall be alternately illuminated and alternative lights shall be illuminated in unison.

5.3.23.19 The lights shall be illuminated between 30 and 60 cycles per minute and the light suppression and illumination periods shall be equal and opposite in each light.

Note: The optimum flash rate is dependent on the rise and fall times of the lamps used. Runway guard lights, Configuration A, installed on 6.6 ampere series circuits have been found to look best when operated at 45 to 50 flashes per minute per lamp. Runway guard lights, Configuration B, installed on 6.6 ampere series circuits have been found to look best when operated at 30 to 32 flashes per minute per lamp.

5.3.24 Apron floodlighting

(Refer also to 5.3.17.1 and 5.3.18.1)

Application

5.3.24.1 Apron floodlighting shall be provided on an apron, on a de-icing/anti-icing facility and on a designated isolated aircraft parking position intended to be used at night.

Note (1): Where a de-icing/anti-icing facility is located in close proximity to the runway and permanent floodlighting could be confusing to pilots, other means of illumination of the facility may be required.

Note (2): The designation of an isolated aircraft parking position is specified in Chapter 3, Section 3.14.

Note (3): Guidance on apron floodlighting is given in CARC Guidance Material 34-GM-17 Visual Aids for Navigation.

Location

5.3.24.2 Apron floodlights shall be located so as to provide adequate illumination on all apron service areas, with a minimum of glare to pilots of aircraft in flight and on the ground, aerodrome and apron controllers, and personnel on the apron. The arrangement and aiming of floodlights shall be such that an aircraft stand receives light from two or more directions to minimize shadows.

Characteristics

5.3.24.3 The spectral distribution of apron floodlights shall be such that the colors used for aircraft marking connected with routine servicing, and for surface and obstacle marking, can be correctly identified.

5.3.24.4 The average illuminance shall be at least the following:

Aircraft stand:

— horizontal illuminance — 20 lux with a uniformity ratio (average to minimum) of not more than 4 to 1; and

— vertical illuminance — 20 lux at a height of 2 m above the apron in relevant directions.

Other apron areas:

— horizontal illuminance — 50 per cent of the average illuminance on the aircraft stands with a uniformity ratio (average to minimum) of not more than 4 to 1.

5.3.25 Visual docking guidance system

Application

5.3.25.1 A visual docking guidance system shall be provided when it is intended to indicate, by a visual aid, the precise positioning of an aircraft on an aircraft stand and other alternative means, such as marshallers, are not practicable.

Note: The factors to be considered in evaluating the need for a visual docking guidance system are in particular: the number and type(s) of aircraft using the aircraft stand, weather conditions, space available on the apron and the precision required for maneuvering into the parking position due to aircraft servicing installation, passenger boarding bridges, etc. Refer to CARC Guidance Material 34-GM-17 Visual Aids for Navigation on the selection of suitable systems.

Characteristics

5.3.25.2 The system shall provide both azimuth and stopping guidance.

5.3.25.3 The azimuth guidance unit and the stopping position indicator shall 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 shall 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.

5.3.25.4 The azimuth guidance unit and the stopping position indicator shall 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.

5.3.25.5 The azimuth guidance unit and the stopping position indicator shall be located in such a way that there is continuity of guidance between the aircraft stand markings, the aircraft stand maneuvering guidance lights, if present, and the visual docking guidance system.

5.3.25.6 The accuracy of the system shall be adequate for the type of passenger boarding bridge and fixed aircraft servicing installations with which it is to be used.

5.3.25.7 The system shall be usable by all types of aircraft for which the aircraft stand is intended, preferably without selective operation.

5.3.25.8 If selective operation is required to prepare the system for use by a particular type of aircraft, then the system shall 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.

Azimuth guidance unit

Location

5.3.25.9 The azimuth guidance unit shall be located on or close to the extension of the stand center line ahead of the aircraft so that its signals are visible from the cockpit of an aircraft throughout the docking maneuver and aligned for use at least by the pilot occupying the left seat.

5.3.25.10 The azimuth guidance unit shall be aligned for use by the pilots occupying both the left and right seats.

Characteristics

5.3.25.11 The azimuth guidance unit shall provide unambiguous left/right guidance which enables the pilot to acquire and maintain the lead-in line without over-controlling.

5.3.25.12 When azimuth guidance is indicated by color change, green shall be used to identify the center line and red for deviations from the center line.

Stopping position indicator

Location

5.3.25.13 The stopping position indicator shall 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.

5.3.25.14 The stopping position indicator shall be usable at least by the pilot occupying the left seat.

5.3.25.15 The stopping position indicator shall be usable by the pilots occupying both the left and right seats.

Characteristics

5.3.25.16 The stopping position information provided by the indicator for a particular aircraft type shall account for the anticipated range of variations in pilot eye height and/or viewing angle.

5.3.25.17 The stopping position indicator shall show the stopping position for the aircraft for which guidance is being provided, and shall provide closing rate information to enable the pilot to gradually decelerate the aircraft to a full stop at the intended stopping position.

5.3.25.18 The stopping position indicator shall provide closing rate information over a distance of at least 10 m.

5.3.25.19 When stopping guidance is indicated by color change, green shall 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 stop point a third color may be used to warn that the stopping point is close.

5.3.26 Advanced visual docking guidance system

Application

Note (1): Advanced visual docking guidance systems (A-VDGS) include those systems that, in addition to basic and passive azimuth and stop position information, provide pilots with active (usually sensor-based) guidance information, such as aircraft type indication (in accordance with ICAO Document 8643), distance-to-go information and closing speed. Docking guidance information is usually provided on a single display unit.

Note (2): An A-VDGS may provide docking guidance information in three stages: the acquisition of the aircraft by the system, the azimuth alignment of the aircraft, and the stopping position information.

5.3.26.1 An A-VDGS shall be provided where it is operationally desirable to confirm the correct aircraft type for which guidance is being provided, and/or to indicate the stand centre line in use, where more than one is provided for.

5.3.26.2 The A-VDGS shall be suitable for use by all types of aircraft for which the aircraft stand is intended.

5.3.26.3 The A-VDGS shall only be used in conditions in which its operational performance is specified.

Note (1): The use of the A-VDGS in conditions such as weather, visibility, and background lighting both by day and night would need to be specified.

Note (2): Care is required in both the design and on-site installation of the system to ensure that glare, reflection of sunlight, or other light in the vicinity, does not degrade the clarity and conspicuity of the visual cues provided by the system.

5.3.26.4 The docking guidance information provided by an A-VDGS shall not conflict with that provided by a conventional visual docking guidance system on an aircraft stand if both types are provided and are in operational use. A method of indicating that the A-VDGS is not in operational use or unserviceable, shall be provided.

Location

5.3.26.5 The A-VDGS shall be located such that unobstructed and unambiguous guidance is provided to the person responsible for, and persons assisting, the docking of the aircraft throughout the docking manoeuvre.

Note: Usually the pilot-in-command is responsible for the docking of the aircraft. However, in some circumstances, another person could be responsible and this person may be the driver of a vehicle that is towing the aircraft.

Characteristics

5.3.26.6 The A-VDGS shall provide, at minimum, the following guidance information at the appropriate stage of the docking manoeuvre:

(a) an emergency stop indication;
(b) the aircraft type and model for which the guidance is provided;
(c) an indication of the lateral displacement of the aircraft relative to the stand centre line;

(d) the direction of azimuth correction needed to correct a displacement from the stand centre line;
(e) an indication of the distance to the stop position;
(f) an indication when the aircraft has reached the correct stopping position; and
(g) a warning indication if the aircraft goes beyond the appropriate stop position.

5.3.26.7 The A-VDGS shall be capable of providing docking guidance information for all aircraft taxi speeds encountered during the docking manoeuvre.

Note: See CARC Guidance Material 34-GM-17 Visual Aids for Navigation, for an indication of the maximum aircraft speeds relative to distance to the stopping position.

5.3.26.8 The time taken from the determination of the lateral displacement to its display shall not result in a deviation of the aircraft, when operated in normal conditions, from the stand centerline greater than 1 m.

5.3.26.9 The information on displacement of the aircraft relative to the stand centre line and distance to the stopping position, when displayed, shall be provided with the accuracy specified in Table 5-5.

Table 5-5. Required displacement accuracy

Guidance information	max. deviation at stop position (stop area)	max. deviation at 9 m from stop position	max. deviation at 15 m from stop position	max. deviation at 25 m from stop position
Azimuth	±250 mm	±340 mm	±400 mm	±500 mm
Distance	±500 mm	±1000 mm	±1300 mm	Not specified

5.3.26.10 Symbols and graphics used to depict guidance information shall be intuitively representative of the type of information provided.

Note: The use of color would need to be appropriate and need to follow signal convention, i.e. red, yellow and green mean hazard, caution and normal/correct conditions, respectively. The effects of color contrasts would also need to be considered.

5.3.26.11 Information on the lateral displacement of the aircraft relative to the stand center line shall be provided at least 25m prior to the stop position.

Note: The indication of the distance of the aircraft from the stop position may be color-coded and presented at a rate and distance proportional to the actual closure rate and distance of the aircraft approaching the stop point.

5.3.26.12 Continuous closure distance and closure rate shall be provided from at least 15 m prior to the stop position.

5.3.26.13 Where provided, closure distance displayed in numerals shall be provided in meter integers to the stop position and displayed to 1 decimal place at least 3 m prior to the stop position.

5.3.26.14 Throughout the docking manoeuvre, an appropriate means shall be provided on the AVDGS to indicate the need to bring the aircraft to an immediate halt. In such an event, which includes a failure of the A-VDGS, no other information shall be displayed.

5.3.26.15 Provision to initiate an immediate halt to the docking procedure shall be made available to personnel responsible for the operational safety of the stand.

5.3.26.16 The word “STOP” in red characters shall be displayed when an immediate cessation of the docking manoeuvre is required.

5.3.27 Aircraft stand maneuvering guidance lights

Application

5.3.27.1 Aircraft stand maneuvering guidance lights shall be provided to facilitate the positioning of an aircraft on an aircraft stand on a paved apron or on a de-icing/anti-icing facility intended for use in poor visibility conditions, unless adequate guidance is provided by other means.

Location

5.3.27.2 Aircraft stand maneuvering guidance lights shall be collocated with the aircraft stand markings.

Characteristics

5.3.27.3 Aircraft stand maneuvering guidance lights, other than those indicating a stop position, shall be fixed yellow lights, visible throughout the segments within which they are intended to provide guidance.

5.3.27.4 The lights used to delineate lead-in, turning and lead-out lines shall be spaced at intervals of not more than 7.5 m on curves and 15 m on straight sections.

5.3.27.5 The lights indicating a stop position shall be fixed, unidirectional lights, showing red.

5.3.27.6 The intensity of the lights shall be adequate for the condition of visibility and ambient light in which the use of the aircraft stand is intended.

5.3.27.7 The lighting circuit shall be designed so that the lights may be switched on to indicate that an aircraft stand is to be used and switched off to indicate that it is not to be used.

5.3.28 Road-holding position light

Application

5.3.28.1 A road-holding position light shall be provided at each road-holding position serving a runway when it is intended that the runway will be used in runway visual range conditions less than a value of 300m.

5.3.28.2 A road-holding position light shall be provided at each road-holding position serving a runway when it is intended that the runway will be used in runway visual range conditions of values between 300m and 550 m.

Location

5.3.28.3 A road-holding position light shall be located adjacent to the holding position marking 1.5 m (± 0.5 m) from one edge of the road, i.e. left or right as appropriate to the local traffic regulations.

Note: Refer to Chapter 9, paragraph 9.9 for the mass and height limitations and frangibility requirements of navigation aids located on runway strips.

Characteristics

5.3.28.4 The road-holding position light shall comprise:

(a) a controllable red (stop)/green (go) traffic light; or

(b) a flashing-red light.

Note: It is intended that the lights specified in subparagraph a) be controlled by the air traffic services.

5.3.28.5 The road-holding position light beam shall be unidirectional and aligned so as to be visible to the driver of a vehicle approaching the holding position.

5.3.28.6 The intensity of the light beam shall be adequate for the conditions of visibility and ambient light in which the use of the holding position is intended, but shall not dazzle the driver.

Note: The commonly used traffic lights are likely to meet the requirements in 5.3.28.5 and 5.3.28.6.

5.3.28.7 The flash frequency of the flashing-red light shall be between 30 and 60 per minute.

5.3.29 No-Entry Bar

Note: Runway incursions may take place in all visibility or weather conditions. The use of no- entry bars can form part of effective runway incursion prevention measures.

Application

5.3.29.1 A no-entry bar shall be provided across a taxiway which is intended to be used as an exit only taxiway to assist in preventing inadvertent access of traffic to that taxiway.

Location

5.3.29.2 A no-entry bar shall be located across the taxiway at the end of an exit only taxiway where it is desired to prevent traffic from entering the taxiway in the wrong direction.

5.3.29.3 A no-entry bar shall be co-located with a no-entry sign and/or a no-entry marking.

Characteristics

5.3.29.4 A no-entry bar shall consist of unidirectional lights spaced at uniform intervals of no more than 3 m showing red in the intended direction(s) of approach to the runway.

Note: Where necessary to enhance conspicuity, extra lights are installed uniformly.

5.3.29.5 A pair of elevated lights shall be added to each end of the no-entry bar where the in-pavement no entry bar lights might be obscured from a pilot's view, for example, by snow or rain, or 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.

5.3.29.6 The intensity in red light and beam spreads of no-entry bar lights shall be in accordance with the specifications in Appendix 1, Figures A2-12 through A2-16, as appropriate.

5.3.29.7 Where no-entry bars are specified as components of an advanced surface movement guidance and control system and where, from an operational point of view, higher intensities are required to maintain ground movements at a certain speed in very low visibilities or in bright daytime conditions, the intensity in red light and beam spreads of no-entry bar lights should be in accordance with the specifications of Appendix 1, Figure A2-17, A2-18 or A2-19.

Note: High-intensity no-entry bars are typically only used in case of an absolute necessity and following a specific study.

5.3.29.8 Where a wide beam fixture is required, the intensity in red light and beam spreads of no-entry bar lights shall be in accordance with the specifications of Appendix 1, Figure A2-17 or A2-19.

5.3.29.9 Taxiway centre line lights installed beyond the no-entry bar, looking in the direction of the runway, shall not be visible when viewed from the taxiway.

5.3.30 Runway status lights

Note: Runway status lights (RWSL) is a type of autonomous runway incursion warning system (ARIWS). The two basic visual components of RWSL are runway entrance lights (RELs) and take-off hold lights (THLs). Either may be installed by itself, but the two components are designed to be complementary to each other

Location

5.3.30.1 Where provided, RELs shall be offset 0.6 m from the taxiway centre line on the opposite side to the taxiway centre line lights and begin 0.6 m before the runway-holding position extending to the edge of the runway. An additional single light shall be placed on the runway 0.6 m from the runway centre line and aligned with the last two taxiway RELs.

Note: Where two or more runway-holding positions are provided, the runway-holding position referred is that closest to the runway.

5.3.30.2 RELs shall consist of at least five light units and shall be spaced at a minimum of 3.8 m and a maximum of 15.2 m longitudinally, depending upon the taxiway length involved, except for a single light installed near the runway centre line.

5.3.30.3 Where provided, THLs shall be offset 1.8 m on each side of the runway centre line lights and extend, in pairs, starting at a point 115 m from the beginning of the runway and, thereafter, every 30 m for at least 450 m.

Note: Additional THLs may be similarly provided at the starting point of the take-off roll.

Characteristics

5.3.30.4 Where provided, RELs shall consist of a single line of fixed in pavement lights showing red in the direction of aircraft approaching the runway.

5.3.30.5 RELs shall illuminate as an array at each taxiway/runway intersection where they are installed less than 2 seconds after the system determines a warning is needed.

5.3.30.6 Intensity and beam spread of RELs shall be in accordance with the specifications of Appendix 2, Figures A2-12 and A2-14.

Note: Consideration for reduced beam width may be required for some REL lights at acute angled runway/taxiway intersections to ensure the RELs are not visible to aircraft on the runway.

5.3.30.7 Where provided, THLs shall consist of two rows of fixed in pavement lights showing red facing the aircraft taking off.

5.3.30.8 THLs shall illuminate as an array on the runway less than 2 seconds after the system determines a warning is needed.

5.3.30.9 Intensity and beam spread of THLs shall be in accordance with the specifications of Appendix 2, Figure A2-26.

5.3.30.10 RELs and THLs shall be automated to the extent that the only control over each system will be to disable one or both systems.

5.4 Signs

5.4.1 General

Note: Signs shall be either fixed message signs or variable message signs. Guidance on signs is contained in CARC Guidance Material 34-GM-17 Visual Aids for Navigation.

Application

5.4.1.1 Signs shall be provided to convey a mandatory instruction, information on a specific location or destination on a movement area or to provide other information to meet the requirements of paragraph 9.8.1.

Note: Refer to 5.2.17 for specifications on information marking.

5.4.1.2 A variable message sign shall be provided where:

(a) the instruction or information displayed on the sign is relevant only during a certain period of time; and/or

(b) there is a need for variable pre-determined information to be displayed on the sign to meet the requirements of paragraph 9.8.1.

Characteristics

5.4.1.3 Signs shall be frangible. Those located near a runway or taxiway shall be sufficiently low to preserve clearance for propellers and the engine pods of jet aircraft. The installed height of the sign shall not exceed the dimension shown in the appropriate column of Table 5-5, except for runway distance remaining signs (see 5.4.8).

5.4.1.4 Mandatory instruction signs and information signs shall be rectangular, as shown in Figures 5-30 and 5-31with the longer side horizontal.

5.4.1.5 The only signs on the movement area utilizing red shall be mandatory instruction signs.

5.4.1.6 The inscriptions on a sign shall be in accordance with the provisions of Appendix 4.

5.4.1.7 Signs shall be illuminated in accordance with the provisions of Appendix 4 when intended for use:

(a) in runway visual range conditions less than a value of 800 m; or
(b) at night in association with instrument runways; or
(c) at night in association with non-instrument runways where the code number is 3 or 4.

5.4.1.8 Signs shall be retroreflective and/or illuminated in accordance with the provisions of Appendix 4 when intended for use at night in association with non-instrument runways where the code number is 1 or 2.

5.4.1.9 A variable message sign shall show a blank face when not in use.

5.4.1.10 In case of failure, a variable message sign shall not provide information that could lead to unsafe action from a pilot or a vehicle driver.

5.4.1.11 The time interval to change from one message to another on a variable message sign shall be as short as practicable and shall not exceed 5 seconds.

Table 5-5. Location distances for taxiing guidance signs including runway exit signs

Code number	Sign height (mm) Legend	Face (min.)	Installed (max.)	Perpendicular distance from defined taxiway pavement edge to near side of sign	Perpendicular distance from defined runway pavement edge to near side of sign
1 or 2	200	300	700	5 – 11 m	3 – 10 m
1 or 2	300	450	900	5 – 11 m	3 – 10 m
3 or 4	300	450	900	11 – 21 m	8 – 15 m
3 or 4	400	600	1 100	11 – 21 m	8 – 15 m

5.4.2 Mandatory instruction signs

Note: See Figure 5-30 for pictorial representation of mandatory instruction signs and Figure 5-32 for examples of locating signs at taxiway/runway intersections.

Application

5.4.2.1 A mandatory instruction sign shall be provided to identify a location beyond which an aircraft taxiing or vehicle shall not proceed unless authorized by the aerodrome control tower.

5.4.2.2 Mandatory instruction signs shall include runway designation signs, category I, II or III holding position signs, runway-holding position signs, road-holding position signs and NO ENTRY signs.

Note: Refer to 5.4.7 for specifications on road-holding position signs.

5.4.2.3 A pattern “A” runway-holding position marking shall be supplemented at a taxiway/runway intersection or a runway/runway intersection with a runway designation sign.

5.4.2.4 A pattern “B” runway-holding position marking shall be supplemented with a category I, II or III holding position sign.

5.4.2.5 A pattern “A” runway-holding position marking at a runway-holding position established in accordance with Chapter 3 paragraph 3.12.3 shall be supplemented with a runway-holding position sign.

Note: Refer to 5.2.10 for specifications on runway-holding position marking.

5.4.2.6 A runway designation sign at a taxiway/runway intersection shall be supplemented with a location sign in the outboard (farthest from the taxiway position as appropriate).

Note: Refer to 5.4.3 for characteristics of location signs.

5.4.2.7 A NO ENTRY sign shall be provided when entry into an area is prohibited.

Location

5.4.2.8 A runway designation sign at a taxiway/runway intersection or a runway/runway intersection shall be located on each side of the runway-holding position marking facing the direction of approach to the runway.

5.4.2.9 A category I, II or III holding position sign shall be located on each side of the runway-holding position marking facing the direction of the approach to the critical area.

5.4.2.10 A NO ENTRY sign shall be located at the beginning of the area to which entrance is prohibited on each side of the taxiway as viewed by the pilot.

5.4.2.11 A runway-holding position sign shall be located on each side of the runway-holding position established in accordance with Chapter 3 Section 3.12.3, facing the approach to the obstacle limitation surface or ILS/MLS critical/sensitive area, as appropriate.

Characteristics

5.4.2.12 A mandatory instruction sign shall consist of an inscription in white on a red background.

5.4.2.13 Where, owing to environmental or other factors, the conspicuity of the inscription on a mandatory instruction sign needs to be enhanced, the outside edge of the white inscription shall be supplemented by a black outline measuring 10 mm in width for runway code numbers 1 and 2, and 20 mm in width for runway code numbers 3 and 4.

5.4.2.14 The inscription on a runway designation sign shall consist of the runway designations of the intersecting runway properly oriented with respect to the viewing position of the sign, except that a runway designation sign installed in the vicinity of a runway extremity may show the runway designation of the concerned runway extremity only.

5.4.2.15 The inscription on a category I, II, III, joint II/III or joint I/II/III holding position sign shall consist of the runway designator followed by CAT I, CAT II, CAT III, CAT II/III or CAT I/II/III, as appropriate.

5.4.2.16 The inscription on a NO ENTRY sign shall be in accordance with Figure 5-30.

5.4.2.17 The inscription on a runway-holding position sign at a runway-holding position established in accordance with Chapter 3 section 3.12.3 shall consist of the taxiway designation and a number.

5.4.2.18 Where installed, the inscriptions/ symbol of Figure 5-30 shall be used.

5.4.3 Information signs

Note 1: See Figure 5-31 for pictorial representations of information signs.

Note 2: See Chapter 7, 7.4.3 for specifications related to unserviceability signs providing information on operational restrictions and construction works at aerodromes.

Application

5.4.3.1 An information sign shall be provided where there is an operational need to identify by a sign, a specific location, or routing (direction or destination) information.

5.4.3.2 Information signs shall include: direction signs, location signs, destination signs, runway exit signs, runway vacated signs and intersection take-off signs.

5.4.3.3 A runway exit sign shall be provided where there is an operational need to identify a runway exit.

5.4.3.4 A runway vacated sign shall be provided where the exit taxiway is not provided with taxiway center line lights and there is a need to indicate to a pilot leaving a runway the perimeter of the ILS/MLS critical/sensitive area or the lower edge of the inner transitional surface whichever is farther from the runway center line.

Note: Refer to Section 5.3.17 for specifications on color coding taxiway center line lights.

5.4.3.5 An intersection take-off sign shall be provided when there is an operational need to indicate the remaining take-off run available (TORA) for intersection take-offs.

5.4.3.6 Where necessary, a destination sign shall be provided to indicate the direction to a specific destination on the aerodrome, such as cargo area, general aviation, etc.

5.4.3.7 A combined location and direction sign shall be provided when it is intended to indicate routing information prior to a taxiway intersection.

5.4.3.8 A direction sign shall be provided when there is an operational need to identify the designation and direction of taxiways at an intersection.

5.4.3.9 A location sign shall be provided at an intermediate holding position.

5.4.3.10 A location sign shall be provided in conjunction with a runway designation sign except at a runway/runway intersection.

5.4.3.11 A location sign shall be provided in conjunction with a direction sign, except that it may be omitted where an aeronautical study indicates that it is not needed.

5.4.3.12 Where necessary, a location sign shall be provided to identify taxiways exiting an apron or taxiways beyond an intersection.

5.4.3.13 Where a taxiway ends at an intersection such as a ‘‘T’’ and it is necessary to identify this, a barricade, direction sign and/or other appropriate visual aid shall be used.

Location

5.4.3.14 Except as specified in 5.4.3.16 and 5.4.3.24 information signs shall, wherever practicable, be located on the left-hand side of the taxiway in accordance with Table 5-5.

5.4.3.15 At a taxiway intersection, information signs shall be located prior to the intersection and in line with the intermediate holding position marking. Where there is no intermediate holding position marking, the signs shall be installed at least 60 m from the center line of the intersecting taxiway where the code number is 3 or 4 and at least 40 m where the code number is 1 or 2.

Note: A location sign installed beyond a taxiway intersection may be installed on either side of a taxiway.

5.4.3.16 A runway exit sign shall be located on the same side of the runway as the exit is located (i.e. left or right) and positioned in accordance with Table 5-5.

5.4.3.17 A runway exit sign shall be located prior to the runway exit point in line with a position at least 60 m prior to the point of tangency where the code number is 3 or 4, and at least 30 m where the code number is 1 or 2.

5.4.3.18 A runway vacated sign shall be located at least on one side of the taxiway. The distance between the sign and the centre line of a runway shall be not less than the greater of the following:

(a) the distance between the center line of the runway and the perimeter of the ILS/MLS critical/sensitive area; or
(b) the distance between the center line of the runway and the lower edge of the inner transitional surface.

5.4.3.19 Where provided in conjunction with a runway vacated sign, the taxiway location sign shall be positioned outboard of the runway vacated sign.

5.4.3.20 An intersection take-off sign shall be located at the left-hand side of the entry taxiway. The distance between the sign and the center line of the runway shall be not less than 60 m where the code number is 3 or 4 and not less than 45 m where the code number is 1 or 2.

5.4.3.21 A taxiway location sign installed in conjunction with a runway designation sign shall be positioned outboard of the runway designation sign.

5.4.3.22 A destination sign shall not normally be collocated with a location or direction sign.

5.4.3.23 An information sign other than a location sign shall not be collocated with a mandatory instruction sign.

5.4.3.24 A direction sign, barricade and/or other appropriate visual aid used to identify a ‘‘T’’ intersection shall be located on the opposite side of the intersection facing the taxiway.

Characteristics

5.4.3.25 An information sign other than a location sign shall consist of an inscription in black on a yellow background.

5.4.3.26 A location sign shall consist of an inscription in yellow on a black background and where it is a stand-alone sign shall have a yellow border.

5.4.3.27 The inscription on a runway exit sign shall consist of the designator of the exit taxiway and an arrow indicating the direction to follow.

5.4.3.28 The inscription on a runway vacated sign shall depict the pattern A runway-holding position marking as shown in Figure 5-31.

5.4.3.29 The inscription on an intersection take-off sign shall consist of a numerical message indicating the remaining take-off run available in meters plus an arrow, appropriately located and oriented, indicating the direction of the take-off as shown in Figure 5-31.

5.4.3.30 The inscription on a destination sign shall comprise an alpha, alphanumerical or numerical message identifying the destination plus an arrow indicating the direction to proceed as shown in Figure 5-31.

5.4.3.31 The inscription on a direction sign shall comprise an alpha or alphanumerical message identifying the taxiway(s) plus an arrow or arrows appropriately oriented as shown in Figure 5-31.

5.4.3.32 The inscription on a location sign shall comprise the designation of the location taxiway, runway or other pavement the aircraft is on or is entering and shall not contain arrows.

5.4.3.33 Where it is necessary to identify each of a series of intermediate holding positions on the same taxiway, the location sign shall consist of the taxiway designation and a number.

5.4.3.34 Where a location sign and direction signs are used in combination:

(a) all direction signs related to left turns shall be placed on the left side of the location sign and all direction signs related to right turns shall be placed on the right side of the location sign, except that where the junction consists of one intersecting taxiway, the location sign may alternatively be placed on the left hand side;
(b) the direction signs shall be placed such that the direction of the arrows departs increasingly from the vertical with increasing deviation of the corresponding taxiway;
(c) an appropriate direction sign shall be placed next to the location sign where the direction of the location taxiway changes significantly beyond the intersection; and
(d) adjacent direction signs shall be delineated by a vertical black line as shown in Figure 5-30.

5.4.3.35 A taxiway shall be identified by a designator that is used only once on an aerodrome comprising a single letter, two letters or a combination of a letter or letters followed by a number.

5.4.3.36 When designating taxiways, the use of words such as inner and outer shall be avoided wherever possible.

5.4.3.37 When designating taxiways, the use of the letters I, O or X shall not be used to avoid confusion with the numerals 1,0 and closed marking.

5.4.3.38 The use of numbers alone on the maneuvering area shall be reserved for the designation of runways.

5.4.3.39 Apron stand designators shall not be the same as taxiway designators.

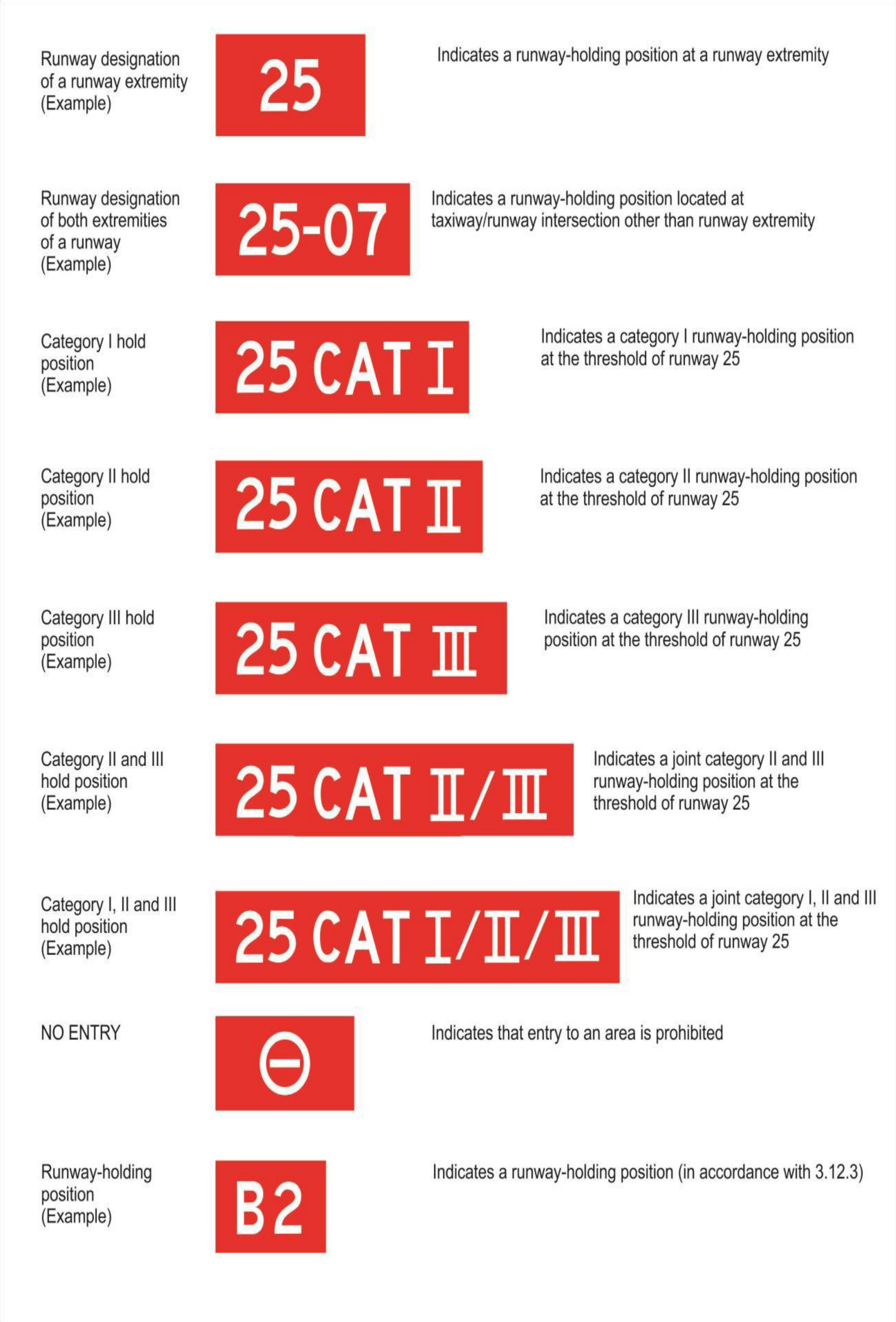


Figure 5-30. Mandatory instruction signs

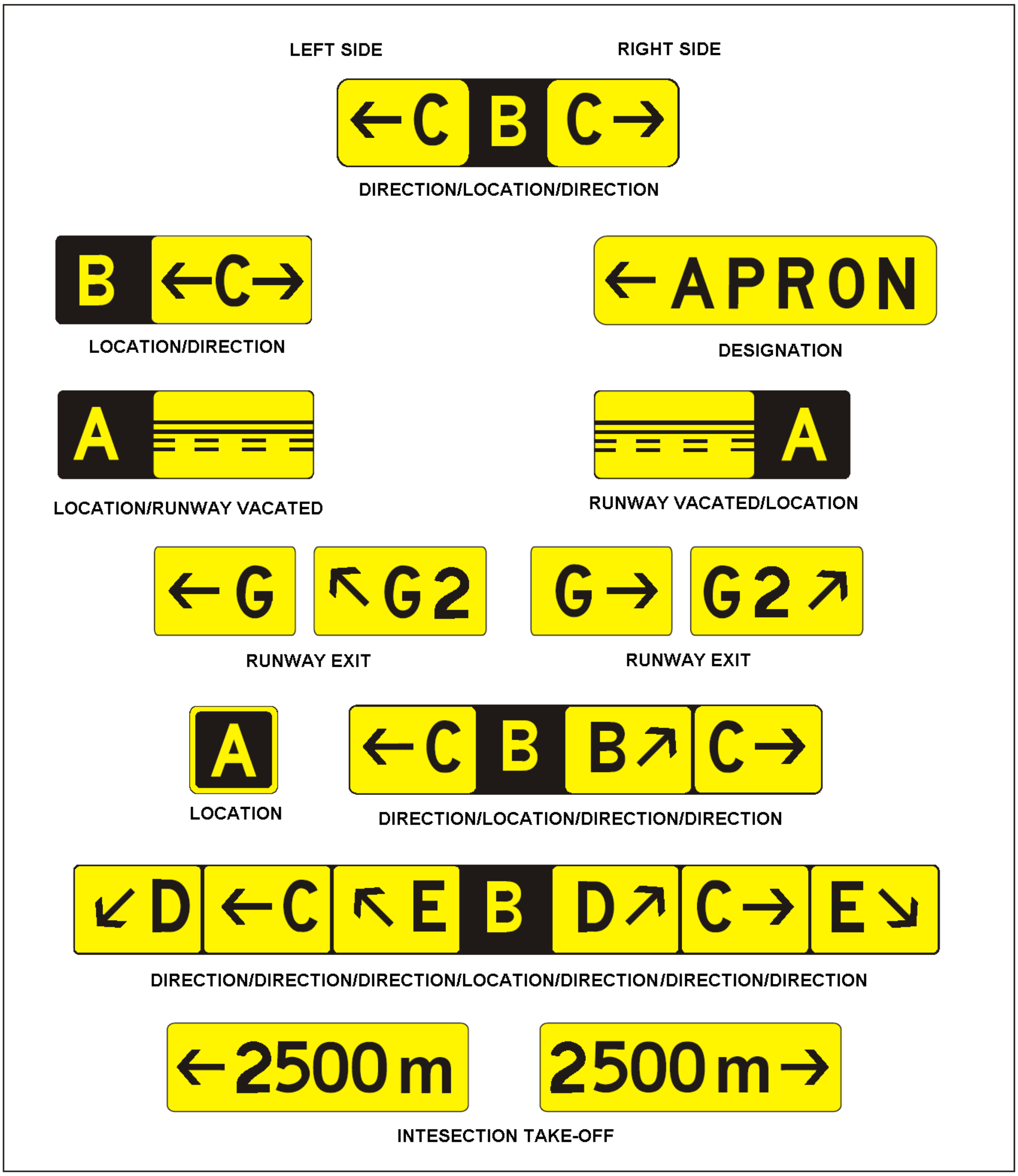
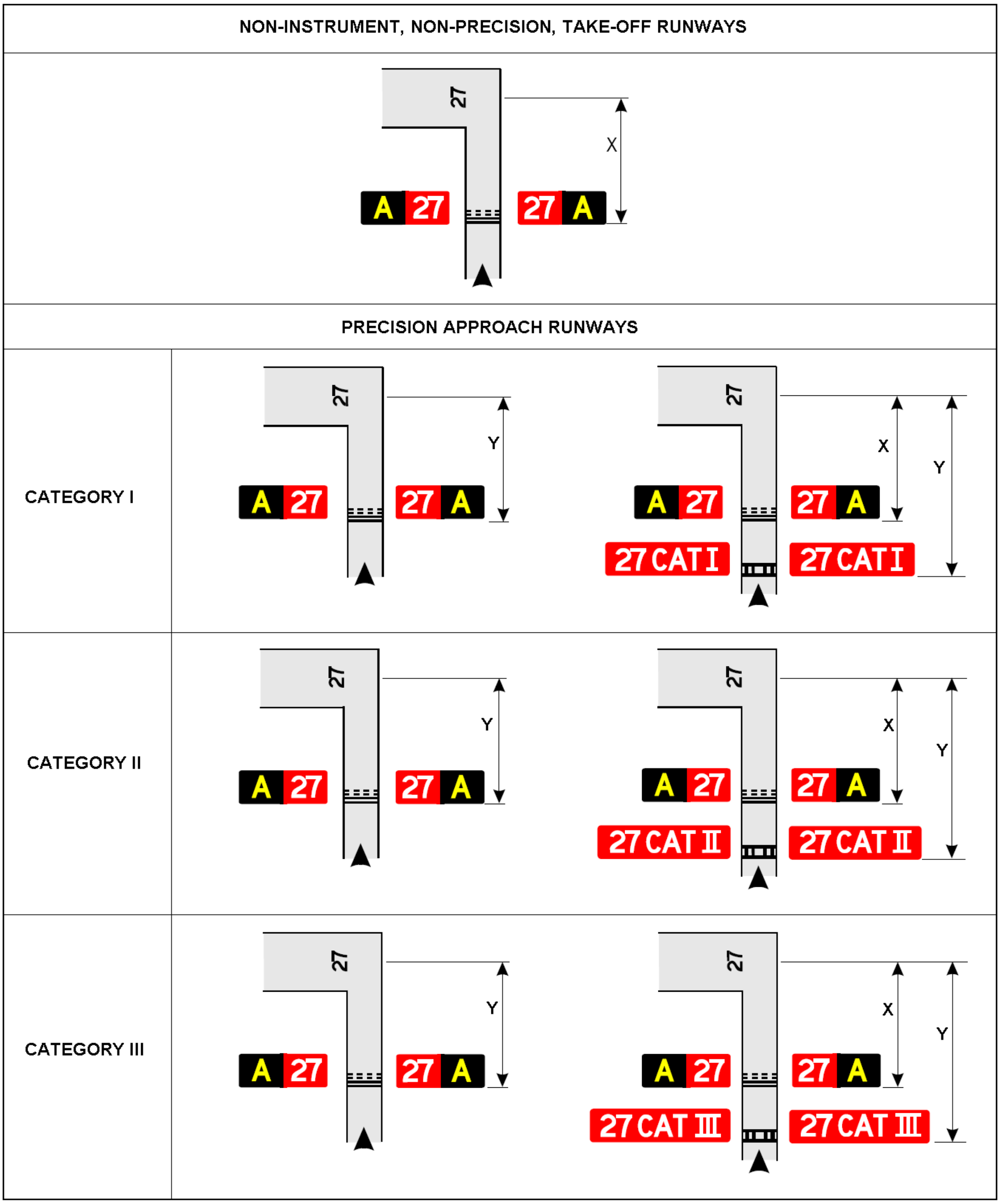


Figure 5-31. Information signs



Note: Distance X is established in accordance with Table 3-2. Distance Y is established at the edge of the ILS/MLS critical/sensitive area.

Figure 5-32. Examples of sign positions at taxiway/runway intersections

5.4.4 VOR aerodrome check-point sign

Application

5.4.4.1 When a VOR aerodrome check-point is established, it shall be indicated by a VOR aerodrome check-point marking and sign.

Note: Refer to 5.2.12 for VOR aerodrome check-point marking.

Location

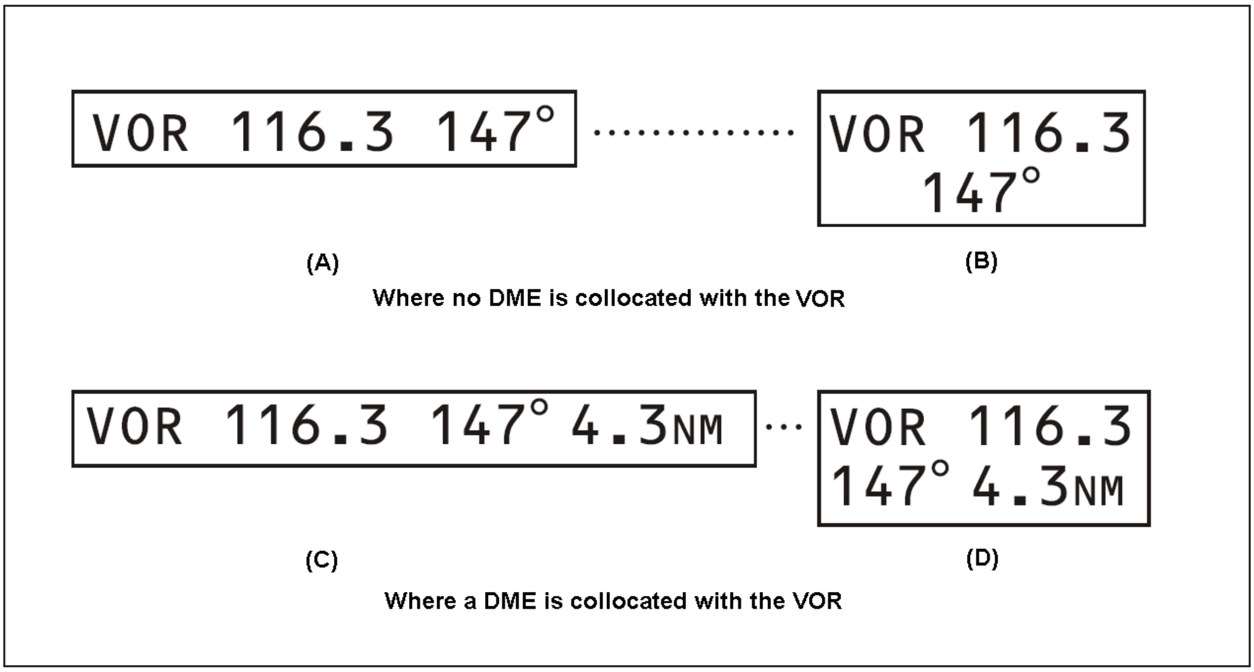
5.4.4.2 A VOR aerodrome check-point sign shall be located as near as possible to the check-point and so that the inscriptions are visible from the cockpit of an aircraft properly positioned on the VOR aerodrome check-point marking.

Characteristics

5.4.4.3 A VOR aerodrome check-point sign shall consist of an inscription in black on a yellow background.

5.4.4.4 The inscriptions on a VOR check-point sign shall be in accordance with one of the alternatives shown in Figure 5-33 in which:

VOR	is an abbreviation identifying this as a VOR check-point;
116.3	is an example of the radio frequency of the VOR concerned;
147°	is an example of the VOR bearing, to the nearest degree, which shall be indicated at the VOR check-point; and
4.3 NM	is an example of the distance in nautical miles to a DME collocated with the VOR concerned.



Note: Tolerances for the bearing value shown on the sign are given in ICAO Annex 10, Volume I, Attachment E. It will be noted that a check-point can only be used operationally when periodic checks show it to be consistently within ± 2 degrees of the stated bearing.

Figure 5-33. VOR aerodrome check-point sign

5.4.5 Aerodrome identification sign

Application

5.4.5.1 An aerodrome identification sign shall be provided at an aerodrome where there is insufficient alternative means of visual identification.

Location

5.4.5.2 The aerodrome identification sign shall be placed on the aerodrome so as to be legible, in so far as is practicable, at all angles above the horizontal.

Characteristics

5.4.5.3 The aerodrome identification sign shall consist of the name of the aerodrome.

5.4.5.4 The color selected for the sign shall give adequate conspicuity when viewed against its background.

5.4.5.5 The characters shall have a height of not less than 3 m.

5.4.6 Aircraft stand identification signs

Application

5.4.6.1 An aircraft stand identification marking shall be supplemented with an aircraft stand identification sign where feasible.

Location

5.4.6.2 An aircraft stand identification sign shall be located so as to be clearly visible from the cockpit of an aircraft prior to entering the aircraft stand.

Characteristics

5.4.6.3 An aircraft stand identification sign shall consist of an inscription in black on a yellow background.

5.4.7 Road-holding position sign

5.4.7.1 A road-holding position sign shall be provided at all road entrances to a runway.

Location

5.4.7.2 The road-holding position sign shall be located 1.5 m from one edge of the road (left or right as appropriate to the local traffic regulations) at the holding position.

Characteristics

5.4.7.3 A road-holding position sign shall consist of an inscription in white on a red background.

5.4.7.4 The inscription on a road-holding position sign shall be in the national language, be in conformity with the local traffic regulations and include the following:

- (a) a requirement to stop; and
- (b) where appropriate:
    - (1) a requirement to obtain ATC clearance; and
    - (2) location designator.

Note: Examples of road-holding position signs are contained in CARC Guidance Material 34-GM-17 Visual Aids for Navigation.

5.4.7.5 A road-holding position sign intended for night use shall be retroreflective or illuminated.

5.4.8 Runway distance remaining signs

Note 1: The inclusion of detailed specifications for runway distance remaining signs (RDRS) in this section is not intended to imply that an RDRS has to be provided. CARC

Guidance Material to Part 14 No. 34 GM-01, Section 23, provides guidance on the need to provide RDRSs. Guidance on installing RDRSs is given in the CARC Guidance Material 34-GM-17 Visual Aids for Navigation.

Note 2: Runway excursions may take place in all visibility or weather conditions. The use of RDRS can form part of effective runway excursion prevention measures. The purpose of RDRSs is to provide pilots with distance-to-go information to the extremity of the runway, to enhance situational awareness and enable pilots to decide whether to commence a go-around or to apply braking action for more efficient rollout and runway exit speeds. It is essential that pilots operating at aerodromes with RDRS be familiar with the purpose of these signs.

Note 3: Provisions related to the identification of hazards and management of safety risks, including the need for safety risk assessment related to runway safety, is available in CARC Guidance Material 34-GM-16 PANS-Aerodromes, Chapter 8.

Location

5.4.8.1 Where provided, runway distance remaining signs (RDRS) shall be placed along the full length of the runway at longitudinal spacing of approximately 300 m, parallel and equidistant from the runway centerline.

Note: Displaced threshold areas that are used for take-off and/or roll-out are treated as part of the runway for purposes of locating the signs.

5.4.8.2 Runway distance remaining signs shall be placed outside the edges of the runway at a distance shown in Table 5-6.

Characteristics

5.4.8.3 Where provided, an RDRS shall consist of an inscription in white on a black background.

5.4.8.4 The installed height of the RDRS shall not exceed the dimension shown in the appropriate column of Table 5-6. All RDRSs on one runway shall be the same size.

Table 5-6. Location distances for runway distance remaining signs

Sign height (mm)				Perpendicular distance from defined runway pavement edge to near side of sign
Code number	Legend	Face (min.)	Installed (max.)	
1 or 2	640	760	1070	6 – 10.5 m
3 or 4	1000	1200	1520	15 – 22.5 m
3 or 4	1200	1500	1600	25 m or more

5.5 Markers

5.5.1 General

Markers shall be frangible. Those located near a runway or taxiway shall be sufficiently low to preserve clearance for propellers and for the engine pods of jet aircraft.

Note (1): Anchors or chains, to prevent markers which have broken from their mounting from blowing away, are sometimes used.

Note (2): Guidance on frangibility of markers is given in ICAO Aerodrome Design Manual, Part 6 — Frangibility (Doc 9157).

5.5.2 Unpaved runway edge markers

Application

5.5.2.1 Markers should be provided when the extent of an unpaved runway is not clearly indicated by the appearance of its surface compared with that of the surrounding ground.

Location

5.5.2.2 Where runway lights are provided, the markers should be incorporated in the light fixtures. Where there are no lights, markers of flat rectangular or conical shape should be placed so as to delimit the runway clearly.

Characteristics

5.5.2.3 The flat rectangular markers should have a minimum size of 1 m by 3 m and should be placed with their long dimension parallel to the runway centre line. The conical markers should have a height not exceeding 50 cm.

5.5.3 Stopway edge markers

Application

5.5.3.1 Stopway edge markers shall be provided when the extent of a stopway is not clearly indicated by its appearance compared with that of the surrounding ground.

Characteristics

5.5.3.2 The stopway edge markers shall be sufficiently different from any runway edge markers used to ensure that the two types of markers cannot be confused.

Note: Markers consisting of small vertical boards camouflaged on the reverse side, as viewed from the runway, have proved operationally acceptable.

5.5.4 Edge markers for snow-covered runways

Application
5.5.4.1 Edge markers for snow-covered runways shall be used to indicate the usable limits of a snow-covered runway when the limits are not otherwise indicated.

Note: Runway lights could be used to indicate the limits.

Location
5.5.4.2 Edge markers for snow-covered runways shall be placed along the sides of the runway at intervals of not more than 100 m, and shall be located symmetrically about the runway center line at such a distance from the center line that there is adequate clearance for wing tips and power plants. Sufficient markers shall be placed across the threshold and end of the runway.

Characteristics
5.5.4.3 Edge markers for snow-covered runways shall consist of conspicuous objects such as evergreen trees about 1.5 m high, or light-weight markers.

5.5.5 Taxiway edge markers

Application
5.5.5.1 Taxiway edge markers shall be provided on a taxiway where the code number is 1 or 2 and taxiway center line or edge lights or taxiway center line markers are not provided.
Location
5.5.5.2 Taxiway edge markers shall be installed at least at the same locations as would the taxiway edge lights had they been used.

Characteristics
A taxiway edge marker shall be retroreflective blue.
5.5.5.3 The marked surface as viewed by the pilot shall be a rectangle and shall have a minimum viewing area of 150 cm^2.

5.5.5.4 Taxiway edge markers shall be frangible. Their height shall be sufficiently low to preserve clearance for propellers and for the engine pods of jet aircraft.

5.5.6 Taxiway center line markers

Application
5.5.6.1 Taxiway center line markers shall be provided on a taxiway where the code number is 1 or 2 and taxiway center line or edge lights or taxiway edge markers are not provided.

5.5.6.2 Taxiway center line markers shall be provided on a taxiway where the code number is 3 or 4 and taxiway center line lights are not provided if there is a need to improve the guidance provided by the taxiway center line marking.

Location
5.5.6.3 Taxiway center line markers shall be installed at least at the same location as would taxiway center line lights had they been used.

Note: Refer to 3.17.12 for the spacing of taxiway center line lights.

5.5.6.4 Taxiway center line markers shall normally be located on the taxiway center line marking except that they may be offset by not more than 30 cm where it is not practicable to locate them on the marking.

Characteristics
5.5.6.5 A taxiway center line marker shall be retroreflective green.

5.5.6.6 The marked surface as viewed by the pilot shall be a rectangle and shall have a minimum viewing area of 20 cm^2.

5.5.6.7 Taxiway center line markers shall be so designed and fitted as to withstand being run over by the wheels of an aircraft without damage either to the aircraft or to the markers themselves.

5.5.7 Unpaved taxiway edge markers

Application
5.5.7.1 Where the extent of an unpaved taxiway is not clearly indicated by its appearance compared with that of the surrounding ground, markers shall be provided.

Location
5.5.7.2 Where taxiway lights are provided, the markers shall be incorporated in the light fixtures. Where there are no lights, markers of conical shape should be placed so as to delimit the taxiway clearly.

5.5.8 Boundary markers

Application
5.5.8.1 Boundary markers shall be provided at an aerodrome where the landing area has no runway.

Location

5.5.8.2 Boundary markers shall be spaced along the boundary of the landing area at intervals of not more than 200 m, if the type shown in Figure 5-34 is used, or approximately 90 m, if the conical type is used with a marker at any corner.

Characteristics

5.5.8.3 Boundary markers shall be of a form similar to that shown in Figure 5-34, or in the form of a cone not less than 50 cm high and not less than 75 cm in diameter at the base. The markers shall be colored to contrast with the background against which they will be seen. A single color, orange or red, or two contrasting colors, orange and white or alternatively red and white, shall be used, except where such colors merge with the background.

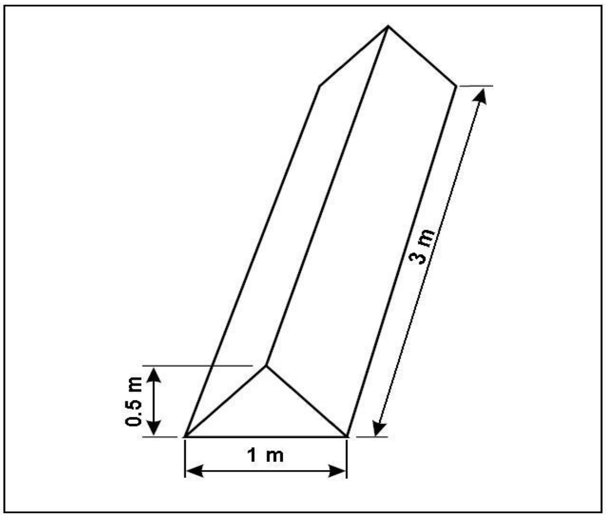


Figure 5-34. Boundary markers

Chapter (6)
Visual Aids for Denoting Obstacles

6.1 Objects to Be Marked and/or Lighted

Note (1): The marking and/or lighting of obstacles are intended to reduce hazards to aircraft by indicating the presence of the obstacles. It does not necessarily reduce operating limitations which may be imposed by an obstacle.

Note (2): An autonomous aircraft detection system may be installed on or near an obstacle (or group of obstacles such as wind farms), designed to operate the lighting only when the system detects an aircraft approaching the obstacle, in order to reduce light exposure to local residents. Guidance on the design and installation of an autonomous aircraft detection system is available in CARC Guidance Material 34-GM-17 Visual Aids for Navigation. The availability of such guidance is not intended to imply that such a system has to be provided.

6.1.1 Objects within the lateral boundaries of the obstacle limitation surfaces

6.1.1.1 Vehicles and other mobile objects, excluding aircraft, on the movement area of an aerodrome are obstacles and shall be marked and, if the vehicles and aerodrome are used at night or in conditions of low visibility, lighted.

6.1.1.2 Elevated aeronautical ground lights within the movement area shall be marked so as to be conspicuous by day. Obstacle lights shall not be installed on elevated ground lights or signs in the movement area.

6.1.1.3 All obstacles within the distance specified in Table 3-1, column 11 or 12, from the center line of a taxiway, an apron taxiway or aircraft stand taxilane shall be marked and, if the taxiway, apron taxiway or aircraft stand taxilane is used at night, lighted.

6.1.1.4 A fixed obstacle that extends above a take-off climb surface within 3000 m of the inner edge of the take-off climb surface shall be marked and, if the runway is used at night, lighted, except that:

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

(b) The marking may be omitted when the obstacle is lighted by medium-intensity obstacle lights, Type A, by day and its height above the level of the surrounding ground does not exceed 150 m;

(c) The marking may be omitted when the obstacle is lighted by high-intensity obstacle lights by day; and

(d) The lighting may be omitted where the obstacle is a lighthouse and an aeronautical study indicates the lighthouse light to be sufficient.

6.1.1.5 A fixed object, other than an obstacle, adjacent to a take-off climb surface shall be marked and, if the runway is used at night, lighted if such marking and lighting is considered necessary to ensure its avoidance, except that the marking may be omitted when:

(a) the object is lighted by medium-intensity obstacle lights, Type A, by day and its height above the level of the surrounding ground does not exceed 150 m; or

(b) the object is lighted by high-intensity obstacle lights by day

6.1.1.6 A fixed obstacle that extends above an approach surface within 3000 m of the inner edge or above a transitional surface shall be marked and, if the runway is used at night, lighted, except that:

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

(b) the marking may be omitted when the obstacle is lighted by medium-intensity obstacle lights, Type A, by day and its height above the level of the surrounding ground does not exceed 150 m;

(c) the marking may be omitted when the obstacle is lighted by high-intensity obstacle lights by day; and

(d) the lighting may be omitted where the obstacle is a lighthouse and an aeronautical study indicates the lighthouse light to be sufficient.

6.1.1.7 A fixed obstacle that extends above a horizontal surface shall be marked and, if the aerodrome is used at night, lighted, except that:

(a) such marking and lighting may be omitted when:

   (1) the obstacle is shielded by another fixed obstacle; or

   (2) for a circuit extensively obstructed by immovable objects or terrain, procedures have been established to ensure safe vertical clearance below prescribed flight paths; or

   (3) an aeronautical study shows the obstacle not to be of operational significance;

(b) the marking may be omitted when the obstacle is lighted by medium-intensity obstacle lights, Type A, by day and its height above the level of the surrounding ground does not exceed 150 m;

(c) the marking may be omitted when the obstacle is lighted by high-intensity obstacle lights by day; and

(d) the lighting may be omitted where the obstacle is a lighthouse and an aeronautical study indicates the lighthouse light to be sufficient.

6.1.1.8 A fixed object that extends above an obstacle protection surface shall be marked and, if the runway is used at night, lighted.

Note: See Chapter 5 section 5.3.5 for information on the obstacle protection surface.

6.1.1.9 Other objects inside the obstacle limitation surfaces shall be marked and/or lighted if an aeronautical study indicates that the object could constitute a hazard to aircraft (this includes objects adjacent to visual routes e.g. waterway or highway). (See note below Chapter 4 paragraph 4.4.2.)

6.1.1.10 Overhead wires, cables, etc., crossing a river, waterway, valley or highway shall be marked and their supporting towers marked and lighted if an aeronautical study indicates that the wires or cables could constitute a hazard to aircraft, except that the marking of the supporting towers may be omitted when they are lighted by high-intensity obstacle lights by day.

6.1.2 Objects outside the lateral boundaries of the obstacle limitation surfaces.

6.1.2.1 Obstacles in accordance with Chapter 4 paragraph 4.3.2 shall be marked and lighted, except that the marking may be omitted when the obstacle is lighted by high-intensity obstacle lights by day.

6.1.2.2 Other objects outside the obstacle limitation surfaces shall be marked and/or lighted if an aeronautical study indicates that the object could constitute a hazard to aircraft (this includes objects adjacent to visual routes e.g. waterway, highway).

6.1.2.3 Overhead wires, cables, etc., crossing a river, waterway, valley or highway shall be marked and their supporting towers marked and lighted if an aeronautical study indicates that the wires or cables could constitute a hazard to aircraft.

6.2 Marking and/or Lighting of Objects

6.2.1 General

6.2.1.1 The presence of objects which must be lighted, as specified in section 1, shall be indicated by low-, medium- or high-intensity lights, or a combination of such lights.

6.2.1.2 Low-intensity obstacle lights, Types A, B, C, D and E, medium-intensity obstacle lights, types A, B and C, high-intensity obstacle lights Type A and B, shall be in accordance with the specifications in Table 6-1 and Appendix 1.

6.2.1.3 The number and arrangement of low, medium or high intensity obstacle lights at each level to be marked shall be such that the object is indicated from every angle in azimuth. Where a light is shielded in any direction by another part of the object, or by an adjacent object, additional lights shall be provided on that adjacent object or the part of the object that is shielding the light, in such a way as to retain the general definition of the object to be lighted. If the shielded light does not contribute to the definition of the object to be lighted, it may be omitted.

6.2.2 Mobile objects

Marking

6.2.2.1 All mobile objects to be marked shall be coloured or display flags.

Marking by colour

6.2.2.2 When mobile objects are marked by colour, a single conspicuous colour, preferably red or yellowish green for emergency vehicles and yellow for service vehicles shall be used.

Marking by flags

6.2.2.3 Flags used to mark mobile objects shall be displayed around, on top of, or around the highest edge of the object. Flags shall not increase the hazard presented by the object they mark.

6.2.2.4 Flags used to mark mobile objects shall not be less than 0.9 m on each side and shall consist of a chequered pattern, each square having sides of not less than 0.3 m. The colors of the pattern shall contrast each with the other and with the background against which they will be seen. Orange and white or alternatively red and white shall be used, except where such colors merge with the background.

Lighting

6.2.2.5 Low intensity obstacle lights, Type C, shall be displayed on vehicles and other mobile objects excluding aircraft.

Note: See ICAO Annex 2 for lights to be displayed by aircraft.

6.2.2.6 Low intensity obstacle lights, Type C, displayed on vehicles associated with emergency or security shall be flashing-blue and those displayed on other vehicles shall be flashing-yellow.

6.2.2.7 Low intensity obstacle lights, type D, shall be displayed on follow-me vehicles.

6.2.2.8 Low intensity obstacle lights on objects with limited mobility such as passenger boarding bridges shall be fixed-red, and as a minimum be in accordance with the specifications for low-intensity obstacle lights, type A, in Table 6-1 intensity of the lights shall be sufficient to ensure conspicuity considering the intensity of the adjacent lights and the general levels of illumination against which they would normally be viewed.

Table 6-1. Characteristics of obstacle lights

Light Type	Color	Signal type/(Flash rate)	Peak intensity (cd) at given Background Luminance (b)			Light Distribution Table
			Day (above 500 cd/m2)	Twilight (50- 500 cd/m2)	Night (below 50 cd/m2)	
Low intensity, Type A (fixed obstacle)	Red	Fixed	N/A	N/A	10	6-X
Low intensity, Type B (fixed obstacle)	Red	Fixed	N/A	N/A	32	6-X
Low intensity, Type C (mobile obstacle)	Yellow/ Blue (a)	Flashing (60-90 fpm)	N/A	40	40	6-X
Low intensity, Type D Follow me vehicle	Yellow	Flashing (60-90 fpm)	N/A	200	200	6-X
Low-intensity, Type E	Red	Flashing (c)	N/A	N/A	32	Table 6-2 (type B)
Medium intensity Type A	White	Flashing (20-60 fpm)	20 000	20 000	2 000	6-Y
Medium intensity Type B	Red	Flashing (20-60 fpm)	N/A	N/A	2 000	6-Y
Medium intensity Type C	Red	Fixed	N/A	N/A	2 000	6-Y
High intensity Type A	White	Flashing (40-60 fpm)	200 000	20 000	2 000	6-Y
High intensity Type B	White	Flashing (40-60 fpm)	100 000	20 000	2 000	6-Y

(a) See 6.2.2.6
(b) For flashing lights, effective intensity as determined with the CARC Guidance Material 34-GM-17 Visual Aids for Navigation.
(c) For wind turbine application, to flash at the same rate as the lighting on the nacelle.

Table 6-2. Light distribution for low intensity obstacle lights

	Maximum intensity (a)	Maximum intensity (a)	Vertical beam spread (f)	
			Maximum beam spread	Intensity
Type A	10cd (b)	N/A	10˚	5cd
Type B	32cd (b)	N/A	10˚	16cd
Type C	40cd (b)	400cd	12˚ (d)	20cd
Type D	200cd (c)	400cd	N/A (e)	N/A

(a) 360° horizontal. For flashing lights, the intensity is read into effective intensity, as determined in accordance with the CARC Guidance Material 34-GM-17 Visual Aids for Navigation.
(b) Between 2 and 10° vertical. Elevation vertical angles are referenced to the horizontal when the light is leveled.
(c) Between 2 and 20° vertical. Elevation vertical angles are referenced to the horizontal when the light is leveled.
(d) Peak intensity shall be located at approximately 2.5° vertical.
(e) Peak intensity shall be located at approximately 17° vertical.
(f) Beam spread is defined as the angle between the horizontal plan and the directions for which the intensity exceeds that mentioned in the "intensity" column.

Note: This table does not include recommended horizontal beam spreads 6.2.1.3 requires 360° coverage around an obstacle. Therefore, the number of lights needed to meet this requirement will depend on the horizontal beam spreads of each light as well as the shape of the obstacle. Thus, with narrower beam spreads, more lights will be required.

Table 6-3. Light distribution for medium and high intensity obstacle lights according to benchmark intensities of Table 6-3

Benchmark intensity	Minimum requirement					Recommendations				
	Vertical elevation angle (b)			Vertical beam spread (c)		Vertical elevation angle (b)			Vertical beam spread (c)	
	0˚		-1˚			0˚	-1˚	-10˚		
	Minimum average intensity (a)	Minimum intensity (a)	Minimum intensity (a)	Minimum beam spread	Intensity (a)	Maximum Intensity (a)	Maximum Intensity (a)	Maximum Intensity (a)	Maximum beam spread	Intensity (a)
200 000	200 000	150 000	75 000	3˚	75 000	250 000	112 500	7 500	7˚	75 000
100 000	100 000	75 000	37 000	3˚	37 000	125 000	56 250	3 750	7˚	37 500
20 000	20 000	15 000	7 500	3˚	7 500	25 000	11 250	750	N/A	N/A
2 000	2 000	1 500	750	3˚	750	25 00	1 125	75	N/A	N/A

(a) 360° horizontal. All intensities are expressed in Candela. For flashing lights, the intensity is read into effective intensity, as determined in accordance with the CARC Guidance Material 34-GM-17 Visual Aids for Navigation.

(b) Elevation vertical angles are referenced to the horizontal when the light unit is leveled.

(c) Beam spread is defined as the angle between the horizontal plan and the directions for which the intensity exceeds that mentioned in the "intensity" column.

Note (1): This table does not include recommended horizontal beam spreads. 6.2.1.3 requires 360° coverage around an obstacle. Therefore, the number of lights needed to meet this requirement will depend on the horizontal beam spreads of each light as well as the shape of the obstacle. Thus, with narrower beam spreads, more lights will be required.

Note (2): An extended beam spread may be necessary under specific configuration and justified by an aeronautical study.

6.2.3 Fixed objects

Note: The fixed objects of wind turbines are addressed separately in 6.2.4 and the fixed objects of overhead wires, cables, etc. and supporting towers are addressed separately in 6.2.5.

Marking

6.2.3.1 All fixed objects to be marked shall, whenever practicable, be coloured, but if this is not practicable, markers or flags shall be displayed on or above them, except that objects that are sufficiently conspicuous by their shape, size or colour need to be otherwise marked.

Marking by colour

6.2.3.2 An object shall be coloured to show a chequered pattern if it has essentially unbroken surfaces and its projection on any vertical plane equals or exceeds 4.5 m in both dimensions. The pattern shall consist of rectangles not less than 1.5 m and not more than 3 m on a side, the corners being of the darker colour. The colours of the pattern shall contrast each with the other and with the background against which they will be seen. Orange and white or alternatively red and white shall be used, except where such colours merge with the background. (See Figure 6-1).

6.2.3.3 An object shall be coloured to show alternating contrasting bands if:

(a) it has essentially unbroken surfaces and has one dimension, horizontal or vertical, greater than 1.5 m, and the other dimension, horizontal or vertical, less than 4.5 m; or

(b) it is of skeletal type with either a vertical or a horizontal dimension greater than 1.5 m.

The bands shall be perpendicular to the longest dimension and have a width approximately 1/7 of the longest dimension or 30 m, whichever is less. The colours of the bands shall contrast with the background against which they will be seen. Orange and white shall be used, except where such colours are not conspicuous when viewed against the background. The bands on the extremities of the object shall be of the darker colour. (See Figure 6-1 and F-2).

Note: Table 6-4 shows a formula for determining band widths and for having an odd number of bands, thus permitting both the top and bottom bands to be of the darker colour.

6.2.3.4 An object shall be coloured in a single conspicuous colour if its projection on any vertical plane has both dimensions less than 1.5 m. Orange or red shall be used, except where such colours merge with the background.

Note: Against some backgrounds it may be found necessary to use a different colour from orange or red to obtain sufficient contrast.

Table 6-4. Marking band widths

Longest dimension		Band width
Greater than	**Not exceeding**	
1.5 m	210 m	1/7 of longest dimension
210 m	270 m	1/9 of longest dimension
270 m	330 m	1/11 of longest dimension
330 m	390 m	1/13 of longest dimension
390 m	450 m	1/15 of longest dimension
450 m	510 m	1/17 of longest dimension
510 m	570 m	1/19 of longest dimension
570 m	630 m	1/21 of longest dimension

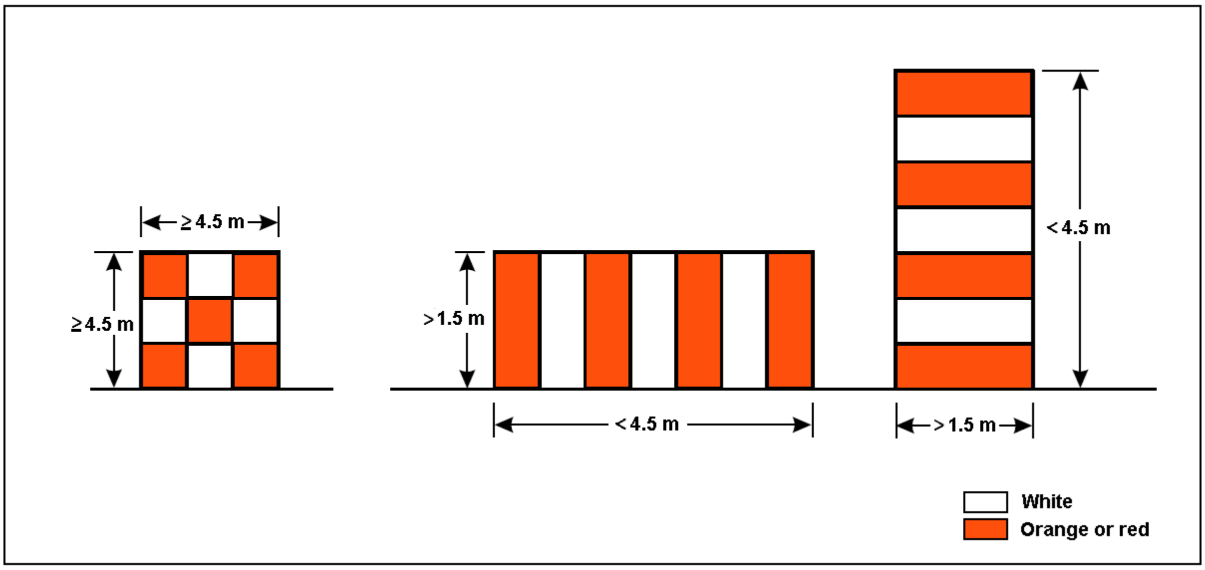


Figure 6-1. Basic marking patterns

Marking by flags

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

6.2.3.6 Flags used to mark fixed objects shall not be less than 0.6 m on each side.

6.2.3.7 Flags used to mark fixed objects shall be orange in colour or a combination of two triangular sections, one orange and the other white, or one red and the other white, except that where such colours merge with the background, other conspicuous colours shall be used.

Marking by markers

6.2.3.8 Markers displayed on or adjacent to objects shall be located in conspicuous positions so as to retain the general definition of the object and shall be recognizable in clear weather from a distance of at least 1000 m for an object to be viewed from the air and 300 m for an object to be viewed from the ground in all directions in which an aircraft is likely to approach the object. The shape of markers shall be distinctive to the extent necessary to ensure that they are not mistaken for markers employed to convey other information, and they shall be such that the hazard presented by the object they mark is not increased.

6.2.3.9 A marker shall be of one colour. When installed, white and red, or white and orange markers shall be displayed alternately. The colour selected shall contrast with the background against which it will be seen.

Lighting

6.2.3.10 In case of an object to be lighted one or more medium- or high-intensity obstacle lights shall be located as close as practicable to the top of the object.

Note: Recommendations on how a combination of medium-, and/or high-intensity lights on obstacles shall be displayed are given in this chapter.

6.2.3.11 In the case of a chimney or other structure of like function, the top lights shall be placed sufficiently below the top so as to minimize contamination by smoke etc. (see Figure 6-2)

6.2.3.12 In the case of a tower or antenna structure indicated by high-intensity obstacle lights by day with an appurtenance, such as a rod or an antenna, greater than 12 m where it is not practicable to locate a high intensity obstacle light on top of the appurtenance, such a light shall be located at the highest practicable point and, if practicable, a medium-intensity obstacle light, type A, mounted on the top.

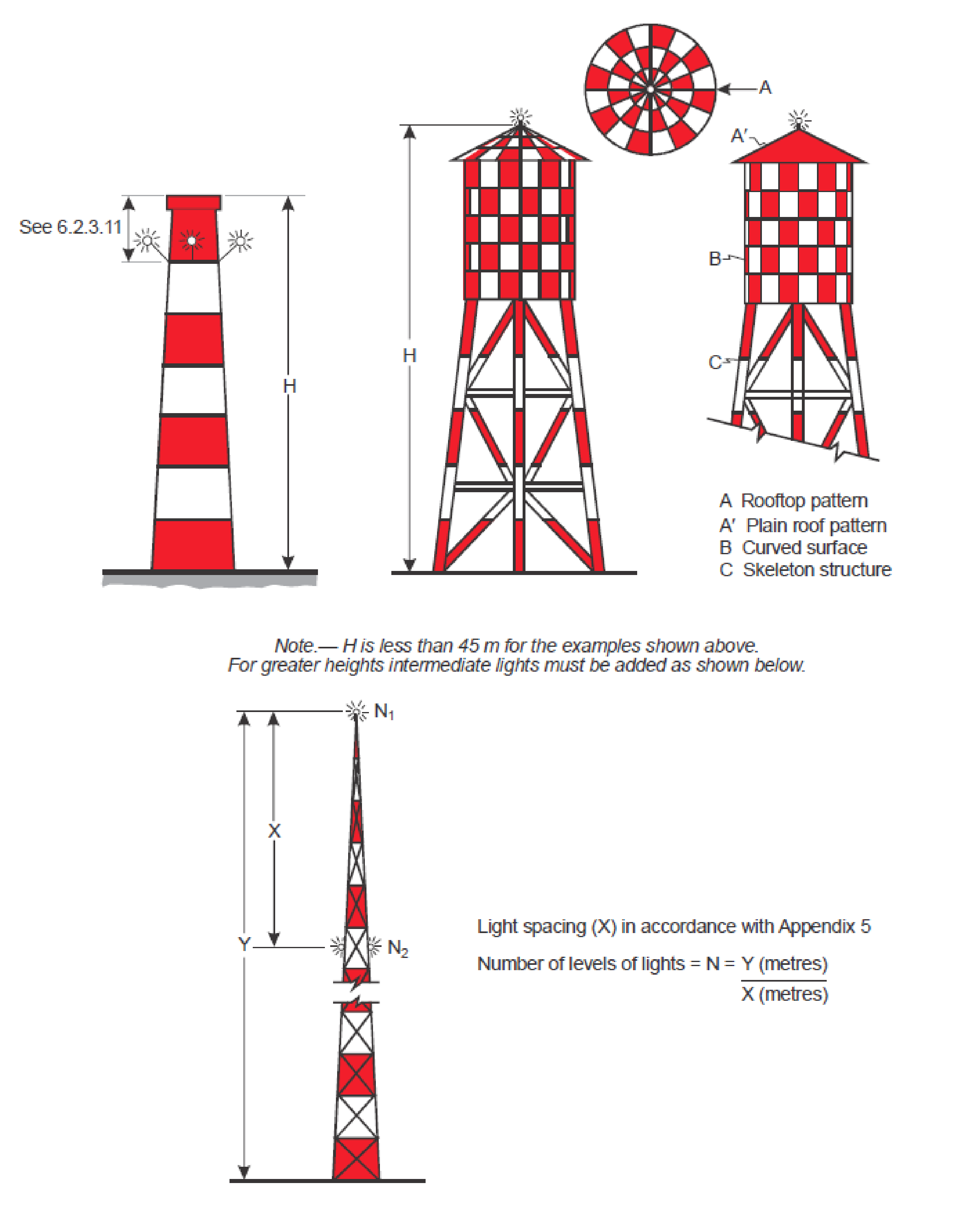


Figure 6-2. Examples of marking and lighting of tall structures

6.2.3.13 In case of an extensive object or a group of closely spaced objects to be lighted that are:

(a) penetrating a horizontal OLS or located outside an OLS, the top lights shall be so arranged as to at least indicate the points or edges of the object highest in relation to the obstacle limitation surface or above the ground, and so as to indicate the general definition and the extent of the objects; and
(b) penetrating a sloping OLS the top lights shall be so arranged as to at least indicate the points or edges of the object highest in relation to the obstacle limitation surface, and so as to indicate the general definition and the extent of the objects. If two or more edges are of the same height, the edge nearest the landing area shall be marked.

6.2.3.14 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 shall be placed on the highest point of the object.

6.2.3.15 Where lights are applied to display the general definition of an extensive object or a group of closely spaced objects, and medium-intensity lights are used, they shall be spaced at longitudinal intervals not exceeding 900 m.

6.2.3.16 High-intensity obstacle lights, Type A, medium-intensity obstacle lights, Types A, located on an object shall flash simultaneously.

6.2.3.17 The installation setting angles for high-intensity obstacle lights, Types A and B, shall be in accordance with Table 6-5.

Note: High intensity obstacle lights are intended for day use as well as night use. Care is needed to ensure that these lights do not create disconcerting dazzle. Guidance on the design, operation and the location of high-intensity obstacle lights is given in the CARC Guidance Material 34-GM-17 Visual Aids for Navigation.

6.2.3.18 Where, in the opinion of the appropriate authority, the use of high-intensity obstacle lights, type A, or medium-intensity obstacle lights, Type A or B, at night may dazzle pilots in the vicinity of an aerodrome (within approximately 10 000 m radius) or cause significant environmental concerns, a dual obstacle lighting system shall be provided. This system shall be composed of high intensity obstacle lights, Type A or B or medium intensity obstacle lights, Type A, as appropriate, for daytime and twilight use and medium-intensity obstacle light, Type B or C, for night-time use.

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

6.2.3.19 Medium -intensity obstacle lights, Type A or B, shall be used where the object is a less extensive one and its height above the surrounding ground is less than 45 m.

6.2.3.20 Where the use of Medium-intensity obstacle lights, Type A or B, would be inadequate or an early special warning is required, then high-intensity obstacle lights shall be used.

6.2.3.21 Medium obstacle lights, Type B, shall be used either alone or in combination with high-intensity obstacle lights, Type B, in accordance with paragraph 6.2.3.22 of this chapter.

6.2.3.22 Medium-intensity obstacle lights, Type A, B or C, shall be used where the object is an extensive one or its height above the level of the surrounding ground is greater than 45 m. Medium-intensity obstacle lights, Types A and C, shall be used alone, whereas medium intensity obstacle lights, Type B, shall be used either alone or in combination with high-intensity obstacle lights, Type B.

Note: A group of buildings is regarded as an extensive object.

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

6.2.3.23 Medium-intensity obstacle lights, Type A, B or C, shall be used. Medium-intensity obstacle lights, Types A and C, shall be used alone, whereas medium intensity obstacle lights, Type B, shall be used either alone or in combination with low-intensity obstacle lights, Type B.

6.2.3.24 Where an object is indicated by medium-intensity obstacle lights, Type A, and the top of the object is more than 105 m above the level of the surrounding ground or the elevation of tops of nearby buildings (when the object to be marked is surrounded by buildings), additional lights shall be provided at intermediate levels. These additional intermediate lights shall be spaced as equally as practicable, between the top lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 105 m.

6.2.3.25 Where an object is indicated by medium-intensity obstacle lights, Type B, and the top of the object is more than 45 m above the level of the surrounding ground or the elevation of tops of nearby buildings (when the object to be marked is surrounded by buildings), additional lights shall be provided at intermediate levels. These additional intermediate lights shall be alternately low-intensity obstacle lights, Type B, and medium-intensity obstacle lights, Type B, and shall be spaced as equally as practicable between the top lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 52 m.

6.2.3.26 Where an object is indicated by medium-intensity obstacle lights, Type C, and the top of the object is more than 45 m above the level of the surrounding ground or the elevation of tops of nearby buildings (when the object to be marked is surrounded by buildings), additional lights shall be provided at intermediate levels. These additional intermediate lights shall be spaced as equally as practicable between the top lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 52 m.

6.2.3.27 Where high-intensity obstacle lights, Type A, are used, they shall be spaced at uniform intervals not exceeding 105 m between the ground level and the top light(s) specified in 6.2.3.10 except that where an object to be marked is surrounded by buildings, the elevation of the tops of the buildings may be used as the equivalent of the ground level when determining the number of light levels.

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

6.2.3.28 High-intensity obstacle lights, Type A, shall be used to indicate the presence of an object if its height above the level of the surrounding ground exceeds 150 m and an aeronautical study indicates such lights to be essential for the recognition of the object by day.

6.2.3.29 Where high-intensity obstacle lights, Type A, are used, they shall be spaced at uniform intervals not exceeding 105 m between the ground level and the top light(s) specified in 6.2.3.10 of this chapter, except that where an object to be marked is surrounded by buildings, the elevation of the tops of the buildings may be used as the equivalent of the ground level when determining the number of light levels.

6.2.3.30 Where, in the opinion of the appropriate authority, the use of high-intensity obstacle lights, Type A, at night may dazzle pilots in the vicinity of an aerodrome (within approximately 10 000 m radius) or cause significant environmental concerns, medium-intensity obstacle lights, Type C, shall be used alone, whereas medium-intensity obstacle lights, Type B, shall be used either alone or in combination with low-intensity obstacle lights, Type B.

6.2.3.31 Where an object is indicated by medium-intensity obstacle lights, Type A, additional lights shall be provided at intermediate levels. These additional intermediate lights shall be spaced as equally as practicable, between the top lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 105 m.

6.2.3.32 Where an object is indicated by medium-intensity obstacle lights, Type B, additional lights shall be provided at intermediate levels. These additional intermediate lights shall be alternately low-intensity obstacle lights, type B, and medium-intensity obstacle lights, type B, and shall be spaced as equally as practicable between the top lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 52 m.

6.2.3.33 Where an object is indicated by medium-intensity obstacle lights, Type C, additional lights shall be provided at intermediate levels. These additional intermediate lights shall be spaced as equally as practicable, between the top lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 52 m.

6.2.4 Wind turbines

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

Note (1): Additional lighting or markings may be provided where in the opinion of the CARC such lighting or markings are deemed necessary.

Note (2): See Chapter 4 Section 4.3.1 and 4.3.2.

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

Lighting
6.2.4.3 When lighting is deemed necessary, in the case of a wind farm, i.e. group of two or more wind turbines the wind farm shall be regarded as an extensive object and the lights shall be installed:

(a) to identify the perimeter of the wind farm;

(b) respecting the maximum spacing, in accordance with 6.2.3.15, between the lights along the perimeter, unless a dedicated assessment shows that a greater spacing can be used;

(c) so that, where flashing lights are used, they flash simultaneously throughout the wind farm;

(d) so that, within a wind farm, any wind turbines of significantly higher elevation are also identified wherever they are located.

(e) at locations prescribed in a), b) and d), respecting the following criteria:

(i) for wind turbines of less than 150 m in overall height (hub height plus vertical blade height), medium intensity lighting on the nacelle shall be provided;

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

(iii) in addition, for wind turbines from 150 m to 315 m in overall height, an intermediate level at half the nacelle height of at least 3 Medium intensity Type B lights, as specified in 6.2.1.3 shall be provided. If an aeronautical study shows that Medium intensity type B lights are not suitable, Medium-intensity type A lights may be used.

Note: The above 6.2.4.3 e) does not address wind turbines of more than 315 m of overall height. For such wind turbines, additional marking and lighting may be required as determined by an aeronautical study.

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

6.2.4.5 Where lighting is deemed necessary for a single wind turbine or short line of wind turbines, the installation shall be in accordance with 6.2.4.3(e) or as determined by an aeronautical study.

6.2.5 Overhead wires, cables, etc. and supporting towers

Marking

6.2.5.1 The wires, cables, etc. to be marked shall be equipped with markers; the supporting tower shall be coloured.

Marking by colours

6.2.5.2 The supporting towers of overhead wires, cables, etc. that require marking shall be marked in accordance with 6.2.3.1 to 6.2.3.4 of this chapter, except that the marking of the supporting towers may be omitted when they are lighted by high-intensity obstacle lights by day.

Marking by markers

6.2.5.3 Markers displayed on or adjacent to objects shall be located in conspicuous positions so as to retain the general definition of the object and shall be recognizable in clear weather from a distance of at least 1 000 m for an object to be viewed from the air and 300 m for an object to be viewed from the ground in all directions in which an aircraft is likely to approach the object. The shape of markers shall be distinctive to the extent necessary to ensure that they are not mistaken for markers employed to convey other information, and they shall be such that the hazard presented by the object they mark is not increased.

6.2.5.4 A marker displayed on an overhead wire, cable, etc. shall be spherical and have a diameter of not less than 60 cm.

6.2.5.5 The spacing between two consecutive markers or between a marker and a supporting tower shall be appropriate to the diameter of the marker, but in no case shall the spacing exceed:

(a) 30 m where the marker diameter is 60 cm progressively increasing with the diameter of the marker to

(b) 35 m where the marker diameter is 80 cm and further progressively increasing to a maximum of

(c) 40 m where the marker diameter is of at least 130 cm.

Where multiple wires, cables, etc. are involved, a marker shall be located not lower than the level of the highest wire at the point marked.

6.2.5.6 A marker shall be of one colour. When installed, white and red, or white and orange markers shall be displayed alternately. The colour selected shall contrast with the background against which it will be seen.

6.2.5.7 When it has been determined that an overhead wire, cable, etc., needs to be marked but it is not practicable to install markers on the wire, cable, etc., then high-intensity obstacle lights, Type B, shall be provided on their supporting towers.

Lighting

6.2.5.8 High intensity obstacle lights, Type B, shall be used to indicate the presence of the tower supporting overhead wires, cables, etc. where:

(a) an aeronautical study indicates such light to be essential for the recognition of the presence of wires, cables, etc.; or

(b) it has not been found practicable to install marker on the wires, cables, etc

6.2.5.9 Where high-intensity obstacle lights, Type B, are used, they shall be located at three levels:

— at the top of the tower;

— at the lowest level of the catenary of the wires or cables; and

— at approximately midway between these two levels.

6.2.5.10 High-intensity obstacle lights, Type B, indicating the presence of a tower supporting overhead wires, cables, etc., shall flash sequentially; first the middle light, second the top light and last, the bottom light. The intervals between flashes of the lights shall be approximate the following ratios:

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

Note: High-intensity obstacle lights are intended for day use as well as night use. Care is needed to ensure that these lights do not create disconcerting dazzle. Guidance on the design, location and operation of high-intensity obstacle lights is given in CARC Guidance Material 34-GM-17 Visual Aids for Navigation.

6.2.5.11 Where, in the opinion of the appropriate authority, the use of high-intensity obstacle lights, Type B, at night may dazzle pilots in the vicinity of an aerodrome (within approximately 10 000 m radius) or cause significant environmental concerns, a dual obstacle lighting system shall be provided. This system shall be composed of high-intensity obstacle lights, Type B, for daytime and twilight use and medium-intensity obstacle lights, Type B, for night-time use. Where medium-intensity lights are used they shall be installed at the same level as the high-intensity obstacle light Type B.

6.2.5.12 The installation setting angles for high-intensity obstacle lights, Type B, shall be in accordance with Table 6-5.

Table 6-5. Installation setting angles for high intensity obstacle lights

Height of light unit above terrain (AGL)		Angle of the peak of the beam above the
Greater than	Not exceeding	horizontal
151 m		0°
122 m	151 m	1°
92 m	122 m	2°
	92	3°

6.2.6 Light failure notification

6.2.6.1 As conspicuity is achieved only when all required lights are working. Partial equipment outages decrease the margin of safety. Any outage shall be corrected as soon as possible. Failure of a fixed light (a steady burning light) or intermediate light within a 15 000 m radius of the airport shall be corrected as soon as possible, but notification is not required.

6.2.6.2 Any failure or malfunction within a 15 000 m radius of the airport that lasts more than thirty (30) minutes and affects a top light or flashing obstruction light, regardless of its position, shall be reported immediately to CARC so a Notice to Airmen (NOTAM) can be issued. This report shall contain the following information:

(a) Name of persons or organizations reporting light failures including any title, address, and telephone number.

(b) The type of structure.

(c) Location of structure (including latitude and longitude, if known, prominent structures, landmarks, etc.).
(d) Height of structure above ground level (AGL)/above mean sea level (AMSL), if known.
(e) A return to service date.

When the primary lamp in a double obstruction light fails, and the secondary lamp comes on, no report is required. However, when one of the lamps in an incandescent medium intensity Type B flashing red beacon fails, it shall be reported.
After 15 days, the NOTAM is automatically deleted from the system. The sponsor is requested to call CARC to extend the outage date. In addition, the sponsor is required to report a return to service date.

6.2.6.3 As soon as normal operation is restored, the sponsor is to notify CARC. Noncompliance with notification procedures could subject its sponsor to penalties as pursued by national laws.

6.2.7 Obstruction Lights During Construction

As the height of the structure exceeds each level at which permanent obstruction lights would be recommended, two or more lights of the type specified in the determination shall be installed at that level. Temporary high or medium intensity flashing white lights, as recommended in the determination, shall be operated 24 hours a day until all permanent lights are in operation. In either case, two or more lights shall be installed on the uppermost part of the structure any time it exceeds the height of the temporary construction equipment. They may be turned off for periods when they would interfere with construction personnel. Permanent obstruction lights shall be installed and operated at each level as construction progresses. The lights shall be positioned to ensure that a pilot has an unobstructed view of at least one light at each level.

6.2.8 Obstruction Lights in Urban Areas

When a structure is located in an urban area where there are numerous other white lights (e.g., streetlights, etc.) red obstruction lights with painting or a medium intensity dual system (which is illustrated in Figure 6-16 of this chapter) is recommended.

6.2.9 Temporary Construction Equipment Lighting

Since there is such a variance in construction cranes, derricks, oil and other drilling rigs, each case shall be considered individually. Lights shall be installed according to the standards given in this chapter, as they would apply to permanent structures.

6.2.10 Inspection, repair, and maintenance

To ensure the proper candela output for fixtures with incandescent lamps, the voltage provided to the lamp filament shall not vary more than plus or minus 3 percent of the rated voltage of the lamp. The input voltage shall be measured at the lamp socket with the lamp operating during the hours of normal operation. (For strobes, the input voltage of the power supplies shall be within 10 percent of rated voltage.) Lamps shall be replaced after being operated for not more than 75 percent of their rated life or immediately upon failure. Flashtubes in a light unit shall be replaced immediately upon failure, when the peak effective intensity falls below specification limits or when the fixture begins skipping flashes, or at the manufacturer's recommended intervals. Due to the effects of harsh environments, beacon lenses shall be visually inspected for ultraviolet damage, cracks, crazing, dirt build up, etc., to insure that the certified light output has not deteriorated.

6.2.11 Nonstandard lights

Moored balloons, chimneys, minarets, church steeples, and similar obstructions may be floodlighted by fixed search light projectors installed at three or more equidistant points around the base of each obstruction. The searchlight projectors shall provide an average illumination of at least 161.5 Lux over the top one-third of the obstruction.

6.2.12 Distraction

6.2.12.1 Where obstruction lights may distract operators of vessels in the proximity of a navigable water body, the sponsor must coordinate with the concerned official authorities to avoid interference with marine navigation.

6.2.12.2 Where lighting systems are installed on structures located near highways, water bodies, airport approach areas, etc., caution shall be exercised to ensure that the lights do not distract or otherwise cause a hazard to motorists, vessel operators, or pilots on an approach to an airport. In these cases, shielding may be necessary. This shielding shall not derogate the intended purpose of the lighting system.

6.2.13 Cylos and hyperbolic cooling towers

6.2.13.1 Light units shall be installed in a manner to ensure an unobstructed view of at least two lights by a pilot approaching from any direction.
number of Light Units. The number of units depends on the diameter of the structure at the top. The number of lights recommended in the following table are the minimum. When the structure diameter is:

(a) 6m or Less. Three light units per level.
(b) Exceeding 6m. But Not More Than 30m. Four light units per level.

(c) Exceeding 30m. But Not More Than 60m. Six light units per level.
(d) Exceeding 60m. Eight light units per level.

6.2.13.2 Structures Exceeding 150m AGL. Structures exceeding 150m AGL shall have a second level of light units installed approximately at the midpoint of the structure and in a vertical line with the top level of lights.

6.2.14 Marking and lighting moored balloons and kites

6.2.14.1 The purpose of marking and lighting moored balloons, kites, and their cables or mooring lines is to indicate the presence and general definition of these objects to pilots when converging from any normal angle of approach.

6.2.14.2 These marking and lighting standards pertain to all moored balloons and kites that require marking and lighting under JCAR Part 101.

6.2.14.3 Flag markers shall be used on mooring lines to warn pilots of their presence during daylight hours as follows:
(a) Markers shall be displayed at no more than 15m intervals and shall be visible for at least 2km.
(b) Markers shall be rectangular in shape and not less than 0.6m on a side. Stiffeners shall be used in the borders so as to expose a large area, prevent drooping in calm wind, or wrapping around the cable.
(c) One of the following color patterns shall be used:
  (1) Solid Color. Aviation orange or red.
  (2) Aviation Orange or red and White**.** Two triangular sections, one of aviation orange or red and the other white, combined to form a rectangle.

6.2.14.4 Flashing obstruction lights shall be used on moored balloons or kites and their mooring lines to warn pilots of their presence during the hours between sunset and sunrise and during periods of reduced visibility. These lights may be operated 24 hours a day as follows:
(a) Flashing red or white beacons may be used to light moored balloons or kites. High intensity lights are not recommended.
(b) Flashing lights shall be displayed on the top, nose section, tail section, and on the tether cable approximately 4.5m below the craft so as to define the extremes of size and shape. Additional lights shall be equally spaced along the cable's overall length for each 105 m or fraction thereof.
(c) When the requirements of this paragraph cannot be met, floodlighting may be used.

6.2.14.5 The light intensity shall be controlled by a device that changes the intensity when the ambient light changes. The system shall automatically turn the lights on and change intensities as ambient light condition change. The reverse order shall apply in changing from nighttime to daytime operation. The lights shall flash simultaneously.

6.2.15 Illustrative figures

6.2.15.1 Figures 6-6 to 6-12 contain additional illustrative figures for obstruction lighting and marking.

6.2.15.2 Figures 6-13 to 6-20 contain illustrations for the location of lights on obstacles.

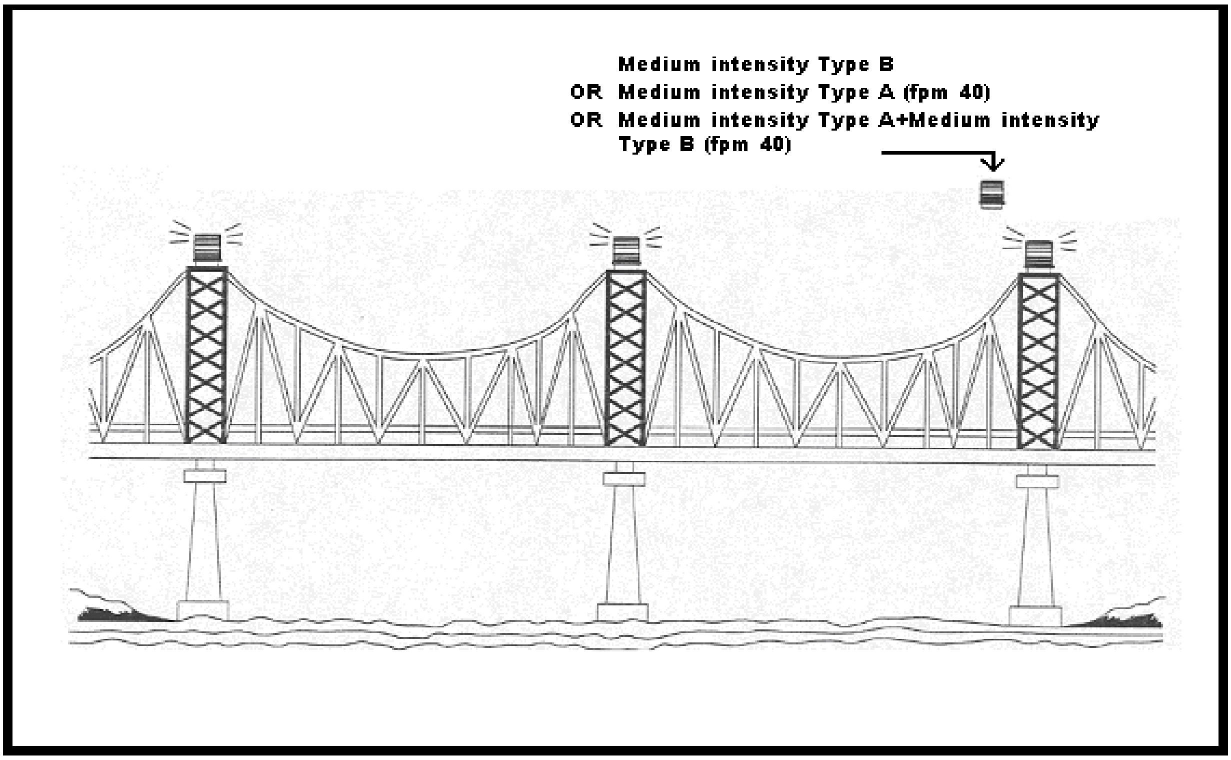


Figure 6-6. Bridge lighting

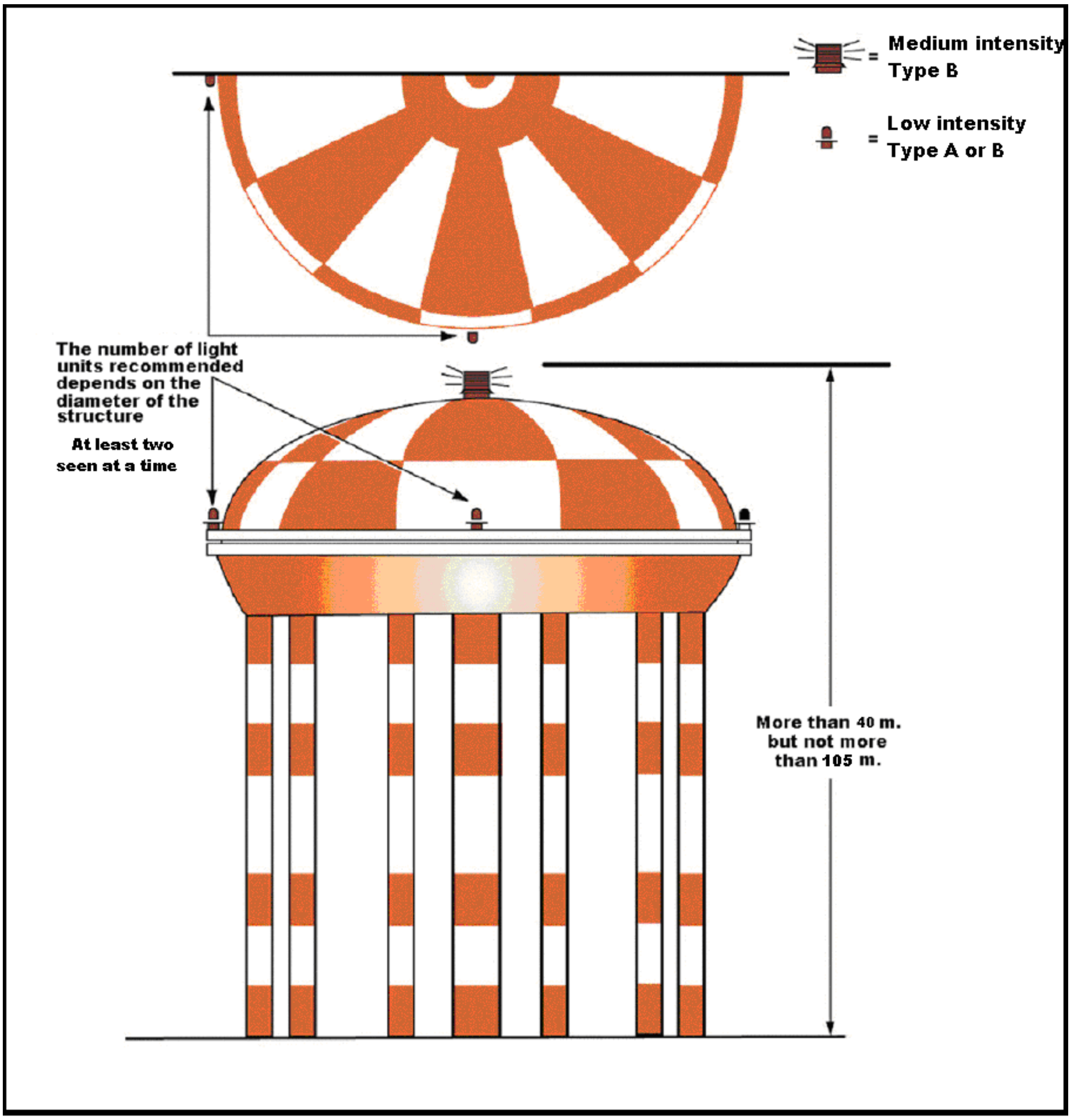


Figure 6-7. Painting and lighting of water towers and similar structures

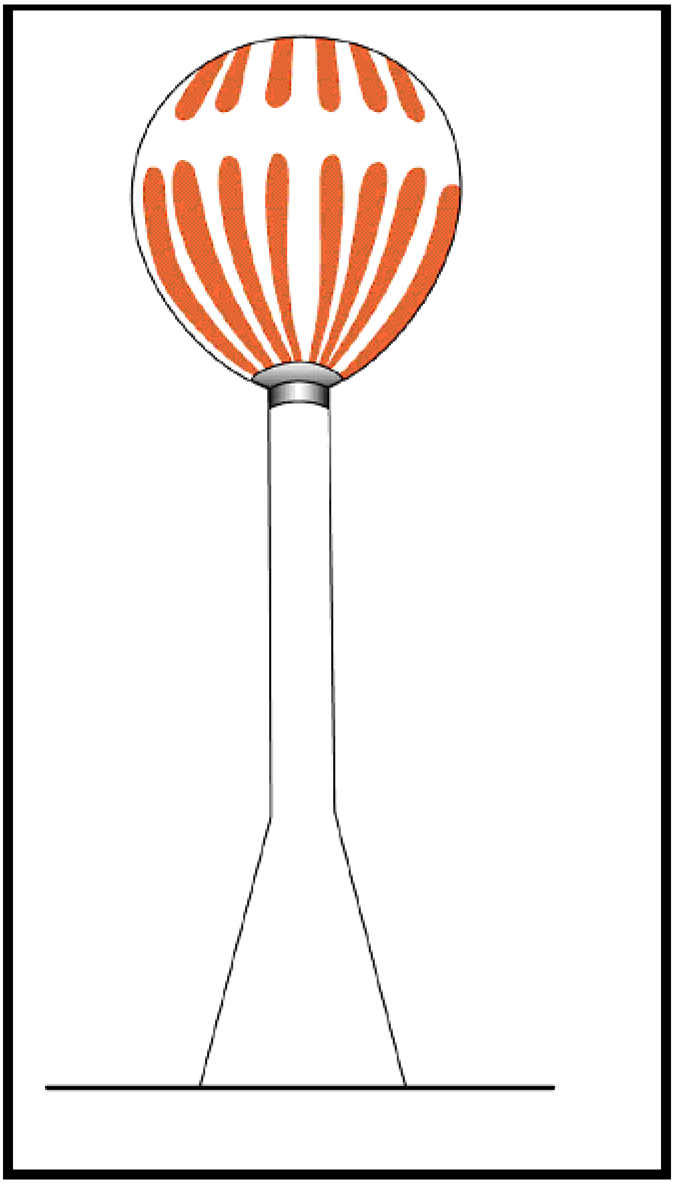


Figure 6-8. Painting of single pedestal water tower by teardrop pattern

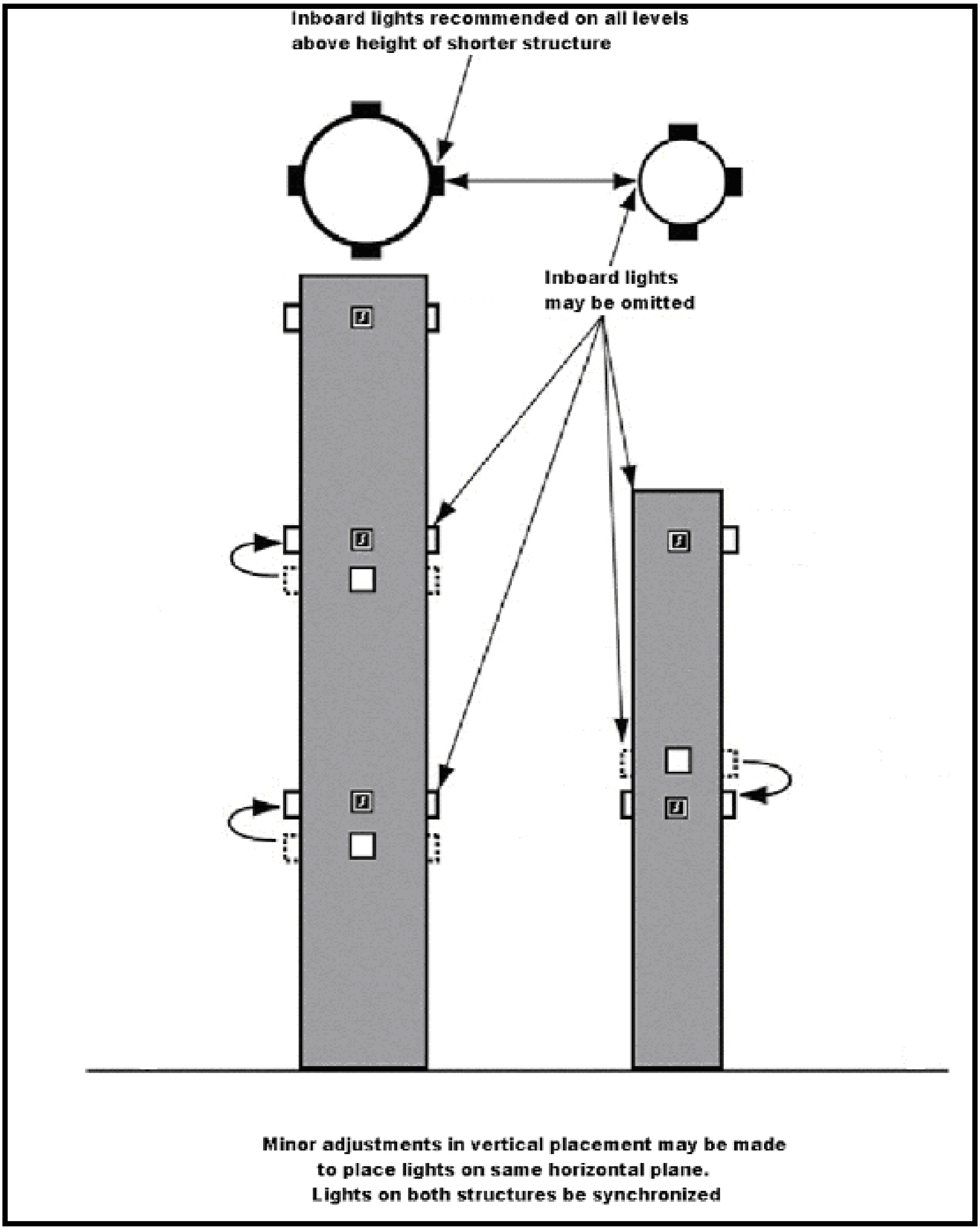


Figure 6-9. Lighting adjacent structures

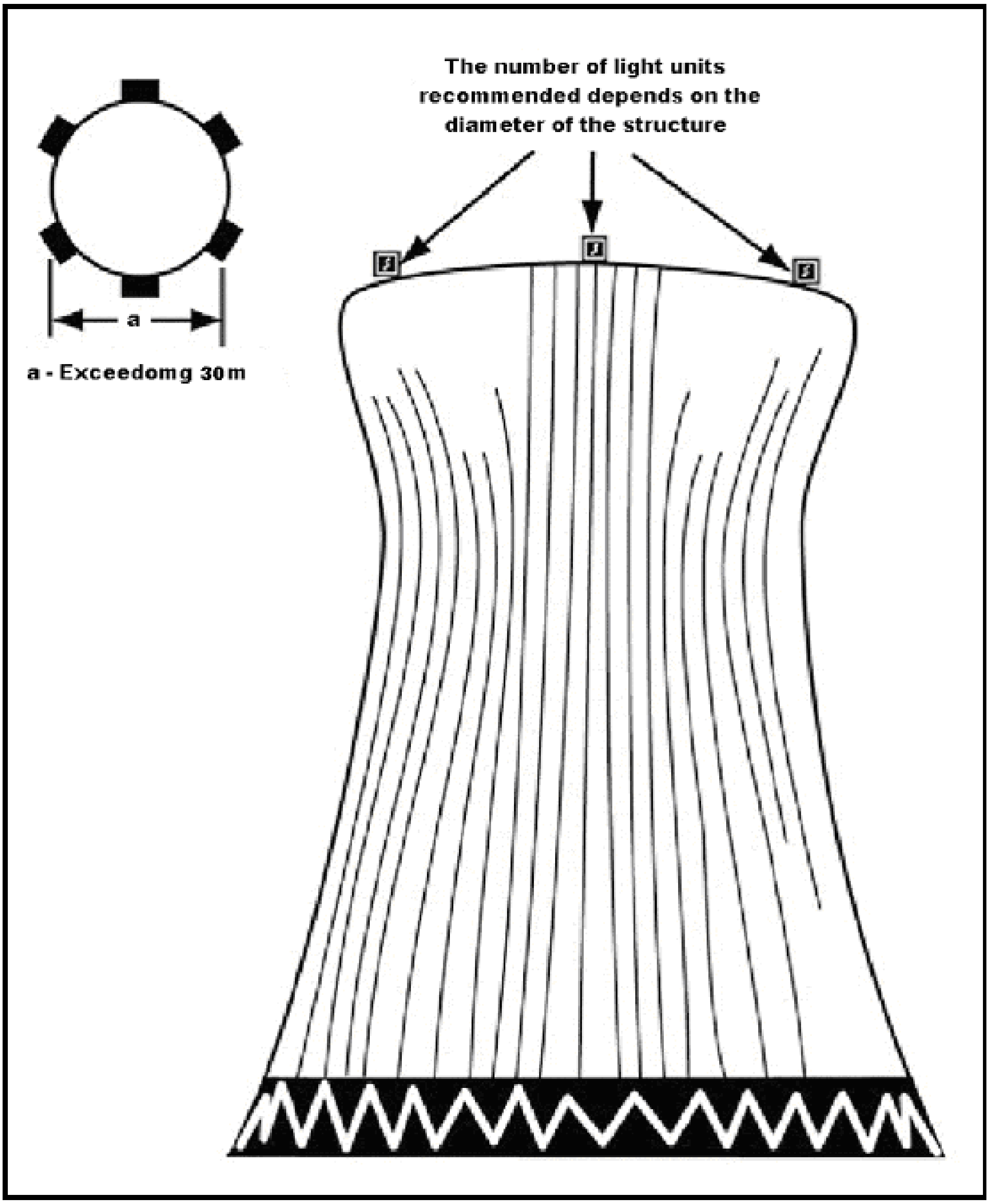


Figure 6-10. Cylos and hyperbolic cooling tower

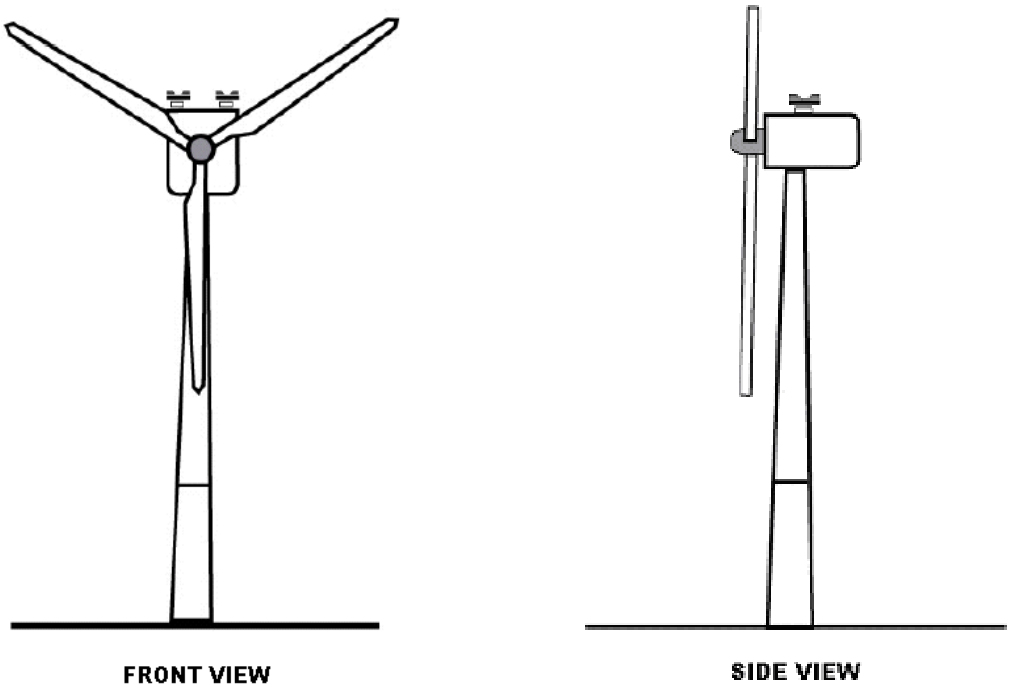


Figure 6-11. Typical lighting of a stand-alone wind turbine

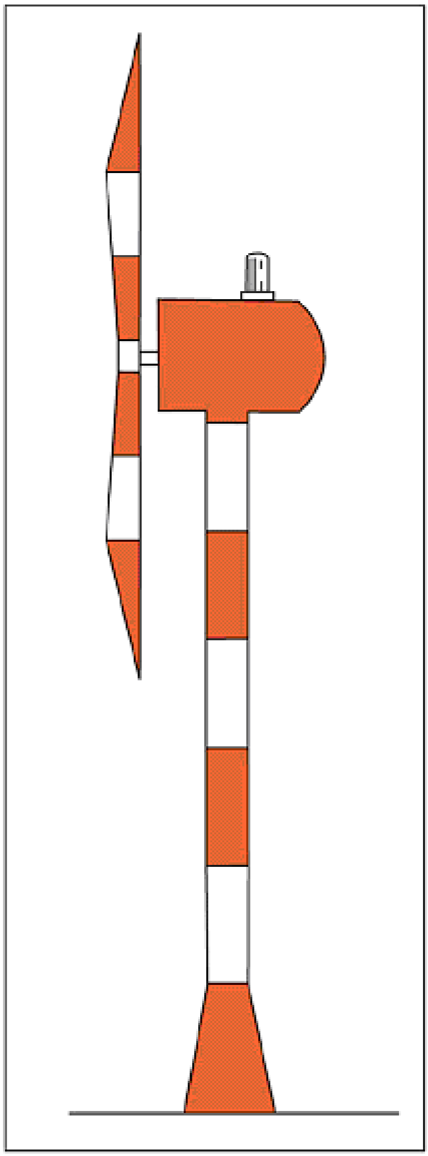
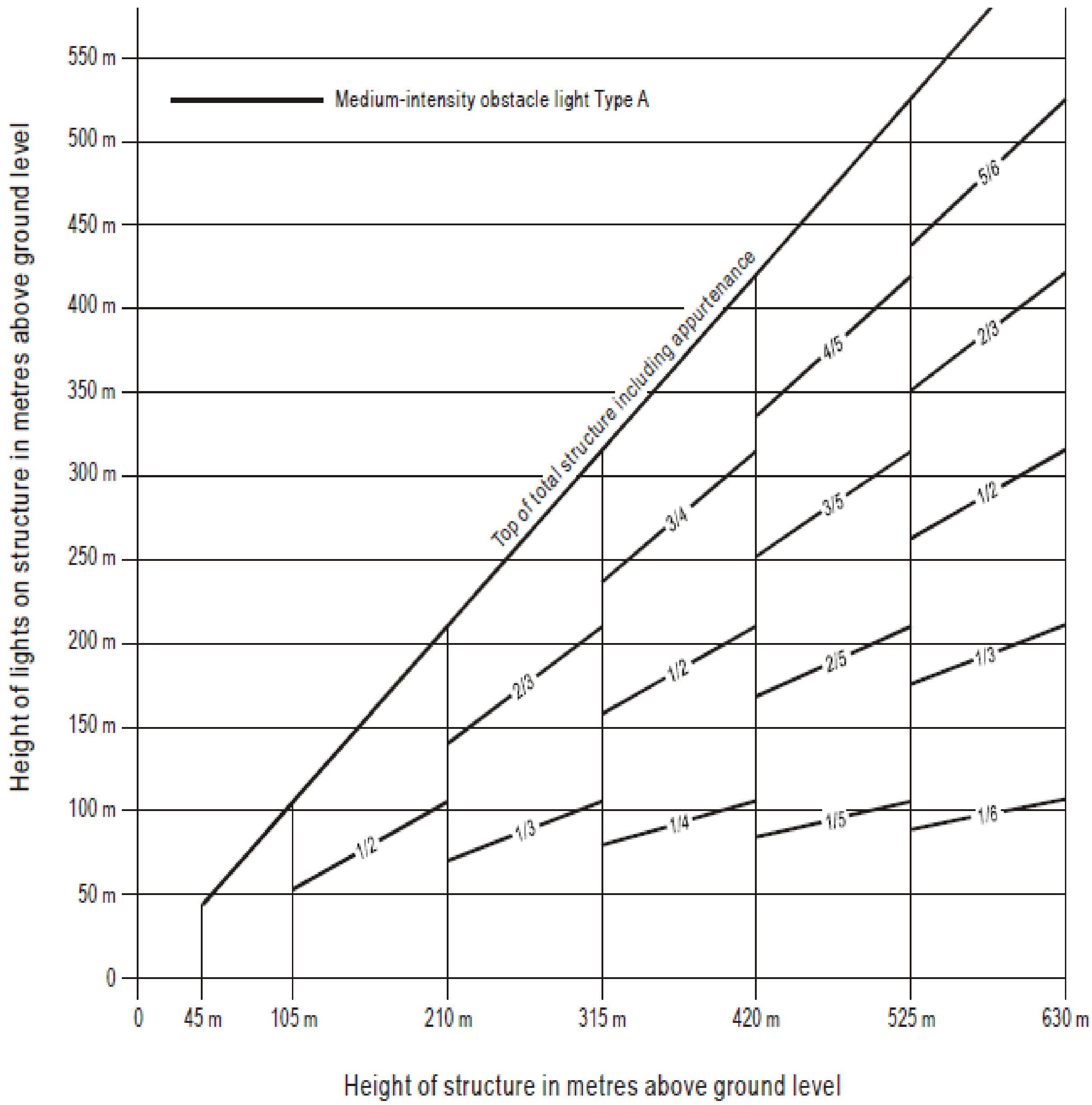


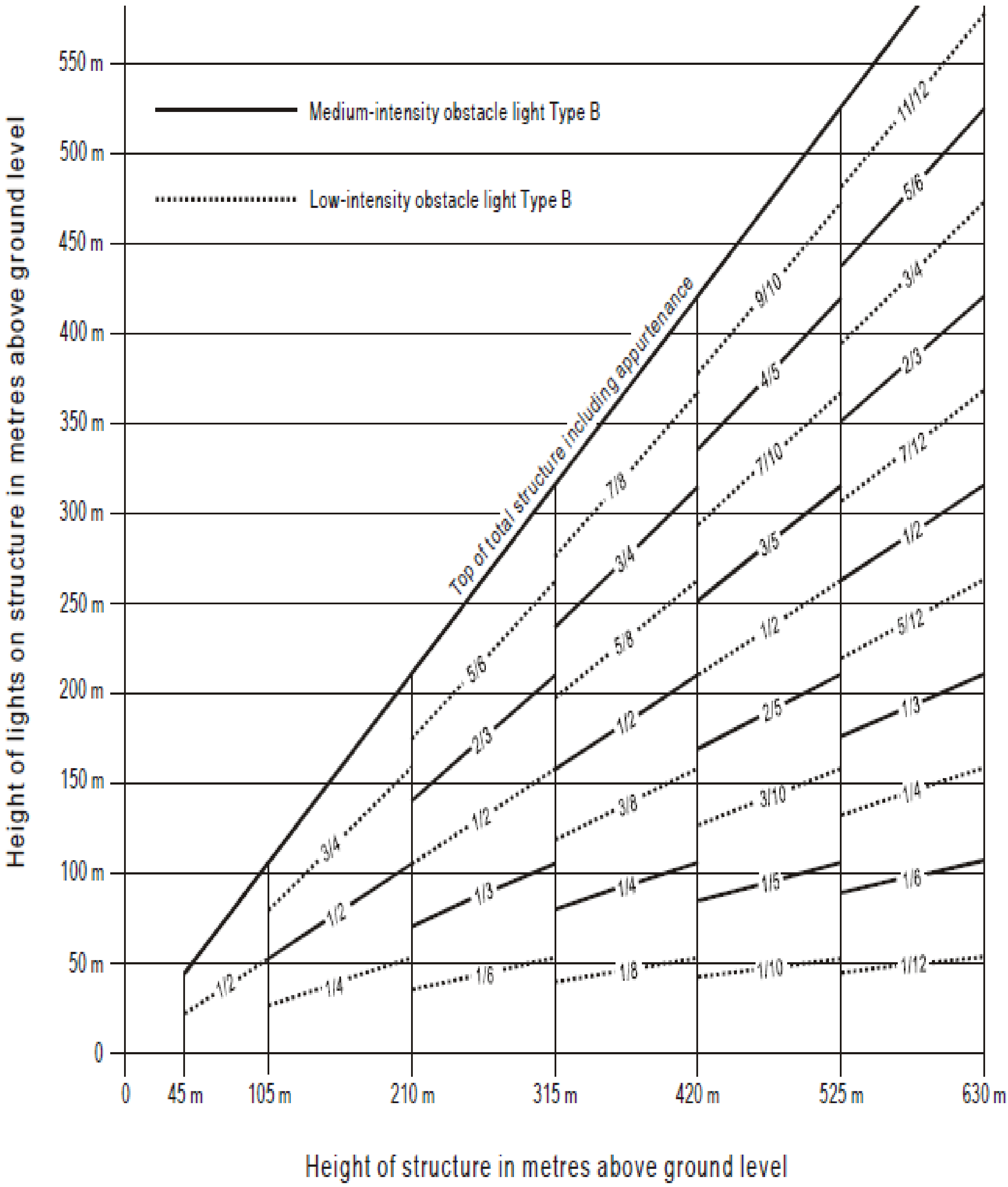
Figure 6-12. Typical lighting and marking of a stand-alone wind turbine



Location of Lights on Obstacles

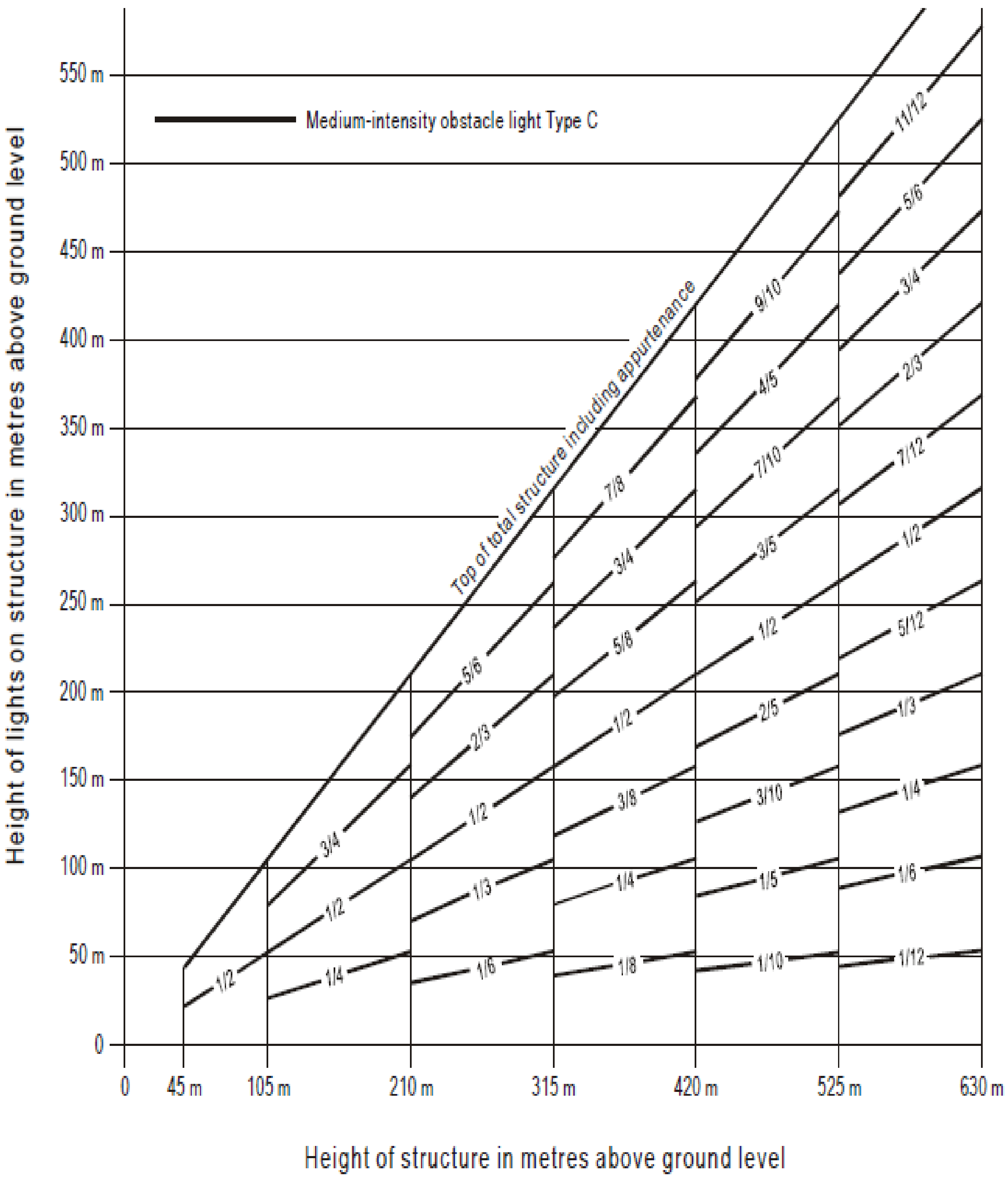
Note: High-intensity obstacle lighting is recommended on structures with a height of more than 150 m above ground level. If medium-intensity lighting is used, marking will also be required.

Figure 6-13. Medium-intensity flashing-white obstacle lighting system, Type A



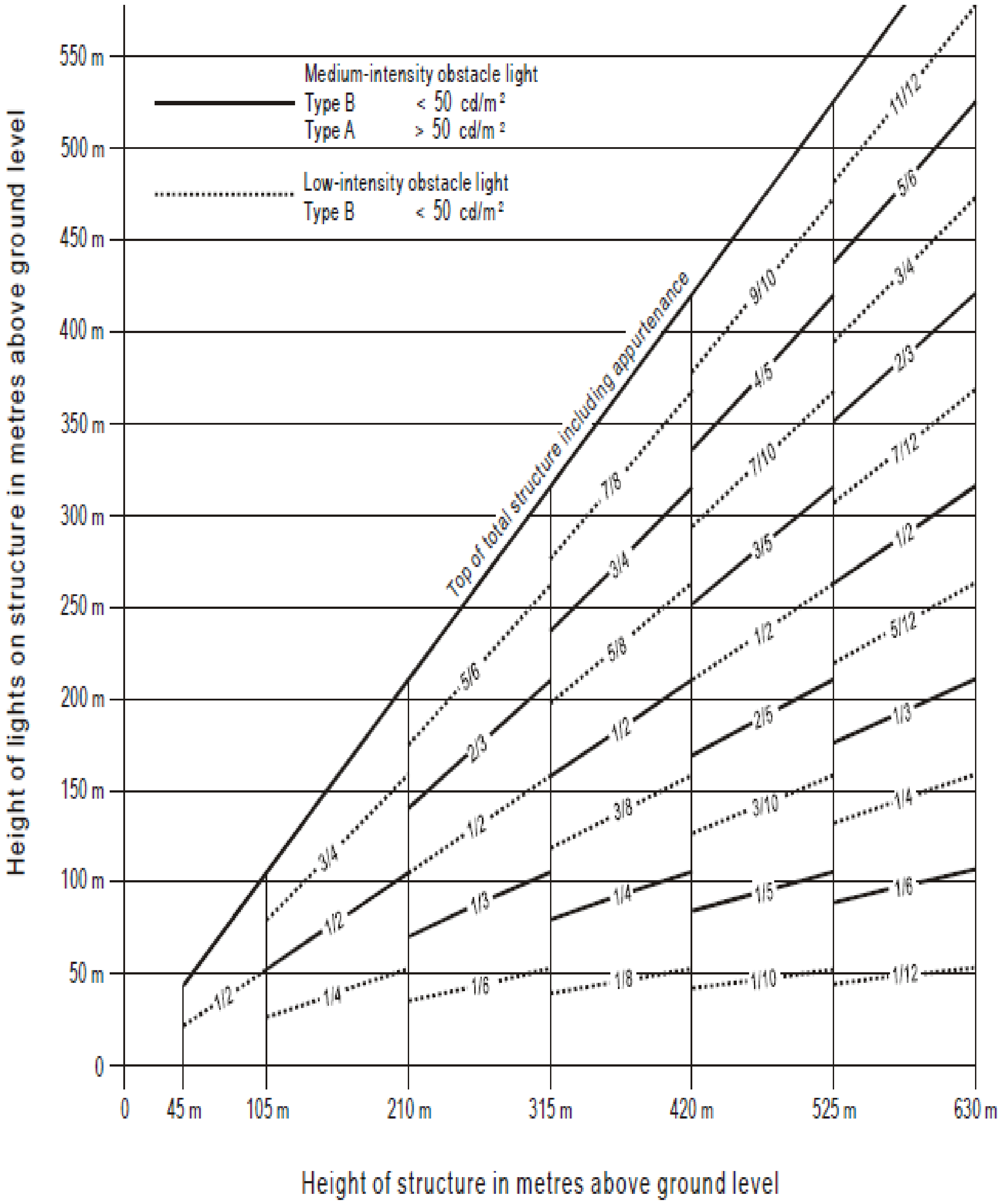
Note: For night-time use only

Figure 6-14. Medium-intensity flashing-red obstacle lighting system, Type B



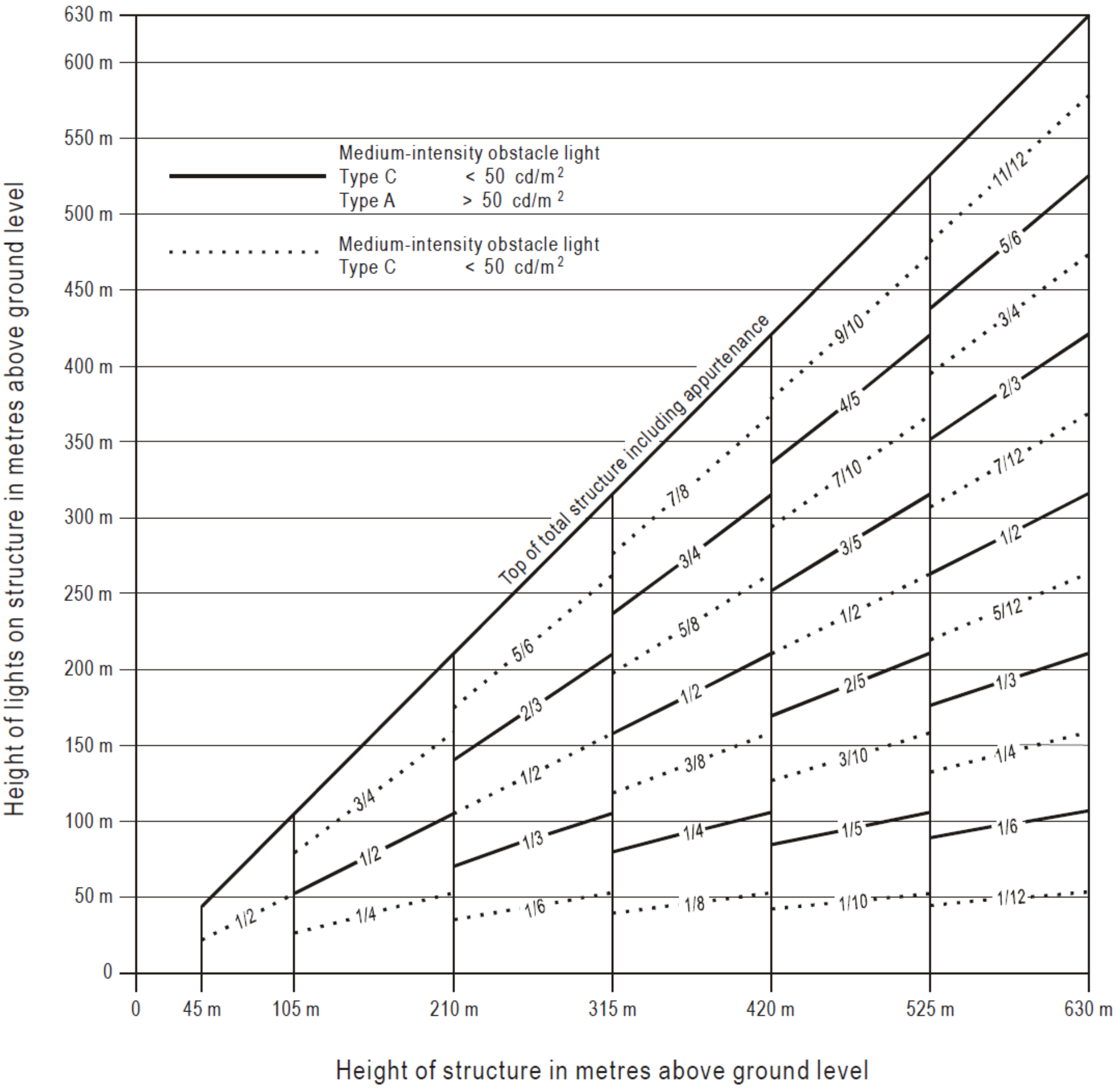
Note: For night-time use only.

Figure 6-15. Medium-intensity fixed-red obstacle lighting system, Type C



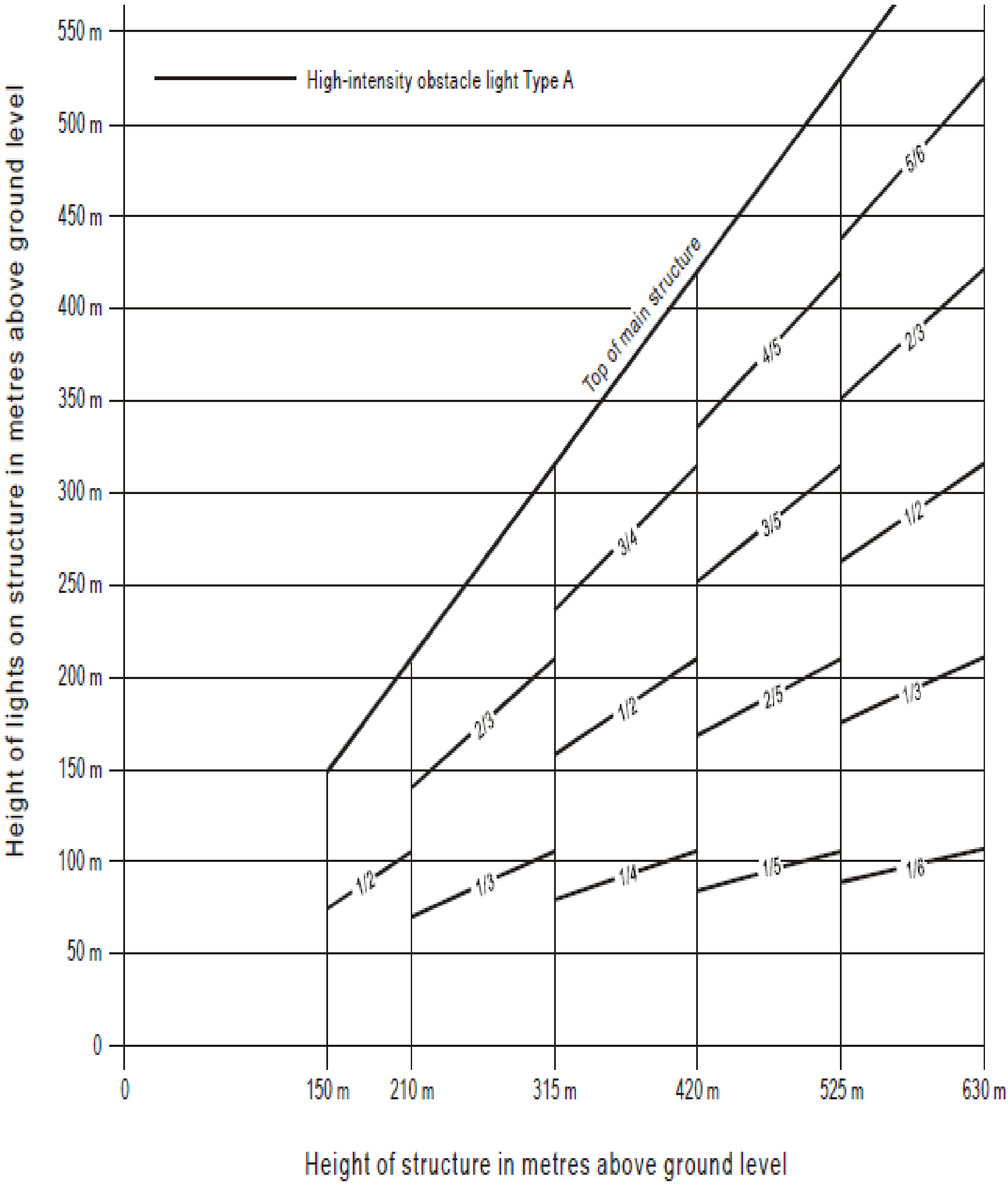
Note: High-intensity obstacle lighting is recommended on structures with a height of more than 150 m above ground level. If medium-intensity lighting is used, marking will also be required.

Figure 6-16. Medium-intensity dual obstacle lighting system, Type A/Type B



Note: High-intensity obstacle lighting is recommended on structures with a height of more than 150 m above ground level. If medium-intensity lighting is used, marking will also be required.

Figure 6-17. Medium-intensity dual obstacle lighting system, Type A/Type C



Note: High-intensity obstacle lighting is recommended on structures with a height of more than 150 m above ground level. If medium-intensity lighting is used, marking will also be required.

Figure 6-18. High-intensity flashing-white obstacle lighting system, Type A

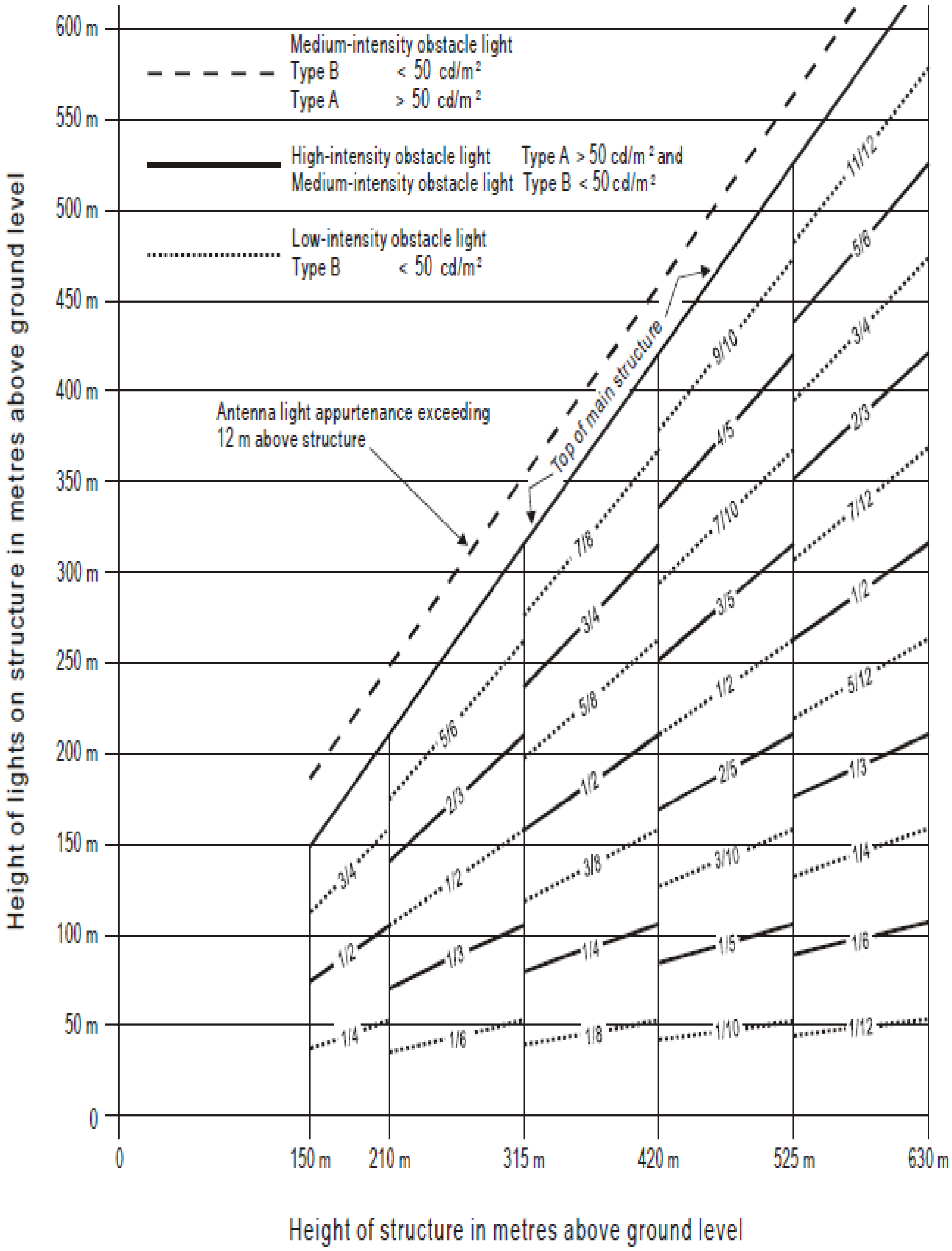


Figure 6-19. High-/medium-intensity dual obstacle lighting system, Type A/Type B

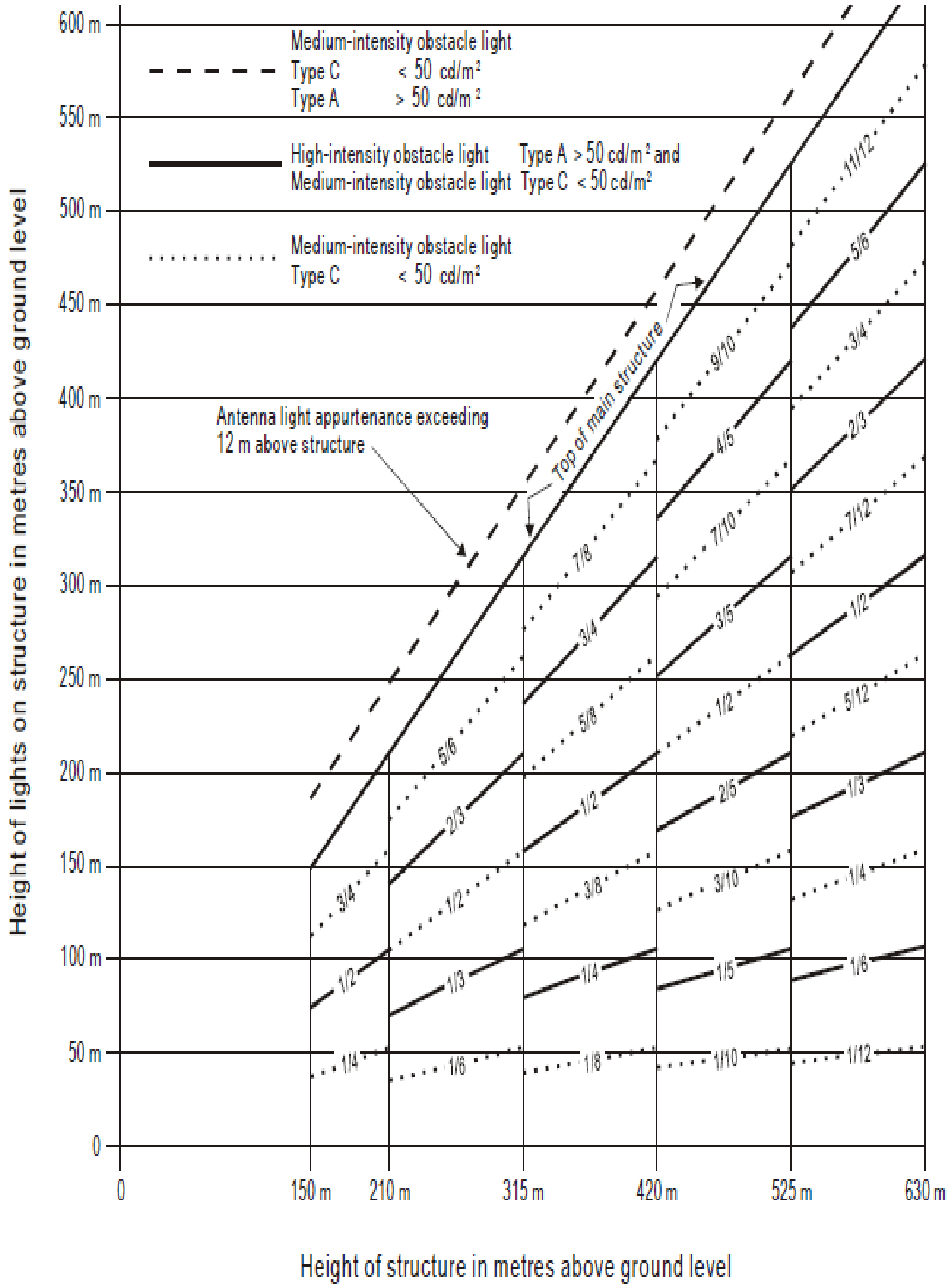


Figure 6-20. High-/medium-intensity dual obstacle lighting system, Type A/Type C

Chapter (7)
Visual Aids for Denoting Restricted Use and Unserviceable Areas

7.1 Closed Runways and Taxiways, or Parts Thereof

7.1.1 General

7.1.1.1 When a runway or taxiway or portion thereof is permanently closed, all normal runway and taxiway markings shall be obliterated.

7.1.1.2 Lighting systems provided for a closed runway or taxiway or portion thereof shall not be operated, except as required for maintenance purposes.

Note: Lighting systems provided for a runway include both approach and runway lighting systems.

7.1.1.3 In addition to closed markings, as specified in 7.1.2 and 7.1.3, when a closed runway or taxiway or portion thereof closed is intercepted by a usable runway or taxiway which can be used at night, unserviceability lights shall be placed across the entrance to the closed area at intervals not exceeding 3 m (see 7.4.2)

7.1.2 Closed runway marking

Application
7.1.2.1 A closed runway marking shall be displayed on a runway, or portion thereof, which is permanently closed to the use of all aircraft.

7.1.2.2 A closed runway marking shall be displayed on a temporarily closed runway or portion thereof, except that such marking may be omitted when the closing is of short duration and adequate warning by air traffic services is provided.

Location
7.1.2.3 A closed runway marking shall be placed at each extremity of the runway, or portion thereof, declared closed, and additional markings shall be so placed that the maximum interval between markings does not exceed 300 m.

Characteristics
7.1.2.4 The closed runway marking shall be white and of the form and proportions as detailed in Figure 7-1, Illustration (a).

Note (1): When an area is temporarily closed, frangible barriers or markings utilizing materials other than paint or other suitable means may be used to identify the closed area.

Note (2): Procedures pertaining to the planning, coordination, monitoring and safety management of works in progress on the movement area are specified in CARC Guidance Material 34-GM-16 PANS-Aerodromes.

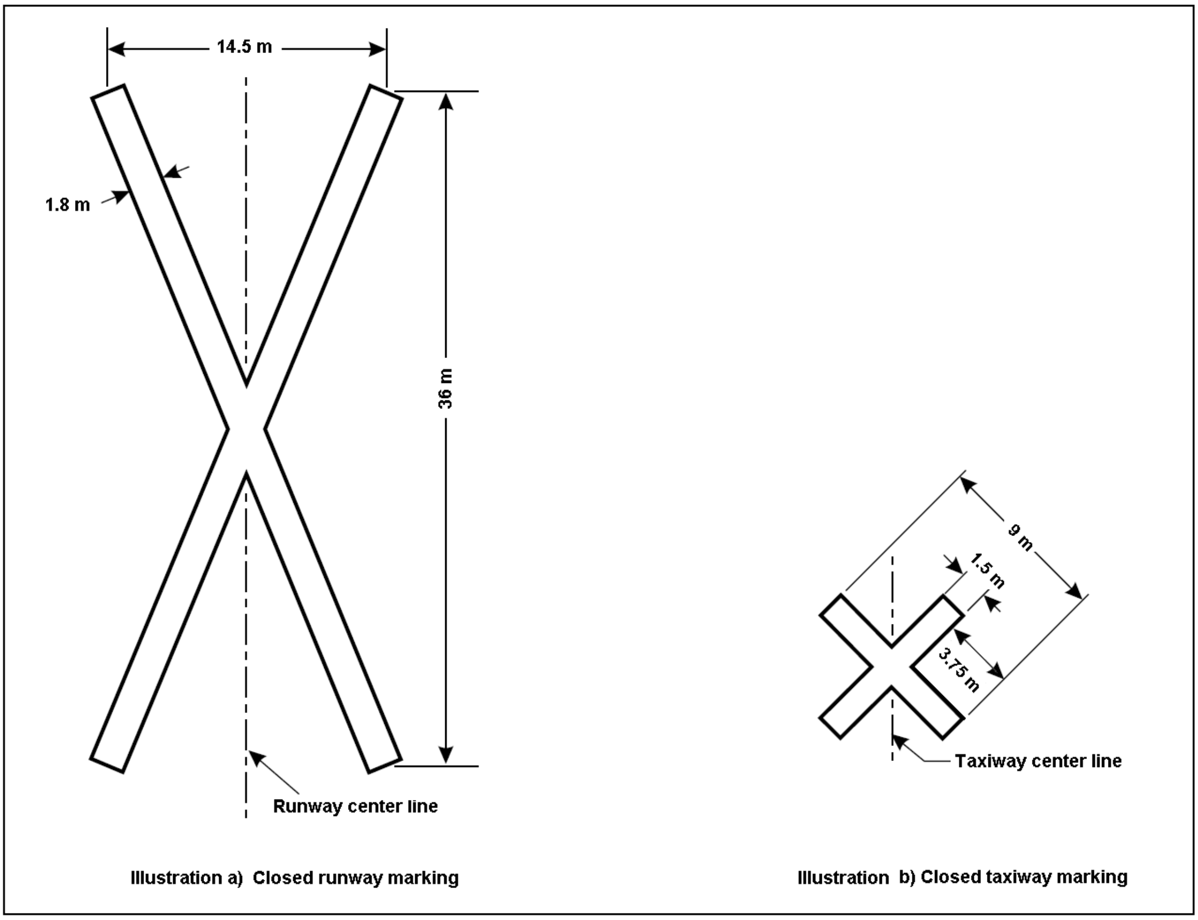


Figure 7-1. Closed runway and taxiway markings

7.1.3 Closed taxiway marking

Application

7.1.3.1 A closed taxiway marking shall be displayed on a taxiway or portion thereof which is permanently closed to the use of all aircraft.

7.1.3.2 A closed taxiway marking shall be displayed on a temporarily closed taxiway or portion thereof, except that such marking may be omitted when the closing is of short duration and adequate warning by air traffic services is provided.

Location
7.1.3.3 A closed taxiway marking shall be placed at least at each extremity of the taxiway or portion thereof closed.

Characteristics
7.1.3.4 The closed taxiway marking shall be yellow and of the form and proportions as detailed in Figure 7-1, Illustration (b).

Note (1) When an area is temporarily closed, frangible barriers or markings utilizing materials other than paint or other suitable means may be used to identify the closed area.

Note (2) Procedures pertaining to the planning, coordination, monitoring and safety management of works in progress on the movement area are specified in the CARC Guidance Material 34-GM-16 PANS-Aerodromes.

7.1.4 Closed runway lighting

Application
7.1.4.1 Where operationally desirable, at an aerodrome provided with runway lighting, closed runway lighting should be provided on runway (s) that are temporarily closed or temporarily restricted for take-off.

Note (1) The purpose of the closed runway lighting is to reduce the likelihood of unintended landings during periods of poor visibility or at night whenever the runway lighting must be switched on for electrical maintenance.

Note (2) In dusk or poor visibility conditions by day, lighting can be more effective than markings.

Note (3) The closed runway lighting is intended to be controlled either automatically or manually by air traffic services or by the aerodrome operator.

Location
7.1.4.2 A closed runway lighting shall be placed on the centre line near each extremity of the runway temporarily declared closed.

Note: Placement of a closed runway lighting would enhance the situational awareness of the runway closure to the pilot.

Characteristics
7.1.4.3 The closed runway lighting as viewed by the pilot shall be of the equivalent elevated form and proportions as detailed in Figure 7-2, showing a minimum of five

lights uniformly spaced on each branch, with a minimum interval as specified by Table 7-1.

Table 7-1. Minimum interval between closed runway lights centres

Number of lights per branch	Minimum interval between lights centres
5	1.5 m
7	1.0 m
9	0.8 m

Note (1) The closed runway lighting may be either fixed or mobile.

Note (2) The fixed closed runway lighting may be formed as if shadowed (i.e. stretched) from the equivalent elevated structure (see Appendix 3, Note 3). Guidance on the sizing of a fixed closed runway lighting is given in the CARC Guidance Material 34-GM-17 Visual Aids for Navigation.

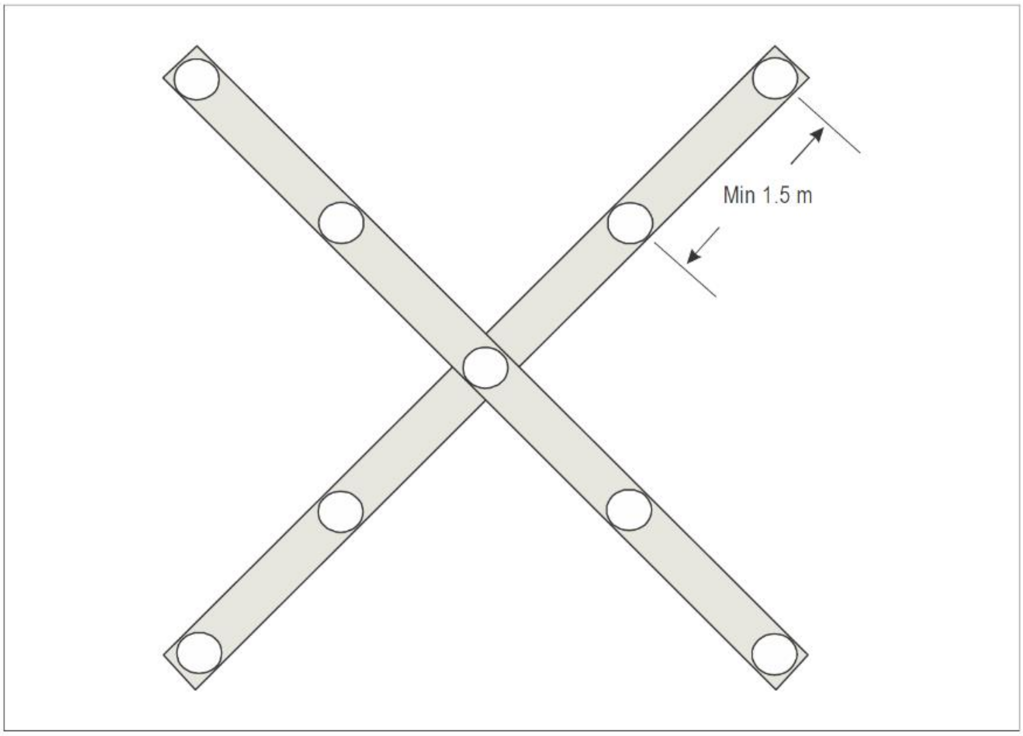


Figure 7-2. Example of equivalent elevated closed runway lighting with five lights per branch

7.1.4.4 Closed runway lights shall show flashing variable white in the direction of approach to the runway, at a rate of one second on and one second off.

7.1.4.5 Closed runway lights shall automatically revert to fixed lights in the event of the flashing system failure.

7.1.4.6 Closed runway lights shall be in accordance with the specifications in Appendix 2, Figure A2-27.

7.2 Non-Load-Bearing Surfaces

Application

7.2.1 Shoulders for taxiways, runway turn pads, holding bays and aprons and other non-load bearing surfaces which cannot readily be distinguished from load-bearing surfaces and which, if used by aircraft, might result in damage to the aircraft shall have the boundary between such areas and the load-bearing surface marked by a taxi side stripe marking.

Note: The marking of runway sides is specified in Chapter 5 section 5.2.7.

Location

7.2.2 A taxi side stripe marking shall be placed along the edge of the load-bearing pavement, with the outer edge of the marking approximately on the edge of the load-bearing pavement.

Characteristics

7.2.3 A taxi side stripe marking shall consist of a pair of solid lines, each 15 cm wide and spaced 15 cm apart and the same color as the taxiway center line marking.

Note: Guidance on providing additional transverse stripes at an intersection or a small area on the apron is given in CARC Guidance Material 34-GM-17 Visual Aids for Navigation.

7.3 Pre-Threshold Area

Application

7.3.1 When the surface before a threshold is paved and exceeds 60 m in length and is not suitable for normal use by aircraft, the entire length before the threshold shall be marked with a chevron marking.

Location

7.3.2 A chevron marking shall point in the direction of the runway and be placed as shown in Figure 7-2.

Characteristics

7.3.3 A chevron marking shall be of conspicuous color and contrast with the color used for the runway markings; it shall be yellow and have an overall width of at least 0.9 m.

7.4 Unserviceable Areas

7.4.1 Unserviceability markings

Application

7.4.1.1 Where operationally required, unserviceability signs shall be supplemented by unserviceability markings on the surface of the pavement.

7.4.1.2 Where it is impracticable to install an unserviceability sign in accordance with 7.4.3.1, an
unserviceability marking shall be provided on the surface of the pavement.

Location

7.4.1.3 Unserviceability markings shall be displayed across the surface of the taxiway or apron where necessary and positioned so as to be legible from the cockpit of an approaching aircraft.

Characteristics

7.4.1.4 Unserviceability markings shall consist of an inscription in black upon an orange background.

7.4.1.5 The inscriptions shall be in the form and proportions shown in Appendix 3.

7.4.1.6 The background shall be rectangular and extend a minimum of 0.5 m laterally and vertically beyond the extremities of the inscription.

7.4.2 Unserviceability lights

Application

7.4.2.1 Unserviceability lights shall be provided on a movement area used at night, wherever any portion of the movement area is unfit for the movement of aircraft but it is still possible for aircraft to bypass the area safely.

Note (1): Unserviceability lights are used for such purposes as warning pilots of a hole in a taxiway or apron pavement or outlining a portion of pavement, such as on an apron, that is under repair. They are not suitable for use when a portion of a runway becomes unserviceable, nor on a taxiway when a major portion of the width becomes unserviceable. In such instances, the runway or taxiway is normally closed.

Note (2): Procedures pertaining to the planning, coordination, monitoring and safety management of works in progress on the movement area are specified in CARC Guidance Material 34-GM-16 PANS-Aerodromes.

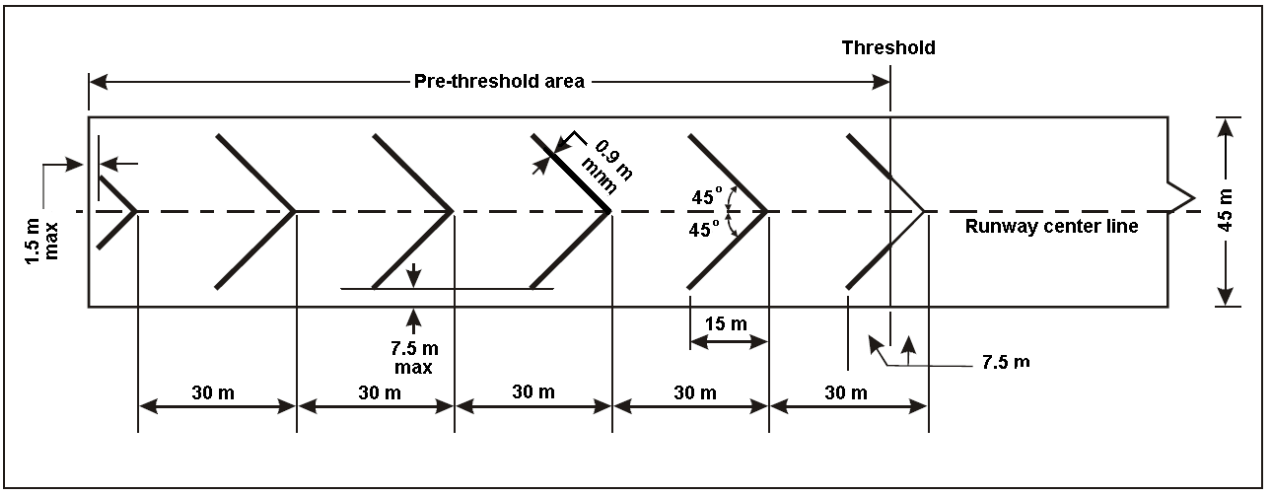


Figure 7-2. Pre- threshold marking

Location

7.4.2.2 Unserviceability lights shall be placed at intervals sufficiently close so as to delineate the unserviceable area.

Note: Guidance on the location of unserviceability lights is given in CARC Guidance Material to Part 14 No. 34 GM-01.

7.4.2.3 An unserviceability light shall consist of a red fixed light. The light shall have an intensity sufficient to ensure conspicuity considering the intensity of the adjacent lights and the general level of illumination against which it would normally be viewed. In no case shall the intensity be less than 10 cd of red light.

7.4.3 Unserviceability signs

Note (1): Temporary changes to the movement area may include, inter alia, reduction in the runway length, reduction in the maximum allowable wingspan, taxiway closure or any other closure to the movement area. Unserviceability signs provide relevant information to aerodrome users to maintain an acceptable level of safety during aircraft and vehicle operations, by reducing the risk of confusion and enhancing the awareness of such temporary changes.

Note (2): Unserviceability signs can be used to indicate temporary closed or restricted areas, as well as to provide information on operational restrictions to aerodrome users.

Application

7.4.3.1 Unserviceability signs shall be provided where there is an operational need to indicate temporary changes to runway declared distances.

7.4.3.2 Unserviceability signs shall be provided where there is an operational need to indicate temporary changes to taxiways and aprons.

7.4.3.3 Existing signs shall be removed or obscured at an aerodrome if they provide inadequate or misleading information regarding unserviceability areas.

7.4.3.4 The information provided by unserviceability signs shall not be in conflict with the information provided by the appropriate aeronautical information services.

Note: The information provided by unserviceability signs supplements that which is provided by the appropriate aeronautical information services unit.

Location

7.4.3.5 Unserviceability signs shall be located where operationally needed on the movement area. The location distances on the manoeuvring area shall be as per taxiing guidance signs in Table 5-5.

7.4.3.6 The location of unserviceability signs shall not visually obscure or provide conflicting information with existing operationally required visual aids.

Characteristics

7.4.3.7 Unserviceability signs shall be frangible. Those located near a runway or taxiway shall be sufficiently low to preserve clearance for propellers and the engine pods of jet aircraft. The installed height of unserviceability signs shall not exceed the dimension for taxiing guidance signs shown in Table 5-5.

7.4.3.8 Unserviceability signs shall be rectangular, as shown in Figure 7-3, with the longer side horizontal.

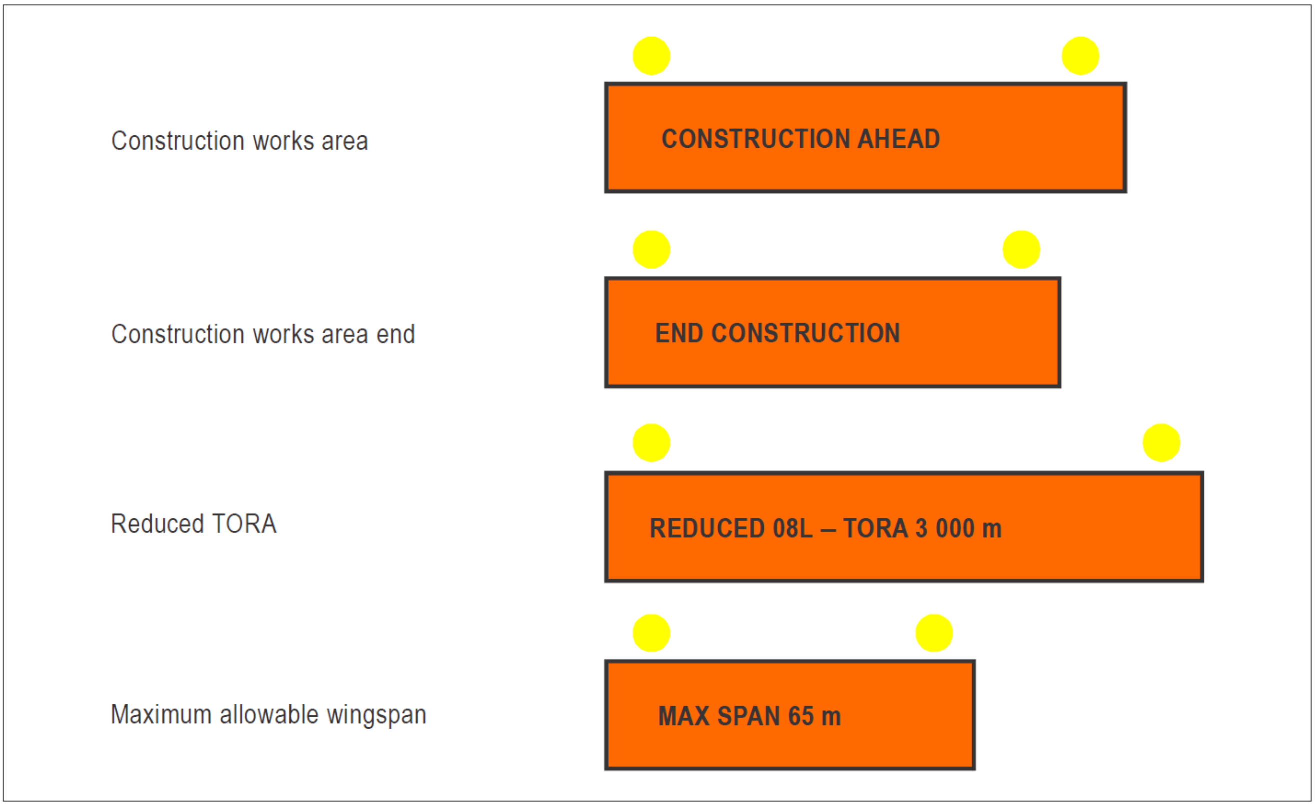


Figure 7-3. Examples of unserviceability signs

7.4.3.9 The inscriptions on an unserviceability sign shall be in accordance with the provisions of Appendix 4.

7.4.3.10 Unserviceability signs shall consist of an inscription in black on an orange background. Unserviceability signs shall be supplemented by a black outline measuring 10 mm in width for runways where the code number is 1 or 2, and 20 mm in width for runways where the code number is 3 or 4.

7.4.3.11 The inscription on an unserviceability sign shall consist of a legible, clear and simple message, only providing the useful and necessary information for the safety of the operation.

Note: *See Figure 7-3 for examples of unserviceability signs.*

7.4.3.12 Unserviceability signs shall be retroreflective in accordance with the provisions of Appendix 4.

7.4.3.13 Where there is a need to enhance the conspicuity of unserviceability signs, they shall be supplemented by two red or yellow simultaneously flashing lights. The intensity and the beam spread of these lights should be in accordance with the specifications in Appendix 2, Figure A2-24.

7.4.4 Unserviceability markers

Application

7.4.4.1 Unserviceability markers shall be displayed wherever any portion of a taxiway, apron or holding bay is unfit for the movement of aircraft but it is still possible for aircraft to bypass the area safely.

Note: Unserviceability markers are used for such purposes as warning pilots of a hole in a taxiway or apron pavement or outlining a portion of pavement, such as on an apron, that is under repair. They are not suitable for use when a portion of a runway becomes unserviceable, nor on a taxiway when a major portion of the width becomes unserviceable. In such instances, the runway or taxiway is normally closed.

Location

7.4.4.2 Unserviceability markers shall be placed at intervals sufficiently close, so as to delineate the unserviceable area.

Characteristics

7.4.4.3 Unserviceability markers shall consist of conspicuous upstanding devices such as flags, cones or marker boards.

7.4.4.4 An unserviceability cone shall be at least 0.5 m in height and red, orange or yellow or any one of these colors in combination with white.

7.4.4.4 An unserviceability flag shall be at least 0.5 m square and red, orange or yellow or any one of these colors in combination with white.

7.4.4.5 An unserviceability marker board shall be at least 0.5 m in height and 0.9 m in length, with alternate red and white or orange and white vertical stripes.

Chapter (8)
Electrical Systems

8.1 Electrical Power Supply Systems for Air Navigation Facilities

The safety of operations at aerodromes depends on the quality of the supplied power. The total electrical power supply system may include connections to one or more external sources of electric power supply, one or more local generating facilities and to a distribution network including transformers and switchgear. Many other aerodrome facilities supplied from the same system need to be taken into account while planning the electrical power system at aerodromes.

8.1.1 Adequate primary power supply shall be available at aerodromes for the safe functioning of air navigation facilities.

8.1.2 The design and provision of electrical power systems for aerodrome visual and radio navigation aids shall be such that an equipment failure will not leave the pilot with inadequate visual and non-visual guidance or misleading information.

Note: The design and installation of the electrical systems need to take into consideration factors that can lead to malfunction, such as electromagnetic disturbances, line losses, power quality, etc. Additional guidance is given in CARC Guidance Material 34-GM-05 Aerodrome Electrical System.

8.1.3 Electric power supply connections to those facilities for which secondary power is required shall be so arranged that the facilities are automatically connected to the secondary power supply on failure of the primary source of power.

8.1.4 The time interval between failure of the primary source of power and the complete restoration of the services required by paragraph 8.1.10 shall be as short as practicable, except that for visual aids associated with non-precision, precision approach or take-off runways the requirements of Table 8-1 for maximum switch-over times shall apply.

Note: A definition of switch-over time is given in Chapter 1 to this part.

8.1.5 The electric power supply connections to those facilities for which secondary power is required shall be so arranged that the facilities are capable of meeting the requirements of Table 8-1 for maximum switch-over times as defined in Chapter 1 to this part.

Visual Aids

Application

8.1.6 For a precision approach runway, a secondary power supply capable of meeting the requirements of Table 8-1 for the appropriate category of precision approach runway shall be provided. Electric power supply connections to those facilities for which secondary power is required shall be so arranged that the facilities are automatically connected to the secondary power supply on failure of the primary source of power.

8.1.7 For a runway meant for take-off in runway visual range conditions less than a value of 800 m, a secondary power supply capable of meeting the relevant requirements of Table 8-1 shall be provided.

8.1.8 At an aerodrome where the primary runway is a non-precision approach runway, a secondary power supply capable of meeting the requirements of Table 8-1 shall be provided, except that a secondary power supply for visual aids need not be provided for more than one non-precision approach runway.

8.1.9 At an aerodrome where the primary runway is a non-instrument runway, a secondary power supply capable of meeting the requirements of paragraph 8.1.4 at this chapter shall be provided, except that a secondary power supply for visual aids need not be provided when an emergency lighting system in accordance with the specification of Chapter 5 paragraph 5.3.2 is provided and capable of being deployed in 15 minutes.

8.1.10 The following aerodrome facilities shall be provided with a secondary power supply capable of supplying power when there is a failure of the primary power supply:

(a) the signaling lamp and the minimum lighting necessary to enable air traffic services personnel to carry out their duties;
Note: The requirement for minimum lighting shall be met by other than electrical means.

(b) all obstacle lights which, in the opinion of the appropriate authority, are essential to ensure the safe operation of aircraft;

(c) approach, runway and taxiway lighting as specified in Section 8.1.9;

(d) closed runway lighting, if provided in accordance with 7.1.4.1 and connected to the primary power supply;

(e) meteorological equipment;

(f) essential security lighting, if provided in accordance with Chapter 9 section 9.11;

(g) essential equipment and facilities for the aerodrome responding emergency agencies;

(h) floodlighting on a designated isolated aircraft parking position if provided in accordance with Chapter 5 section 5.3.24.1; and

(i) illumination of apron areas over which passengers may walk.

Note: Specifications for secondary power supply for radio navigation aids and ground elements of communications systems are given in the ICAO Annex 10, Volume I, Chapter 2.

8.1.11 Requirements for a secondary power supply shall be met by either of the following:

— 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

— standby power unit(s), which are engine generators, batteries, etc., from which electric power can be obtained.

Note: Guidance on electrical systems is included in CARC Guidance Material 34-GM-05 Aerodrome Electrical System.

8.2 System Design

8.2.1 For a runway meant for use in runway visual range conditions less than a value of 550 m, the electrical systems for the power supply, lighting and control of the lighting systems included in Table 8-1 shall be so designed that an equipment failure will not leave the pilot with inadequate visual guidance or misleading information.

Note: Guidance on means of providing this protection is given in CARC Guidance Material 34-GM-05 Aerodrome Electrical System.

8.2.2 Where the secondary power supply of an aerodrome is provided by the use of duplicate feeders, such supplies shall be physically and electrically separate so as to ensure the required level of availability and independence.

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

8.2.4 The electrical systems for the power supply and the control of the closed runway lighting shall be so designed that the closed runway lighting system is operated independently of runway lighting systems.

8.3 Monitoring

Note: Guidance on this subject is given in CARC Guidance Material 34-GM-05 Aerodrome Electrical System.

8.3.1 A system of monitoring shall be employed to indicate the operational status of the lighting systems.

8.3.2 Where lighting systems are used for aircraft control purposes, such systems shall be monitored automatically so as to provide an indication of any fault which may affect the control functions. This information shall be automatically relayed to the air traffic service unit.

8.3.3 Where a change in the operational status of lights has occurred, an indication shall be provided within two seconds for a stop bar at a runway holding position and within five seconds for all other types of visual aids.

8.3.4 For a runway meant for use in runway visual range conditions less than a value of 550 m, the lighting systems detailed in Table 8-1 shall be monitored automatically so as to provide an indication when the serviceability level of any element falls below the minimum serviceability level specified in Chapter 10 paragraph 10.5.7 to 10.5.11, as appropriate. This information shall be automatically relayed to the maintenance crew.

8.3.5 For a runway meant for use in runway visual range conditions less than a value of 550 m, the lighting systems detailed in Table 8-1 shall be monitored automatically to provide an indication when the serviceability level of any element falls below the minimum level specified in Chapter 10 paragraph 10.4.7 to 10.4.11 (in which operation shall not continue). This information shall be automatically relayed to the air traffic services unit and displayed in a prominent position.

Note: Guidance on air traffic control interface and visual aids monitoring is included in CARC Guidance Material 34-GM-05 Aerodrome Electrical System.

Table 8-1. Secondary power supply requirements (See 8.1.4)

Runway	Lighting aids requiring power	Maximum Switch-over time
Non-instrument	Visual approach slope indicators [a]	
	Runway edge [b]	See
	Runway threshold [b]	8.1.4 and
	Runway end [b]	8.1.9
	Obstacle [a]	
Non-precision approach	Approach lighting system	15 seconds
	Visual approach slope indicators [a, d]	15 seconds
	Runway edge [d]	15 seconds
	Runway threshold [d]	15 seconds
	Runway end	15 seconds
	Obstacle [a]	15 seconds
Precision approach category I	Approach lighting system	15 seconds
	Runway edge [d]	15 seconds
	Visual approach slope indicators [a, d]	15 seconds
	Runway threshold [d]	15 seconds
	Runway end	15 seconds
	Essential taxiway [a]	15 seconds
	Obstacle [a]	15 seconds

Precision approach category II / III	Inner 300 m of the approach lighting system	1 second
	Other parts of the approach lighting system	15 seconds
	Obstacle [a]	15 seconds
	Runway edge	15 seconds
	Runway threshold	1 second
	Runway end	1 second
	Runway center line	1 second
	Runway touchdown zone	1 second
	All stop bars	1 second
	Essential taxiway	15 seconds
Runway meant for take-off in runway visual	Runway edge	15 seconds
range conditions less than a value of 800 m	Runway end	1 second
	Runway center line	1 second
	All stop bars	1 second
	Essential taxiway [a]	15 seconds
	Obstacle [a]	15 seconds

(a) Supplied with secondary power when their operation is essential to the safety of flight operation.
(b) See Chapter 5 Section 5.3.2 regarding the use of emergency lighting.
(c) One second where no runway center line lights are provided.
(d) One second where approaches are over hazardous or precipitous terrain.

Chapter (9)
Aerodrome Operational Services, Equipment and Installations

9.1 Aerodrome Emergency Planning

General

Aerodrome emergency planning is the process of preparing an aerodrome to cope with an emergency occurring at the aerodrome or in its vicinity. The objective of aerodrome emergency planning is to minimize the effects of an emergency, particularly in respect of saving lives and maintaining aircraft operations. The aerodrome emergency plan sets forth the procedures for coordinating the response of different aerodrome agencies (or services) and of those agencies in the surrounding community that could be of assistance in responding to the emergency.

Note: Guidance material to assist the appropriate authority in establishing aerodrome emergency planning is given in CARC Guidance Material 34-GM-20 Airport Emergency Planning.

9.1.1 An aerodrome emergency plan shall be established at an aerodrome, commensurate with the aircraft operations and other activities conducted at the aerodrome.

9.1.2 The aerodrome emergency plan shall provide for the coordination of the actions to be taken in an emergency occurring at an aerodrome or in its vicinity.

Note (1): Examples of emergencies are: aircraft emergencies, sabotage including bomb threats, unlawfully seized aircraft, dangerous goods occurrences, building fires, natural disasters and public health emergencies.

Note (2): Examples of public health emergencies are increased risk of travellers or cargo spreading a serious communicable disease internationally through air transport and severe outbreak of a communicable disease potentially affecting a large proportion of aerodrome staff.

9.1.3 The plan shall coordinate the response or participation of all involved agencies which could be of assistance in responding to an emergency.

Note: Examples of agencies are:

— *on the aerodrome: air traffic control unit, rescue and firefighting services, aerodrome administration, medical and ambulance services, aircraft operators, ground handling service providers, security services, and police;*

— *off the aerodrome: fire departments, police, health authorities (including medical, ambulance, hospital and public health services), military, and harbor patrol or coast guard.*

Public health services include planning to minimize adverse effects to the community from health related events and deal with population health issues rather than provision of health services to individuals.

9.1.4 The plan shall provide for cooperation and coordination with the rescue coordination center, as necessary.

9.1.5 The aerodrome emergency plan document shall include at least the following:
- (a) types of emergencies planned for;
- (b) agencies involved in the plan;
- (c) responsibility and role of each agency, the emergency operations center and the command post, for each type of emergency;
- (d) information on names and telephone numbers of offices or people to be contacted in the case of a particular emergency; and
- (e) a grid map of the aerodrome and its immediate vicinity.

9.1.6 The plan shall observe Human Factors principles to ensure optimum response by all existing agencies participating in emergency operations.

Note (1): Guidance material on Human Factors principles can be found in the ICAO Human Factors Training Manual (Doc 9683).

Note (2): General principles and procedures on the training of aerodrome personnel, including training program and competence checks, are specified in CARC Guidance Material 34-GM-16 PANS-Aerodromes.

Emergency operations center and command post

9.1.7 A fixed emergency operations center and a mobile command post shall be available for use during an emergency.

9.1.8 The emergency operations center shall be a part of the aerodrome facilities and shall be responsible for the overall coordination and general direction of the response to an emergency.

9.1.9 The command post shall be a facility capable of being moved rapidly to the site of an emergency, when required, and shall undertake the local coordination of those agencies responding to the emergency.

9.1.10 A person shall be assigned to assume control of the emergency operations center and, when appropriate, another person the command post.

Communication system

9.1.11 Adequate communication systems linking the command post and the emergency operations center with each other and with the participating agencies shall be provided in accordance with the plan and consistent with the particular requirements of the aerodrome.

Aerodrome emergency exercise

9.1.12 The plan shall contain procedures for periodic testing of the adequacy of the plan and for reviewing the results in order to improve its effectiveness.

Note: The plan includes all participating agencies and associated equipment.

9.1.13 The plan shall be tested by conducting:

(a) a full-scale aerodrome emergency exercise at intervals not exceeding two years; and partial emergency exercises in the intervening year to ensure that any deficiencies found during the full-scale aerodrome emergency exercise have been corrected; or

(b) a series of modular tests commencing in the first year and concluding in a full-scale aerodrome emergency exercise at intervals not exceeding three years;

and reviewed thereafter, or after an actual emergency, so as to correct any deficiency found during such exercises or actual emergency.

Note (1): The purpose of a full-scale exercise is to ensure the adequacy of the plan to cope with different types of emergencies. The purpose of a partial exercise is to ensure the adequacy of the response to individual participating agencies and components of the plan, such as the communications system. The purpose of modular tests is to enable concentrated effort on specific components of established emergency plans.
Note (2): Guidance material on airport emergency planning is available in CARC Guidance Material 34-GM-20 Airport Emergency Planning.

Emergencies in difficult environments

9.1.14 The plan shall include the ready availability of and coordination with appropriate specialist rescue services to be able to respond to emergencies where an aerodrome is located close to water and/or swampy areas and where a significant portion of approach or departure operations takes place over these areas.

9.1.15 At those aerodromes located close to water and/or swampy areas, or difficult terrain, the aerodrome emergency plan shall include the establishment, testing and assessment at regular intervals of a pre-determined response for the specialist rescue services.

9.1.16 An assessment of the approach and departure areas within 1,000 m of the runway threshold shall be carried out to determine the options available for intervention.

Note: Guidance material on assessing approach and departure areas within 1,000 m of runway thresholds can be found in CARC Guidance Material Rescue Operations in Difficult Environment.

9.2 Rescue and Fire Fighting

General

Note (1): The principal objective of a rescue and firefighting service is to save lives in the event of an aircraft accident or incident occurring at, or in the immediate vicinity of, an airport. The rescue and firefighting service is provided to create and maintain survivable conditions, to provide egress routes for occupants and to initiate the rescue of those occupants unable to make their escape without direct aid. The rescue may require the use of equipment and personnel other than those assessed primarily for rescue and firefighting purposes.

Note (2): The most important factors bearing on effective rescue in a survivable aircraft accident are: the training received, the effectiveness of the equipment and the speed with which personnel and equipment designated for rescue and firefighting purposes can be put into use.

Note (3): Requirements to combat building and fuel farm fires, or to deal with foaming of runways, are not taken into account.

Application

9.2.1 Rescue and firefighting equipment and services shall be provided at an airport when serving commercial air transport operations.

Note: Public or private organization suitably located and equipped, may be designated to provide the rescue and firefighting services. It is intended that the fire station housing these organizations be normally located on the airport, although an off-airport location is not precluded provided the response time can be met.

9.2.2 Where an airport is located close to water/swampy areas, or difficult terrain, and where a significant portion of approach or departure operations takes place over these areas, specialist rescue services and firefighting equipment appropriate to the hazard and risk shall be available.

Note (1): Special firefighting equipment need not be provided for water areas; this does not prevent the provision of such equipment if it would be of practical use, such as when the areas concerned include reefs or islands.

Note (2): The objective is to plan and deploy the necessary life-saving flotation equipment as expeditiously as possible in a number commensurate with the largest airplane normally using the airport.

Note (3): Additional guidance is available in Chapter 13 of the ICAO Airport Services Manual (Doc 9137), Part 1.

Level of Protection to be Provided

9.2.3 The level of protection provided at an aerodrome for rescue and firefighting shall be equal to the aerodrome category determined using the principles in 9.2.5 and 9.2.6.

9.2.4 Reserved.

9.2.5 The aerodrome category shall be determined from Table 9-1 and shall be based on the longest aeroplanes normally using the aerodrome and their fuselage width.

Note: To categorize the airplanes using the airport, first evaluate their overall length and second, their fuselage width.

9.2.6 If, after selecting the category appropriate to the longest aeroplane's overall length, that aeroplane's fuselage width is greater than the maximum width in Table 9-1, column 3, for that category, then the category for that aeroplane shall actually be one category higher.

Note (1): See guidance in ICAO Airport Services Manual (Doc 9137), Part 1, for categorizing aerodromes, including those for all-cargo aircraft operations, for rescue and firefighting purposes.

Note (2): Principles and procedures on training, including training programs and competence checks, are specified in CARC Guidance Material 34-GM-16 PANS-Aerodromes. Further guidance on the training of personnel, rescue equipment for difficult environments and other facilities and services for rescue and firefighting is given in CARC 34 GM-01, Section 18, and in CARC Guidance Material 34-GM-11 Runway Design.

9.2.7 During anticipated periods of reduced activity, the level of protection available shall be no less than that needed for the highest category of airplane planned to use the airport during that time irrespective of the number of movements.

Table 9-1
Aerodrome category for rescue and firefighting

Aerodrome category (1)	**Airplane overall length** (2)	**Maximum fuselage width** (3)
1	0 m up to but not including 9 m	2 m
2	9 m up to but not including 12 m	2 m
3	12 m up to but not including 18 m	3 m
4	18 m up to but not including 24 m	4 m
5	24 m up to but not including 28 m	4 m
6	28 m up to but not including 39 m	5 m
7	39 m up to but not including 49 m	5 m
8	49 m up to but not including 61 m	7 m
9	61 m up to but not including 76 m	7 m
10	76 m up to but not including 90 m	8 m

Extinguishing Agents

9.2.8 Both principal and complementary extinguishing agents shall be provided at an airport.

9.2.9 The principal extinguishing agent shall be:

(a) a foam meeting the minimum performance level A; or

(b) a foam meeting the minimum performance level B; or

(c) a foam meeting the minimum performance Level C; or

(d) a combination of these agents;

except that the principal extinguishing agent for airports in categories 1 to 3 shall preferably meet performance level B or C foam.

Note: Information on the required physical properties and fire extinguishing performance criteria needed for a foam to achieve an acceptable performance level A, B or C rating is given in the ICAO Airport Services Manual (Doc 9137), Part 1.

9.2.10 The complementary extinguishing agent shall be a dry chemical powder suitable for extinguishing hydrocarbon fires.

Note (1): When selecting dry chemical powders for use with foam, care shall be exercised to ensure compatibility.

Note (2): Alternate complementary agents having equivalent firefighting capability may be utilized. Additional information on extinguishing agents is given in the ICAO Airport Services Manual (Doc 9137), Part 1.

9.2.11 The amounts of water for foam production and the complementary agents to be provided on the rescue and firefighting vehicles shall be in accordance with the airport category determined under 9.2.4, 9.2.5, 9.2.6 and Table 9-2, except that for airport categories 1 and 2 up to 100 per cent of the water may be complementary agent.

For the purpose of agent substitution, 1 kg of complementary agent shall be taken as equivalent to 1.0L of water for production of a foam meeting performance level A.

Note (1): The amounts of water specified for foam production are predicated on an application rate of 8.2 L/min/m2 for a foam meeting performance level A, 5.5 L/min/m2 for a foam meeting performance level B and 3.75L/min/m2 for a foam meeting performance Level C.

Note (2): When any other complementary agent is used, the substitution ratios need to be checked.

9.2.12 At aerodromes where operations by aeroplanes larger than the average size in a given category are planned, the quantities of water shall be recalculated and the amount of water for foam production and the discharge rates for foam solution shall be increased accordingly.

Note: Guidance on the determination of quantities of water and discharge rates based on the largest overall length of aeroplane in a given category is available in Chapter 2 of the ICAO Airport Services Manual (Doc 9137), Part 1.

9.2.13 The quantity of foam concentrates separately provided on vehicles for foam production shall be in proportion to the quantity of water provided and the foam concentrate selected.

9.2.14 The amount of foam concentrate provided on a vehicle shall be sufficient to produce at least two loads of foam solution.

9.2.15 Supplementary water supplies, for the expeditious replenishment of rescue and firefighting vehicles at the scene of an aircraft accident, shall be provided.

9.2.16 When a combination of different, the total amount of water to be provided for foam production shall be calculated for each foam type and the distribution of these quantities shall be documented for each vehicle and applied to the overall rescue and firefighting requirement.

9.2.17 The discharge rate of the foam solution shall not be less than the rates shown in Table 9-2.

9.2.18 The complementary agents shall comply with the appropriate specifications of the International Organization for Standardization (ISO).

9.2.19 The discharge rate of complementary agents shall be no less than the rates shown in Table 9-2.

9.2.20 Dry chemical powders shall only be substituted with an agent that has equivalent or better firefighting capabilities, for all types of fires where complementary agent is expected to be used.

9.2.21 A reserve supply of foam concentrate, equivalent to 200 per cent of the quantities identified in Table 9-2, shall be maintained on the airport for vehicle replenishment purposes.

Note: Foam concentrate carried on fire vehicles in excess of the quantity identified in Table 9-2 can contribute to the reserve.

9.2.22 A reserve supply of complementary agent, equivalent to 100 per cent of the quantity identified in Table 9-2, shall be maintained on the airport for vehicle replenishment purposes. Sufficient propellant gas shall be included to utilize this reserve complementary agent.

9.2.23 Category 1 and 2 airports that have replaced up to 100 per cent of the water with complementary agent shall hold a reserve supply of complementary agent of 200 per cent.

9.2.24 Where a major delay in the replenishment of the supplies is anticipated, the amount of reserve supply in 9.2.21, 9.2.22 and 9.2.23 should be increased as determined by a risk assessment.

Note: See the *ICAO Airport Services Manual (Doc 9137), Part 1.* for guidance on the conduct of a risk analysis to determine the quantities of reserve extinguishing agents.

Table 9-2
Minimum usable amounts of extinguishing agents

Aerodrome Category (1)	Foam meeting performance level A		Foam meeting performance level B		Foam meeting performance level C		Complementary agents	
	Water (L) (2)	Discharge rate foam solution/minute (L) (3)	Water (L) (4)	Discharge rate foam solution/minute (L) (5)	Water (L) (6)	Discharge rate foam solution/minute (L) (7)	Dry Chemical powder (kg) (8)	Discharge Rate Kg/sec (9)
1	350	350	230	230	160	160	45	2.25
2	1000	800	670	550	460	360	90	2.25
3	1800	1300	1200	900	820	630	135	2.25
4	3600	2600	2400	1800	1700	1100	135	2.25
5	8100	4500	5400	3000	3900	2200	180	2.25
6	11800	6000	7900	4000	5800	2900	225	2.25
7	18200	7900	12100	5300	8800	3800	225	2.25
8	27300	10800	18200	7200	12800	5100	450	4.5
9	36400	13500	24300	9000	17100	6300	450	4.5
10	48200	16600	32300	11200	22800	7900	450	4.5

Note: The quantities of water shown in columns 2, 4 and 6 are based on the average overall length of airplanes in a given category.

Rescue Equipment

9.2.25 Rescue equipment commensurate with the level of aircraft operations shall be provided on the rescue and firefighting vehicle(s).

Note: Guidance on the rescue equipment to be provided at an aerodrome is given in the ICAO Airport Services Manual (Doc 9137), Part 1.

Response Time

9.2.26 The operational objective of the rescue and firefighting service shall be to achieve a response time not exceeding three minutes to any point of each operational runway, in optimum visibility and surface conditions.

9.2.27 The aerodrome operator should strive to achieve a response time not exceeding two minutes to any point of each operational runway, in optimum visibility and surface conditions.

9.2.28 The operational objective of the rescue and firefighting service shall be to achieve a response time not exceeding three minutes to any other part of the movement area, in optimum visibility and surface conditions.

Note (1): Response time is considered to be the time between the initial call to the rescue and firefighting service, and the time when the first responding vehicle(s) is (are) in position to apply foam at a rate of at least 50 per cent of the discharge rate specified in Table 9-2.

Note (2): Optimum visibility and surface conditions are defined as daytime, good visibility, no precipitation with normal response route free of surface contamination e.g. water, ice or snow.

9.2.29 To meet the operational objective as nearly as possible in less than optimum conditions of visibility, especially during low visibility operations, suitable guidance, equipment and/or procedures for rescue and firefighting services shall be provided.

Note: Additional guidance is available in the ICAO Airport Services Manual (Doc 9137), Part 1.

9.2.30 Reserved.

9.2.31 Any vehicles, other than the first responding vehicle(s), required to deliver the amounts of extinguishing agents specified in Table 9-2 shall ensure continuous agent application and shall arrive no more than four minutes from the initial call.

9.2.32 A system of preventive maintenance of rescue and firefighting vehicles shall be employed to ensure effectiveness of the equipment and compliance with the specified response time throughout the life of the vehicle.

Emergency Access Roads

9.2.33 Emergency access roads shall be provided on an airport where terrain conditions permit their construction, so as to facilitate achieving minimum response times. Particular attention shall be given to the provision of ready access to approach areas up to 1000 m from the threshold, or at least within the airport boundary. Where a fence is provided, the need for convenient access to outside areas shall be taken into account.

Note: Aerodrome service roads may serve as emergency access roads when they are suitably located and constructed.

9.2.34 Emergency access roads shall be capable of supporting the heaviest vehicles which will use them, and be usable in all weather conditions. Roads within 90 m of a runway shall be surfaced to prevent surface erosion and the transfer of debris to the runway. Sufficient vertical clearance shall be provided from overhead obstructions for the largest vehicles.

9.2.35 When the surface of the road is indistinguishable from the surrounding area, or in areas where snow may obscure the location of the roads, edge markers shall be placed at intervals of about 10 m.

Fire Stations

9.2.36 All rescue and firefighting vehicles shall normally be housed in a fire station. Satellite fire stations shall be provided whenever the response time cannot be achieved from a single fire station.

9.2.37 The fire station shall be located so that the access for rescue and firefighting vehicles into the runway area is direct and clear, requiring a minimum number of turns.

Communication and Alerting Systems

9.2.38 A discrete communication system shall be provided linking a fire station with the control tower, any other fire station on the airport and the rescue and firefighting vehicles.

9.2.39 An alerting system for rescue and firefighting personnel, capable of being operated from that station, shall be provided at a fire station, any other fire station on the airport and the airport control tower.

Number of Rescue and Firefighting Vehicles

9.2.40 The minimum number of rescue and firefighting vehicles provided at an airport shall be in accordance with the following tabulation:

Table 9-3

Number of Rescue and Firefighting Vehicles

Aerodrome category	Rescue and firefighting vehicles
1	1
2	1
3	1
4	1
5	1
6	2
7	2
8	3
9	3
10	3

Note: Guidance on minimum characteristics of rescue and firefighting vehicles is given in the *CARC Guidance Material 34-GM-19 Rescue and Firefighting.*

Personnel

9.2.41 All rescue and firefighting personnel shall be properly trained to perform their duties in an efficient manner and shall participate in live fire drills commensurate with the types of aircraft and type of rescue and firefighting equipment in use at the airport, including pressure-fed fuel fires.

Note (1): Guidance to assist the appropriate authority in providing proper training is given in CARC Guidance Material to Part 14 No. 34 GM-01, Section 17, and the CARC Guidance Material 34-GM-19 Rescue and Firefighting.

Note (2): Fires associated with fuel discharged under very high pressure from a ruptured fuel tank are known as "pressure-fed fuel fires".

9.2.42 The rescue and firefighting personnel training program shall include training in human performance, including team coordination.
Note: Guidance material to design training programs on human performance and team coordination can be found in the ICAO Human Factors Training Manual (Doc 9683).

9.2.43 During flight operations, sufficient trained and competent personnel shall be designated to be readily available to ride the rescue and firefighting vehicles and to operate the equipment at maximum capacity. These personnel shall be deployed in a way that ensures that minimum response times can be achieved and that continuous agent application at the appropriate rate can be fully maintained. Consideration shall also be given for personnel to use hand lines, ladders and other rescue and firefighting equipment normally associated with aircraft rescue and firefighting operations.

9.2.44 In determining the number personnel required a task resource analysis should be completed and the level of staffing documented in the Airport Manual.

Note: Guidance on the use of a task resource analysis can be found in the CARC Guidance Material 34-GM-19 Rescue and Firefighting.

9.2.45 All responding rescue and firefighting personnel shall be provided with protective clothing and respiratory equipment to enable them to perform their duties in an effective manner.

9.3 Disabled Aircraft Removal

Note: Guidance on removal of a disabled aircraft, including recovery equipment, is given in CARC Guidance Material 34-GM-10 Removal of Disabled Aircraft. See also ICAO Annex 13 concerning protection of evidence, custody and removal of aircraft.

9.3.1 A plan for the removal of an aircraft disabled on, or adjacent to, the movement area shall be established for an aerodrome, and a coordinator designated to implement the plan, when necessary.

9.3.2 The disabled aircraft removal plan shall be based on the characteristics of the aircraft that may normally be expected to operate at the aerodrome, and include among other things:

(a) a list of equipment and personnel on, or in the vicinity of, the aerodrome which would be available for such purpose; and
(b) arrangements for the rapid receipt of aircraft recovery equipment kits available from other aerodromes.

9.4 Wildlife Strike Hazard Reduction

Note: The presence of wildlife (birds and other animals) on and in the airport vicinity poses a serious threat to aircraft operational safety.

9.4.1 The wildlife strike hazard on, or in the vicinity of, an aerodrome shall be assessed through:

(a) the establishment of a national procedure for recording and reporting wildlife strikes to aircraft;
(b) the collection of information from aircraft operators, airport personnel, and other sources. on the presence of wildlife on or around the aerodrome constituting a potential hazard to aircraft operations; and

(c) an ongoing evaluation of the wildlife hazard by competent personnel.

Note: Refer to ICAO Annex 15, Chapter 5.

9.4.2 Wildlife strike reports shall be collected and forwarded to ICAO for inclusion in the ICAO Bird Strike Information System (IBIS) database.

Note: The ICAO IBIS is designed to collect and disseminate information on wildlife strikes to aircraft. Information on the system is included in the Manual on CARC Guidance Material National Bird Strike Information System (IBIS).

9.4.3 Action shall be taken to decrease the risk to aircraft operations by adopting measures to minimize the likelihood of collisions between wildlife and aircraft.

Note: Procedures on the management of wildlife hazards on and within the vicinity of aerodromes, including the establishment of a wildlife hazard management program (WHMP), wildlife risk assessment, land-use management and personnel training, are specified in CARC Guidance Material 34-GM-16 PANS-Aerodromes. Further guidance is given in CARC Guidance Material 34-GM-15 Wildlife Control and Reduction.

9.4.4 The airport operator, in collaboration with concerned authorities, shall take action to eliminate or to prevent the establishment of garbage disposal dumps or any other source which may attracts wildlife to the aerodrome, or its vicinity, unless an appropriate wildlife assessment indicates that they are unlikely to create conditions conducive to a wildlife hazard problem. Where the elimination of existing sites is not possible, the airport operator, in collaboration with concerned authorities, shall ensure that any risk to aircraft posed by these sites is assessed and reduced to as low as reasonably practicable.

9.4.5 The concerned authorities, shall give due consideration to aviation safety concerns related to land developments in the vicinity of the aerodrome that may attract wildlife.

9.5 Apron Management Service

9.5.1 When warranted by the volume of traffic and operating conditions, an appropriate apron management service shall be provided on an apron by an aerodrome ATS unit, by aerodrome operations unit, or by a cooperative combination of these, in order to:

(a) regulate movement with the objective of preventing collisions between aircraft, and between aircraft and obstacles;

(b) regulate entry of aircraft into, and coordinate exit of aircraft from, the apron with the aerodrome control tower; and
(c) ensure safe and expeditious movement of vehicles and appropriate regulation of other activities.

9.5.2 When the aerodrome control tower does not participate in the apron management service, procedures shall be established to facilitate the orderly transition of aircraft between the apron management unit and the aerodrome control tower.

Note: Procedures on apron safety are specified in CARC Guidance Material 34-GM-16 PANS-Aerodromes. Guidance on an apron management service is given in CARC Guidance Materials, Aerodrome Operational Services and Surface Movement Guidance and Control Systems (SMGCS).

9.5.3 An apron management service shall be provided with radiotelephony communications facilities.

9.5.4 Where low visibility procedures are in effect, persons and vehicles operating on an apron shall be restricted to the essential minimum.

Note: Guidance on related special procedures is given in CARC Guidance Material 34-GM-21 Surface Movement Guidance and Control System (SMGCS).

9.5.5 Aircraft shall be allocated to an aircraft stand or apron area appropriate to the aircraft characteristics.

9.5.6 A risk assessment shall be carried out if there is a need to allocate aircraft parking to areas other than aircraft stands or apron areas.

Note: The need to allocate aircraft to other areas could arise from situations such as mass diversions, special events, adverse weather conditions, contingency requirements, work in progress, etc.

9.5.7 When allocating an aircraft to an aircraft stand, the following parameters shall be considered:

a) parking aids;

b) facilities serving the aircraft stand;

c) proximity of infrastructure;

d) other parked aircraft in the neighbouring aircraft stands;

e) aircraft stand dependencies; and

f) jet blast and propeller wash related protection.

Apron Safety

9.5.8 An emergency vehicle responding to an emergency shall be given priority over all other surface movement traffic.

9.5.9 A vehicle operating on an apron shall:

(a) give way to an emergency vehicle; an aircraft taxiing, about to taxi, or being pushed or towed; and

(b) give way to other vehicles in accordance with local regulations.

9.5.10 Aircraft shall be guided while arriving on or departing from the aircraft stand.

Note: Means for guidance can be a visual docking guidance systems, personnel, lighting or markings.

9.5.11 An aircraft stand shall be visually monitored in-person or remotely to ensure that the recommended clearance distances are maintained.

Note: Stand dependencies may occur when multiple centre lines are used on the same stand, creating possible variations in fixed or mobile obstacle separations with adjacent stands.

9.5.12 Emergency stop procedures shall be in place to stop an aircraft when entering the stand if the safety of operations on the aircraft stand is compromised.

Note: Procedures on the training of operational personnel and on apron safety and operations, are specified in CARC Guidance Material 34-GM-16 PANS-Aerodromes.

9.5.13 Personnel, other than those required to assist the initial arrival and departure of the aircraft, shall not be allowed to approach the aircraft when anti-collision lights are turned on and engines are running.

Note: This does not apply to helicopter operations as per ICAO Annex 6, Part 3.

9.5.14 Parked aircraft shall be appropriately secured to prevent any unintended movement.

9.6 Aircraft fueling – Safety considerations

9.6.1 Fire extinguishing equipment suitable for at least initial intervention in the event of a fuel fire and personnel trained in its use shall be readily available during fueling operations, and there shall be a means of quickly summoning the rescue and firefighting service in the event of a fire or major fuel spill.

9.6.2 When aircraft re-fueling operations take place while passengers are embarking, on board or disembarking, ground equipment shall be positioned so as to allow:

(a) the use of a sufficient number of exits for expeditious evacuation; and

(b) a ready escape route from each of the exits to be used in an emergency.

9.7 Ground handling

(Applicable as of 26 November 2026)

Note (1): Ground handling can be provided by an aircraft operator, an aerodrome operator or an independent organization. When provided by an aircraft operator or an aerodrome operator, this organization is also considered, as a ground handling service provider (GHSP).

Note (2): A list of ground handling services is provided in the ICAO Manual on Ground Handling (Doc 10121), *Appendix B.*

9.7.1 As part of its continuous safety oversight, CARC conducts regular assessments on the impact of ground handling operations on aviation safety.

Note: Guidance on the assessment of the impact of ground handling operations on aviation safety is provided in the ICAO Manual on Ground Handling *(Doc 10121), Chapter 2.*

9.7.2. As part of the State Safety Program (SSP), CARC defines the criteria for the safety oversight of ground handling operations.

Note (1): Guidance on the establishment of criteria for the safety oversight of ground handling, and approaches for safety oversight are contained in the ICAO Manual on Ground Handling *(Doc 10121)*

Note (2): Provisions on periodically reviewing the need to extend SMS to additional aviation sectors are contained in ICAO Annex 19 – Safety Management. *Examples of additional aviation sectors can include GHSP.*

9.8 Aerodrome Vehicle Operations

Note (1): Procedures on the establishment of an airside driver permit (ADP) scheme and vehicle/equipment safety requirements, including detailed personnel training, are specified in CARC Guidance Material 34-GM-16 PANS-Aerodromes.

Note (2): Guidance on aerodrome vehicle operations is contained in CARC Guidance Material to Part 14 No. 34 GM-01, and on traffic rules and regulations for vehicles in CARC Guidance Material 34-GM-21 Surface Movement Guidance and Control System (SMGCS).

Note (3): It is intended that roads located on the movement area be restricted to the exclusive use of aerodrome personnel and other authorized persons, and that access to the public buildings by an unauthorized person will not require use of such roads.

9.8.1 A vehicle shall be operated:

(a) on a maneuvering area only as authorized by the aerodrome control tower;
(b) on an apron only as authorized by the designated authority.

9.8.2 The driver of a vehicle on the movement area shall comply with all mandatory instructions conveyed by markings and signs unless otherwise authorized by:

(a) the aerodrome control tower when on the maneuvering area; or
(b) the designated authority when on the apron.

9.8.3 The driver of a vehicle on the movement area shall comply with all mandatory instructions conveyed by lights.

9.8.4 The driver of a vehicle on the movement area shall be appropriately trained for the tasks to be performed and shall comply with the instructions issued by:

(a) the aerodrome control tower, when on the maneuvering area; and
(b) the designated authority, when on the apron.

9.8.5 The driver of a radio-equipped vehicle shall establish satisfactory two-way radio communication with the aerodrome control tower before entering the maneuvering area and with the appropriate designated authority before entering the apron. The driver shall maintain a continuous listening watch on the assigned frequency when on the movement area.

9.9 Surface Movement Guidance and Control Systems

Application

9.9.1 A surface movement guidance and control system shall be provided at an aerodrome.

Note: Guidance on surface movement guidance and control systems is contained in CARC Guidance Material 34-GM-21 Surface Movement Guidance and Control System (SMGCS).

Characteristics

9.9.2 The design of a surface movement guidance and control system shall take into account:
(a) the density of air traffic;
(b) the visibility conditions under which operations are intended;
(c) the need for pilot orientation;
(d) the complexity of the aerodrome layout; and
(e) movements of vehicles.

9.9.3 The visual aid components of a surface movement guidance and control system, i.e. markings, lights and signs shall be designed to conform with the relevant specifications in Chapter 5 Sections 5.2, 5.3 and 5.4, respectively.

9.9.4 A surface movement guidance and control system shall be designed to assist in the prevention of inadvertent incursions of aircraft and vehicles onto an active runway.

9.9.5 The system shall be designed to assist in the prevention of collisions between aircraft, and between aircraft and vehicles or objects, on any part of the movement area.

Note: Guidance on control of stop bars through induction loops and on a visual taxiing guidance and control system is contained in CARC Guidance Material 34-GM-17 Visual Aids for Navigation.

9.9.6 Where a surface movement guidance and control system is provided by selective switching of stop bars and taxiway center line lights, the following requirements shall be met:
(a) taxiway routes which are indicated by illuminated taxiway center line lights shall be capable of being terminated by an illuminated stop bar;
(b) the control circuits shall be so arranged that when a stop bar located ahead of an aircraft is illuminated, the appropriate section of taxiway center line lights beyond it is suppressed; and
(c) the taxiway center line lights are activated ahead of an aircraft when the stop bar is suppressed.

Note (1): Refer to Sections Chapter 5 paragraph 5.3.17 and 5.3.20 for specifications on taxiway center line lights and stop bars, respectively.

Note (2): Guidance on installation of stop bars and taxiway center line lights in surface movement guidance and control systems is given in CARC Guidance Material 34-GM-17 Visual Aids for Navigation.

9.9.7 Surface movement radar for the maneuvering area should be provided at an aerodrome intended for use in runway visual range conditions less than a value of 350 m.

9.9.8 Surface movement radar for the maneuvering area shall be provided at an aerodrome other than that in 9.9.7 when traffic density and operating conditions are such that regularity of traffic flow cannot be maintained by alternative procedures and facilities.

Note: Guidance on the use of surface movement radar is given in CARC Guidance Material 34-GM-21 Surface Movement Guidance and Control System (SMGCS).

9.10 Siting of Equipment and Installations on Operational Areas

Note (1): Requirements for obstacle limitation surfaces are specified in Chapter 4 Section 4.2.

Note (2): The design of light fixtures and their supporting structures, light units of visual approach slope indicators, signs, and markers, is specified in chapter 5, paragraph 5.3.1, 5.3.5, 5.4.1 and 5.5.1, respectively. Guidance on the frangible design of visual and non-visual aids for navigation is given in ICAO Aerodrome Design Manual, Part 6 — Frangibility (Doc 9157).

9.10.1 Unless its function requires it to be there for air navigation purposes, no equipment or installation shall be:

- (a) on a runway strip, a runway end safety area, a taxiway strip or within the distances specified in Table 3-1, column 11, if it would endanger an aircraft; or
- (b) on a clearway if it would endanger an aircraft in the air.

9.10.2 Any equipment or installation required for air navigation purposes which must be located:

- (a) on that portion of a runway strip within:
  - (1) 75 m of the runway center line where the code number is 3 or 4; or
  - (2) 45 m of the runway center line where the code number is 1 or 2; or
- (b) on a runway end safety area, a taxiway strip or within the distances specified in Table 3-1; or
- (c) on a clearway and which would endanger an aircraft in the air;

shall be frangible and mounted as low as possible.

9.10.3 Any equipment or installation required for air navigation or for aircraft safety purposes which must be located on the non-graded portion of a runway strip shall be regarded as an obstacle and shall be frangible and mounted as low as possible.

Note: Guidance on the siting of navigation aids is contained in ICAO Aerodrome Design Manual, Part 6 — Frangibility (Doc 9157).

9.10.4 Unless its function requires it to be there for air navigation or for aircraft safety purposes, no equipment or installation shall be located within 240 m from the end of the strip and within:

(a) 60 m of the extended center line where the code number is 3 or 4; or
(b) 45 m of the extended center line where the code number is 1 or 2;

of a precision approach runway category I, II or III.

9.10.5 Any equipment or installation required for air navigation or for aircraft safety purposes which must be located on or near a strip of a precision approach runway category I, II or III and which:

(a) is situated within 240 m from the end of the strip and within:
  (1) 60 m of the extended runway center line where the code number is 3 or 4; or
  (2) 45 m of the extended runway center line where the code number is 1 or 2; or
(b) penetrates the inner approach surface, the inner transitional surface or the balked landing surface;

shall be frangible and mounted as low as possible.

9.10.6 Any equipment or installation required for air navigation purposes which is an obstacle of operational significance in accordance with Chapter 4 paragraph 4.2.4, 4.2.11, 4.2.20 or 4.2.27 shall be frangible and mounted as low as possible.

9.11 Fencing

Application

9.11.1 A fence shall be provided on an aerodrome to prevent the entrance to the movement area of animals large enough to be a hazard to aircraft.

9.11.2 A fence shall be provided on an aerodrome to deter the inadvertent or premeditated access of unauthorized persons onto a non-public area of the aerodrome.

Note (1): This is intended to include the barring of sewers, ducts, tunnels, etc., where necessary to prevent access.

Note (2): Special measures may be required to prevent the access of an unauthorized person to runways or taxiways which overpass public roads.

9.11.3 Suitable means of protection shall be provided to deter the inadvertent or premeditated access of unauthorized persons into ground installations and facilities essential for the safety of civil aviation located off the aerodrome.

Location

9.11.4 The fence shall be located so as to separate the movement area and other facilities or zones on the aerodrome vital to the safe operation of aircraft from areas open to public access.

9.11.5 When greater security is thought necessary, a cleared area shall be provided on both sides of the fence to facilitate the work of patrols and to make trespassing more difficult. Consideration shall be given to the provision of a perimeter road inside the aerodrome fencing for the use of both maintenance personnel and security patrols.

9.12 Security Lighting

At an aerodrome where it has been found necessary to satisfy security requirements, and upon the request of concerned authorities, a fence provided for the protection of international civil aviation and its facilities shall be illuminated at a minimum essential level. Consideration shall be given to locating lights so that the ground area on both sides of the fence, particularly at access points, is illuminated.

9.13 Autonomous Runway Incursion Warning System

Note (1): The inclusion of detailed specification for an ARIWS in this section is not intended to imply that an ARIWS has to be provided at an aerodrome.

Note (2): The implementation of an ARIWS is a complex issue deserving careful consideration by aerodrome operators, air traffic services, CARC and in coordination with the aircraft operators.

Note (3): CARC Guidance Material to Part 14 No. 34 GM-01, provides a description of an autonomous runway incursion warning system (ARIWS) and information on its use.

Characteristics

9.13.1 Where an ARIWS is installed at an aerodrome:

(a) it shall provide autonomous detection of a potential incursion or of the occupancy of an active runway and a direct warning to a flight crew or vehicle operator;

(b) it shall function and be controlled independently of any other visual system on the aerodrome;

(c) its visual aid components, i.e. lights, shall be designed to conform with the relevant specifications in Chapter 5 section 5.3; and

(d) failure of part or all of it shall not interfere with normal aerodrome operations. To this end, provision shall be made to allow the ATC unit to partially or entirely shut down the system

Note (1): An ARIWS may be installed in conjunction with enhanced taxiway centre line markings, stop bars or runway guard lights.
Note (2): It is intended that the system(s) be operational under all weather conditions, including low visibility.
Note (3): An ARIWS may share common sensory components of an SMGCS or A-SMGCS, however, it operates independently of either system

9.13.2 Where an ARIWS is installed at an aerodrome, information on its characteristics and status shall be provided to the appropriate aeronautical information services for promulgation in the AIP with the description of the aerodrome surface movement guidance and control system and markings as specified in ICAO Annex 15.

Chapter (10)
Aerodrome Maintenance

10.1 General

10.1.1 A maintenance program, including preventive maintenance, shall be established at an aerodrome to maintain facilities in a condition which does not impair the safety, regularity or efficiency of air navigation.

Note (1): Preventive maintenance is programmed maintenance work done in order to prevent a failure or degradation of facilities.

Note (2): "Facilities" are intended to include such items as pavements, visual aids, fencing, drainage and electrical systems and buildings.

10.1.2 The design and application of the maintenance program shall observe Human Factors principles.

Note (1): Guidance material on Human Factors principles can be found in the ICAO Human Factors Training Manual (Doc 9683), and CARC Guidance Materials 34-GM-03 Aerodrome Operational Service.

Note (2): General principles and procedures on the training of aerodrome personnel, including training programs and competence checks, are specified in CARC Guidance Material 34-GM-16 PANS-Aerodromes.

10.2 Pavements

10.2.1 The surfaces of all movement areas including pavements (runways, taxiways, and aprons) and (adjacent areas) shall be inspected and their conditions monitored regularly as part of an aerodrome preventive and corrective maintenance program with the objective of avoiding and eliminating any foreign object debris (FOD) that might cause damage to aircraft or impair the operation of aircraft systems.

Note (1): See Chapter 2 paragraph 2.9.3 for inspections of movement areas.

Note (2): Procedures on carrying out daily inspections of the movement area and control of FOD are given in CARC Guidance Materials; PANS-Aerodromes, Surface Movement Guidance and Control Systems and the Advanced Surface Movement Guidance and Control Systems.

Note (3): Additional guidance on sweeping/cleaning of surfaces is contained in CARC Guidance Material 34-GM-02 Aerodrome Maintenance Service.

Note (4): Guidance on precautions to be taken in regard to the surface of shoulders is given in CARC Guidance Material to Part 14 No. 34 GM-01, and ICAO Aerodrome Design Manual, Part 2 — Taxiways, Aprons and Holding Bays (Doc 9157).

Note (5): Where the pavement is used by large aircraft or aircraft with tire pressures in the upper categories referred to in Chapter 2 section 2.6.6(c), particular attention should be given to the integrity of light fittings in the pavement and pavement joints.

10.2.2 The surface of a runway shall be maintained in a condition such as to preclude formation of harmful irregularities.

Note: Refer to CARC Guidance Material to Part 14 No. 34 GM-01.

10.2.3 A paved runway shall be maintained in a condition so as to provide surface friction characteristics at or above the minimum friction level specified in table 10-1.

Note: Assessment, Measurement and Reporting of Runway Surface Conditions (Cir 329) contains further information on this subject.

10.2.4 Runway surface friction characteristics for maintenance purpose shall be periodically measured with a continuous friction measuring device using self-wetting features. The frequency of these measurements shall be sufficient to determine the trend of the surface friction characteristics of the runway.

Note (1): Guidance on evaluating the runway surface friction characteristics is provided in Assessment, Measurement and Reporting of Runway Surface Conditions (Cir 329).

Note (2): The objective of 10.2.3 to 10.2.8 is to ensure that the surface friction characteristics for the entire runway remain at or above a minimum friction level specified in table 10-1.

10.2.5 When runway surface friction measurements are made for maintenance purposes using a self-wetting continuous friction measuring device, the performance of the device shall meet the standard set or agreed by CARC.

10.2.6 Personnel measuring runway surface friction required in 10.2.5 shall be trained to fulfil their duties.

10.2.7 Corrective maintenance action shall be taken to prevent the runway surface friction characteristics for either the entire runway or a portion thereof from falling below the specified minimum friction level.

Note: A portion of runway in the order of 100 m long may be considered significant for maintenance or reporting action.

Table 10-1. Minimum friction level

Test equipment	Tire Type	Pressure (kPa)	Test speed (km/h)	Test water depth (mm)	Design objective for new surface	Maintenance planning level	Minimum friction level
Mu-meter Trailer	A	70	65	1.0	0.72	0.52	0.42
Mu-meter Trailer	A	70	95	1.0	0.66	0.38	0.26
Skiddometer Trailer	B	210	65	1.0	0.82	0.6	0.5
Skiddometer Trailer	B	210	95	1.0	0.74	0.47	0.34
Surface Friction Tester Veh.	B	210	65	1.0	0.82	0.6	0.5
Surface Friction Tester Veh.	B	210	95	1.0	0.74	0.47	0.34
Runway Friction Tester Veh.	B	210	65	1.0	0.82	0.6	0.5
Runway Friction Tester Veh.	B	210	95	1.0	0.74	0.54	0.41
TATRA Friction Tester Veh.	B	210	65	1.0	0.76	0.57	0.48
TATRA Friction Tester Veh.	B	210	95	1.0	0.67	0.52	0.42
RUNAR Trailer	B	210	65	1.0	0.69	0.52	0.45
RUNAR Trailer	B	210	95	1.0	0.63	0.42	0.32
GRIPTESTER Trailer	C	140	65	1.0	0.74	0.53	0.43
GRIPTESTER Trailer	C	140	95	1.0	0.64	0.36	0.24

10.2.8 The runway surface should be visually assessed, as necessary, under natural or simulated rain conditions for ponding or poor drainage and where required, corrective maintenance action taken.

10.2.9 When a taxiway is used by turbine-engined airplanes, the surface of the taxiway shoulders shall be maintained so as to be free of any loose stones or other objects that could be ingested by the airplane engines.

Note: Guidance on this subject is given in CARC Guidance Material 34-GM-08 Pavement Surface Conditions.

10.3 Removal of Contaminants

10.3.1 Snow, slush, ice, standing water, mud, dust, sand, oil, rubber deposits and other contaminants shall be removed from the surface of runways in use as rapidly and completely as possible to minimize accumulation.

Note: *the above requirement does not imply that winter operations on compacted snow and ice are prohibited. Information on snow removal and ice control and removal of other contaminants is given in CARC Guidance Material 34-GM-16 PANS-Aerodromes.*

10.3.2 Taxiways shall be kept clear of snow, slush, ice, etc., to the extent necessary to enable aircraft to be taxied to and from an operational runway.

10.3.3 Aprons shall be kept clear of snow, slush, ice, etc., to the extent necessary to enable aircraft to maneuver safely or, where appropriate, to be towed or pushed.

10.3.4 Whenever the clearance of snow, slush, ice, etc., from the various parts of the movement area cannot be carried out simultaneously, the order of priority after the runway(s) in use shall be set in consultation with the affected parties such as rescue and fire fighting service and documented in a snow plan.

Note: See PANS-AIM for information to be promulgated in an AIP concerning a snow plan. The Aeronautical Information Services Manual contains guidance on the description of a snow plan including general policy concerning operational priorities established for the clearance of movement areas.

10.3.5 Chemicals to remove or to prevent the formation of ice and frost on aerodrome pavements shall be used when conditions indicate their use could be effective. Caution shall be exercised in the application of the chemicals so as not to create a more slippery condition.

Note: information on the use of chemicals for aerodrome pavements is given in CARC Guidance Material 34-GM-16 PANS-Aerodromes.

10.3.6 Chemicals which may have harmful effects on aircraft or pavements, or chemicals which may have toxic effects on the aerodrome environment, shall not be used.

10.4 Runway Pavement Overlays

Note: The following specifications are intended for runway pavement overlay projects when the runway is to be returned temporarily to an operational status before *resurfacing is complete. This may necessitate a temporary ramp between the new and old runway surfaces. Guidance on overlaying pavements and assessing their operational status is given in CARC Guidance Material 34-GM-09 Pavement Design.*

10.4.1 The longitudinal slope of the temporary ramp, measured with reference to the existing runway surface or previous overlay course, shall be:
(a) 0.5 to 1.0 per cent for overlays up to and including 5 cm in thickness; and
(b) not more than 0.5 per cent for overlays more than 5 cm in thickness.

10.4.2 Overlaying shall proceed from one end of the runway toward the other end so that based on runway utilization most aircraft operations will experience a down ramp.

10.4.3 The entire width of the runway shall be overlaid during each work session.

10.4.4 Before a runway being overlaid is returned to a temporary operational status, a runway center line marking conforming to the specifications in Section Chapter 5 paragraph 5.2.3 shall be provided. Additionally, the location of any temporary threshold shall be identified by a 3.6 m wide transverse stripe.

10.4.5 The overlay shall be constructed and maintained above the minimum friction level specified in 10.2.3.

10.5 Visual Aids

Note (1): These specifications are intended to define the maintenance performance level objectives. They are not intended to define whether the lighting system is operationally out of service.

Note (2): The energy savings of light emitting diodes (LEDs) are due in large part to the fact that they do not produce the infra-red heat signature of incandescent lamps. Aerodrome operators who have come to expect the melting of ice and snow by this heat signature may wish to evaluate whether or not a modified maintenance schedule is required during such conditions, or evaluate the possible operational value of installing LED fixtures with heating elements.

Note (3): Enhanced vision systems (EVS) technology relies on the infra-red heat signature provided by incandescent lighting. ICAO Annex 15 protocols provide an appropriate means of notifying aerodrome users of EVS when lighting systems are converted to LED.

10.5.1 A light shall be deemed to be unserviceable when the main beam average intensity is less than 50 per cent of the value specified in the appropriate figure in Appendix 2. For light units where the main beam average intensity is required to be higher than the value specified in the appropriate figure in Appendix 2, a light shall be deemed to be unserviceable when the main beam average intensity value is less than 50 per cent of this higher value and not the value specified in Appendix 2.

Note: Guidance on maintenance criteria for aeronautical ground lights, on the use of a site standard and on using a higher main beam average intensity is contained in the CARC Guidance Material 34-GM-02 Visual Aids for Navigation.

10.5.2 A system of preventive maintenance of visual aids shall be employed to ensure lighting and marking system reliability.

Note: Guidance on preventive maintenance of visual aids is given in CARC Guidance Material 34-GM-02 Aerodrome Maintenance Service.

10.5.3 The system of preventive maintenance employed for a precision approach runway category II or III shall include at least the following checks:

(a) visual inspection and in-field measurement of the intensity, beam spread and orientation of lights included in the approach and runway lighting systems;
(b) control and measurement of the electrical characteristics of each circuitry included in the approach and runway lighting systems; and
(c) control of the correct functioning of light intensity settings used by air traffic control.

10.5.4 In-field measurement of intensity, beam spread and orientation of lights included in approach and runway lighting systems for a precision approach runway category II or III shall be undertaken by measuring all lights, as far as practicable, to ensure conformance with the applicable specification of Appendix 2.

10.5.5 Measurement of intensity, beam spread and orientation of lights included in approach and runway lighting systems for a precision approach runway category II or III shall be undertaken using a mobile measuring unit of sufficient accuracy to analyze the characteristics of the individual lights.

10.5.6 The frequency of measurement of lights for a precision approach runway category II or III shall be based on traffic density, the local pollution level, the reliability of the installed lighting equipment and the continuous assessment of the results of the in-field measurements but in any event shall not be less than twice a year for in-pavement lights and not less than once a year for other lights.

10.5.7 The system of preventive maintenance employed for a precision approach runway category II or III shall have as its objective that, during any period of category II or III operations, all approach and runway lights are serviceable, and that in any event at least:

(a) 95 per cent of the lights are serviceable in each of the following particular significant elements:
    (1) precision approach category II and III lighting system, the inner 450 m;
    (2) runway center line lights;
    (3) runway threshold lights; and
    (4) runway edge lights;

(b) 90 per cent of the lights are serviceable in the touchdown zone lights;

(c) 85 per cent of the lights are serviceable in the approach lighting system beyond 450 m; and

(d) 75 per cent of the lights are serviceable in the runway end lights.

In order to provide continuity of guidance, the allowable percentage of unserviceable lights shall not be permitted in such a way as to alter the basic pattern of the lighting system. Additionally, an unserviceable light shall not be permitted adjacent to another unserviceable light, except in a barrette or a crossbar where two adjacent unserviceable lights may be permitted.

Note: With respect to barrettes, crossbars and runway edge lights, lights are considered to be adjacent if located consecutively and:

— laterally: in the same barrette or crossbar; or
— longitudinally: in the same row of edge lights or barrettes.

10.5.8 The system of preventive maintenance employed for a stop bar provided at a runway-holding position used in conjunction with a runway intended for operations in runway visual range conditions less than a value of 300 m shall have the following objectives:

a) no more than two lights will remain unserviceable; and
b) two adjacent lights will not remain unserviceable unless the light spacing is significantly less than that specified.

10.5.9 The system of preventive maintenance employed for a taxiway intended for use in runway visual range conditions less than a value of 300 m shall have as its objective that no two adjacent taxiway center line lights be unserviceable.

10.5.10 The system of preventive maintenance employed for a precision approach runway category I shall have as its objective that, during any period of category I operations, all approach and runway lights are serviceable, and that in any event at least 85 per cent of the lights are serviceable in each of the following:

(a) precision approach category I lighting system;
(b) runway threshold lights;
(c) runway edge lights; and
(d) runway end lights.

In order to provide continuity of guidance an unserviceable light shall not be permitted adjacent to another unserviceable light unless the light spacing is significantly less than that specified.

Note: In barrettes and crossbars, guidance is not lost by having two adjacent unserviceable lights.

10.5.11 The system of preventive maintenance employed for a runway meant for take-off in runway visual range conditions less than a value of 550 m shall have as its objective that, during any period of operations, all runway lights are serviceable and that in any event:

a) at least 95 per cent of the lights are serviceable in the runway center line lights (where provided) and in the runway edge lights; and
b) at least 75 per cent of the lights are serviceable in the runway end lights.

In order to provide continuity of guidance, an unserviceable light shall not be permitted adjacent to another unserviceable light.

10.5.12 The system of preventive maintenance employed for a runway meant for take-off in runway visual range conditions of a value of 550 m or greater shall have as its objective that, during any period of operations, all runway lights are serviceable and that, in any event, at least 85 per cent of the lights are serviceable in the runway edge lights and runway end lights. In order to provide continuity of guidance, an unserviceable light shall not be permitted adjacent to another unserviceable light.

10.5.13 During low visibility procedures the designated authority shall restrict construction or maintenance activities in the proximity of aerodrome electrical systems.

Appendix (1)
Colours for Aeronautical Ground Lights, Markings, Signs and Panels

1. General

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

It is not possible to establish specifications for colors such that there is no possibility of confusion. For reasonably certain recognition, it is important that the eye illumination be well above the threshold of perception, that the color not be greatly modified by selective atmospheric attenuations and that the observer's color vision be adequate. There is also a risk of confusion of color at an extremely high level of eye illumination such as may be obtained from a high-intensity source at very close range. Experience indicates that satisfactory recognition can be achieved if due attention is given to these factors.
The chromaticities are expressed in terms of the standard observer and coordinate system adopted by the International Commission on Illumination (CIE) at its Eighth Session at Cambridge, England, in 1931.
The chromaticities for solid state lighting (e.g. LED) are based upon the boundaries given in the standard S 004/E-2001 of the International Commission on Illumination (CIE), except for the blue boundary of white.

2. Colors for Aeronautical Ground Lights

2.1 Chromaticities for lights having filament-type light sources

2.1.1 The chromaticities of aeronautical ground lights shall be within the following boundaries:

CIE Equations (see Figure A1-1a):

(a) <u>Red</u>

Purple boundary	y = 0.980 – x
Yellow boundary	y = 0.335 except for visual approach slope indicator systems;
Yellow boundary	y = 0.320, for visual approach slope indicator systems.

Note: See Chapter 5 5.3.5.14 and 5.3.5.30

(b) Yellow

Red boundary	y = 0.382
White boundary	y = 0.790 – 0.667x
Green boundary	y = x – 0.120

(c) Green

Yellow boundary	x = 0.360 – 0.080y
White boundary	x = 0.650y
Blue boundary	y = 0.390 – 0.171x

(d) Blue

Green boundary	y = 0.805x + 0.065
White boundary	y = 0.400 – x
Purple boundary	x = 0.600y + 0.133

(e) White

Yellow boundary	x = 0.500
Blue boundary	x = 0.285
Green boundary	y = 0.440 and y = 0.150 + 0.640x
Purple boundary	y = 0.050 + 0.750x and y = 0.382

(f) Variable white

Yellow boundary	x = 0.255 + 0.750y and y = 0.790 - 0.667x
Blue boundary	x = 0.285
Green boundary	y = 0.440 and y = 0.150 + 0.640x
Purple boundary	y = 0.050 + 0.750x and y = 0.382

Note: Guidance on chromaticity changes resulting from the effect of temperature on filtering elements is given in CARC Guidance material visual aids.

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

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

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

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

Yellow boundary	$y = 0.726 - 0.726x$
White boundary	$x = 0.625y - 0.041$
Blue boundary	$y = 0.390 - 0.171x$

2.2 Discrimination between lights having filament-type sources

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

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

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

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

(a) the x coordinate of the yellow is at least 0.050 greater than the x coordinate of the white; and

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

2.3 Chromaticities for lights having a solid state light source

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

CIE Equations (see Figure A1-1b):

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

Note: See Chapter 5, paragraph 5.3.5.14 and 5.3.5.30.

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

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

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

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

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

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

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

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

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

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

2.4.1 The colour of aeronautical ground lights shall be verified as being within the boundaries specified in Figure A1-1a or K1-1b, as appropriate, by measurement at five points within the area limited by the innermost isocandela curve (isocandela diagrams in Appendix 2 refer), with operation at rated current or voltage. In the case of elliptical or circular isocandela curves, the colour measurements shall be taken at the centre and at the horizontal and vertical limits. In the case of rectangular isocandela curves, the colour measurements shall be taken at the centre and the limits of the diagonals (corners). In addition, the colour of the light shall be checked at the outermost isocandela curve to ensure that there is no colour shift that might cause signal confusion to the pilot.

Note (1): For the outermost isocandela curve, a measurement of colour coordinates should be made and recorded for review and judgement of acceptability by CARC.

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

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

3. Colors for Markings, Signs and Panels

Note (1): The specifications of surface colors given below apply only to freshly colored surfaces. Colors used for markings, signs and panels usually change with time and therefore require renewal.

Note (2): The specifications recommended in 3.4 below for trans-illuminated panels are interim in nature and are based on the CIE specifications for trans-illuminated *signs. It is intended that these specifications will be reviewed and updated as and when CIE develops specifications for trans-illuminated panels.*

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

(a) angle of illumination: 45°;
(b) direction of view: perpendicular to surface; and
(c) illuminant: CIE standard illuminant D65.

3.2 The chromaticity and luminance factors of ordinary colors for markings and externally illuminated signs and panels shall be within the following boundaries when determined under standard conditions. CIE Equations (see Figure A1-2):

(a) Red

Purple boundary	y = 0.345 – 0.051x
White boundary	y = 0.910 – x
Orange boundary	y = 0.314 + 0.047x
Luminance factor	ß = 0.07 (mnm)

(b) Orange

Red boundary	y = 0.285 + 0.100x
White boundary	y = 0.940 – x
Yellow boundary	y = 0.250 + 0.220x
Luminance factor	ß = 0.20 (mnm)

(c) Yellow

Orange boundary	y = 0.108 + 0.707x
White boundary	y = 0.910 – x
Green boundary	y = 1.35x – 0.093
Luminance factor	ß = 0.45 (mnm)

(d) White

Purple boundary	y = 0.010 + x
Blue boundary	y = 0.610 – x
Green boundary	y = 0.030 + x
Yellow boundary	y = 0.710 – x
Luminance factor	ß = 0.75 (mnm)

(e) Black

Purple boundary	y = x – 0.030
Blue boundary	y = 0.570 – x
Green boundary	y = 0.050 + x

Yellow boundary	y = 0.740 – x
Luminance factor	ß = 0.03 (max)

(f) Yellowish green

Green boundary	y = 1.317x + 0.4
White boundary	y = 0.910 – x
Yellow boundary	y = 0.867x + 0.4

(g) Green

Yellow boundary	x=0.313
White boundary	y=0.243+0.670x
Blue boundary	y=0.493-0.524x
Luminance factor	β=0.10 (mnm)

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

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

CIE Equations (see Figure A1-3):

(a) Red

Purple boundary	y = 0.345 – 0.051x
White boundary	y = 0.910 – x
Orange boundary	y = 0.314 + 0.047x
Luminance factor	ß = 0.03 (mnm)

(b) Orange

Red boundary	y = 0.265 + 0.205x
White boundary	y = 0.910 – x
Yellow boundary	y = 0.207 + 0.390x
Luminance factor	ß = 0.14 (mnm)

(c) Yellow

Orange boundary	y = 0.160 + 0.540x
White boundary	y = 0.910 – x
Green boundary	y = 1.35x – 0.093
Luminance factor	ß = 0.16 (mnm)

(d) White

Purple boundary	y = x

Blue boundary	y = 0.610 – x
Green boundary	y = 0.040 + x
Yellow boundary	y = 0.710 – x
Luminance factor	ß = 0.27 (mnm)

(e) <u>Blue</u>

Green boundary	y = 0.118 + 0.675x
White boundary	y = 0.370 – x
Purple boundary	y = 1.65x – 0.187
Luminance factor	ß = 0.01 (mnm)

(f) <u>Green</u>

Yellow boundary	y = 0.711 – 1.22x
White boundary	y = 0.243 + 0.670x
Blue boundary	y = 0.405 – 0.243x
Luminance factor	ß = 0.03 (mnm)

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

CIE Equations (see Figure A1-4):

(a) <u>Red</u>

Purple boundary	y = 0.345 – 0.051x
White boundary	y = 0.910 – x
Orange boundary	y = 0.314 + 0.047x
Luminance factor (day condition)	ß = 0.07 (mnm)
Relative luminance to white (night condition)	5% (mnm) 20% (max)

(b) <u>Yellow</u>

Orange boundary	y = 0.108 + 0.707x
White boundary	y = 0.910 – x
Green boundary	y = 1.35x – 0.093
Luminance factor (day condition)	ß = 0.45 (mnm)
Relative luminance to white	30% (mnm)

(night condition)	80% (max)

(c) <u>White</u>

Purple boundary	y = 0.010 + x
Blue boundary	y = 0.610 – x
Green boundary	y = 0.030 + x
Yellow boundary	y = 0.710 – x
Luminance factor (day condition)	ß = 0.75 (mnm)
Relative luminance to white (night condition)	100%

(d) <u>Black</u>

Purple boundary	y = x – 0.030
Blue boundary	y = 0.570 – x
Green boundary	y = 0.050 + x
Yellow boundary	y = 0.740 – x
Luminance factor (day condition)	ß = 0.03 (max)
Relative luminance to white	0% (mnm)
(night condition)	2% (max)

(e) <u>Green</u>

Yellow boundary	x=0.313
White boundary	y=0.243+0.670x
Blue boundary	y=0.493-0.524x
Luminance factor	β=0.10 minimum (day conditions)
Relative luminance	5% (minimum)
to white (night conditions)	30% (maximum)

Note: Figures A1-1 to A1-4 are on pages 10 to 14 of this appendix.

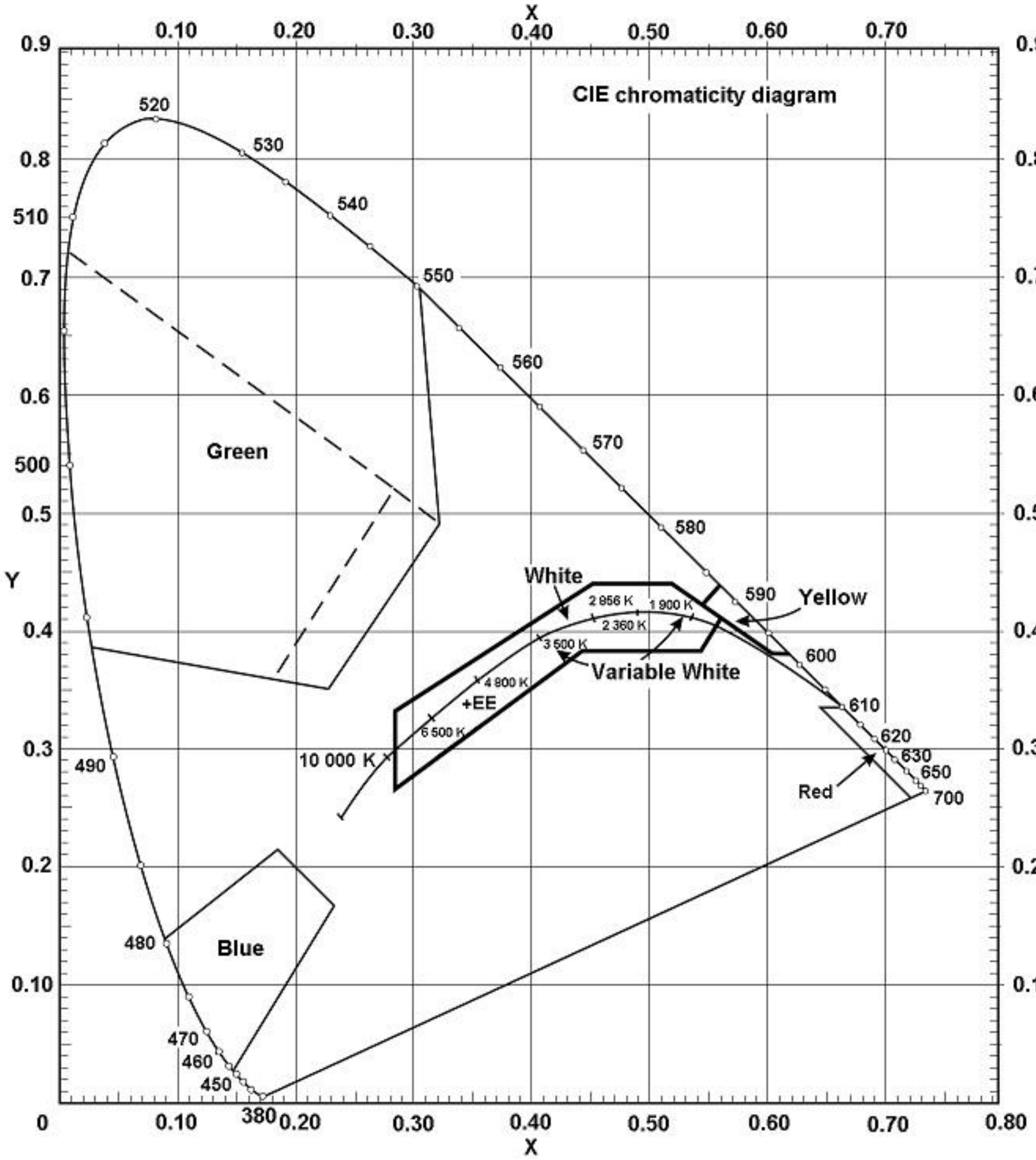


Figure A1-1a. Colors for aeronautical ground lights (filament-type lamps)

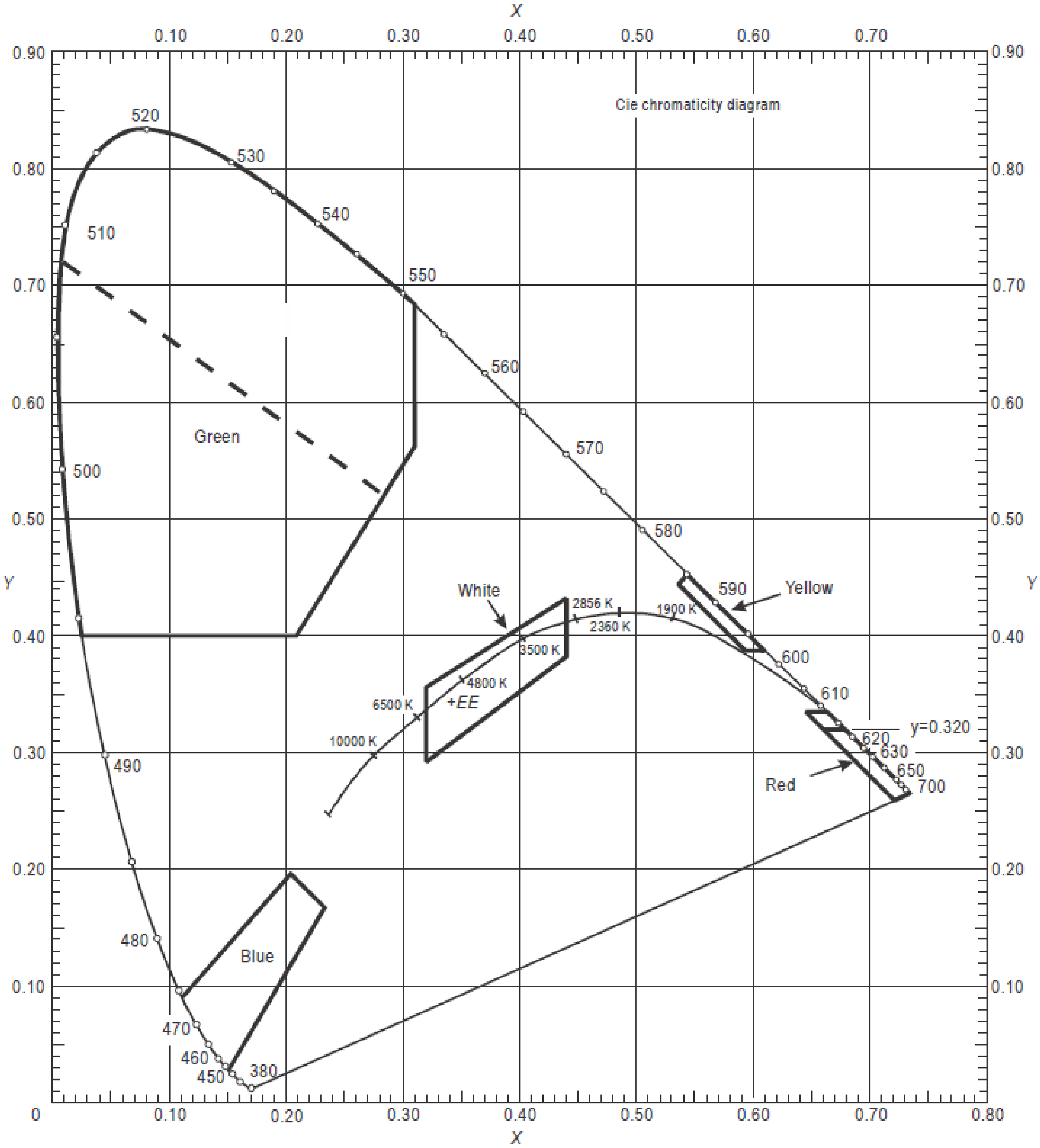


Figure A1-1b. Colors for aeronautical ground lights (solid state lighting)

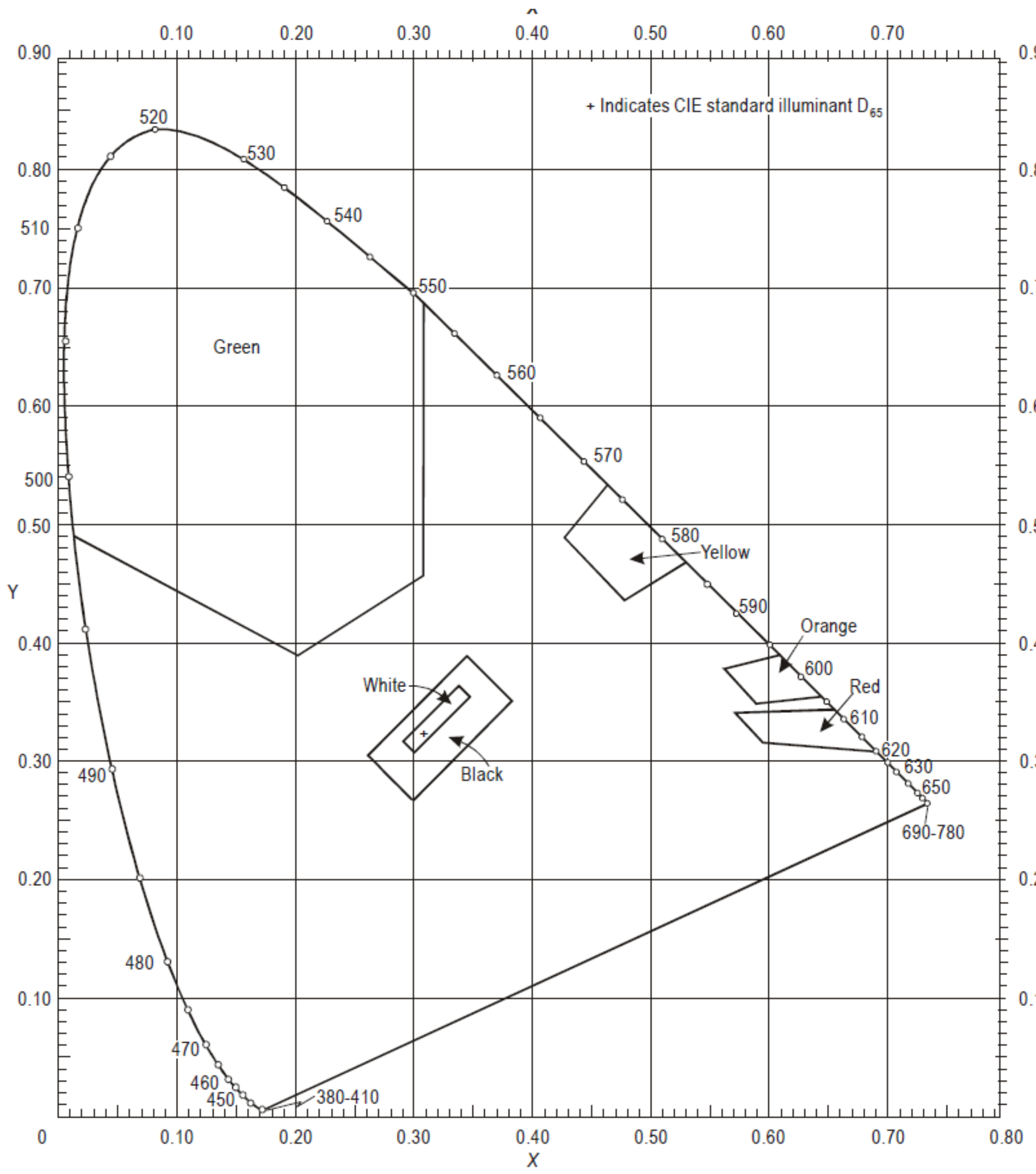


Figure A1-2. Ordinary colors for markings and externally illuminated signs and panels

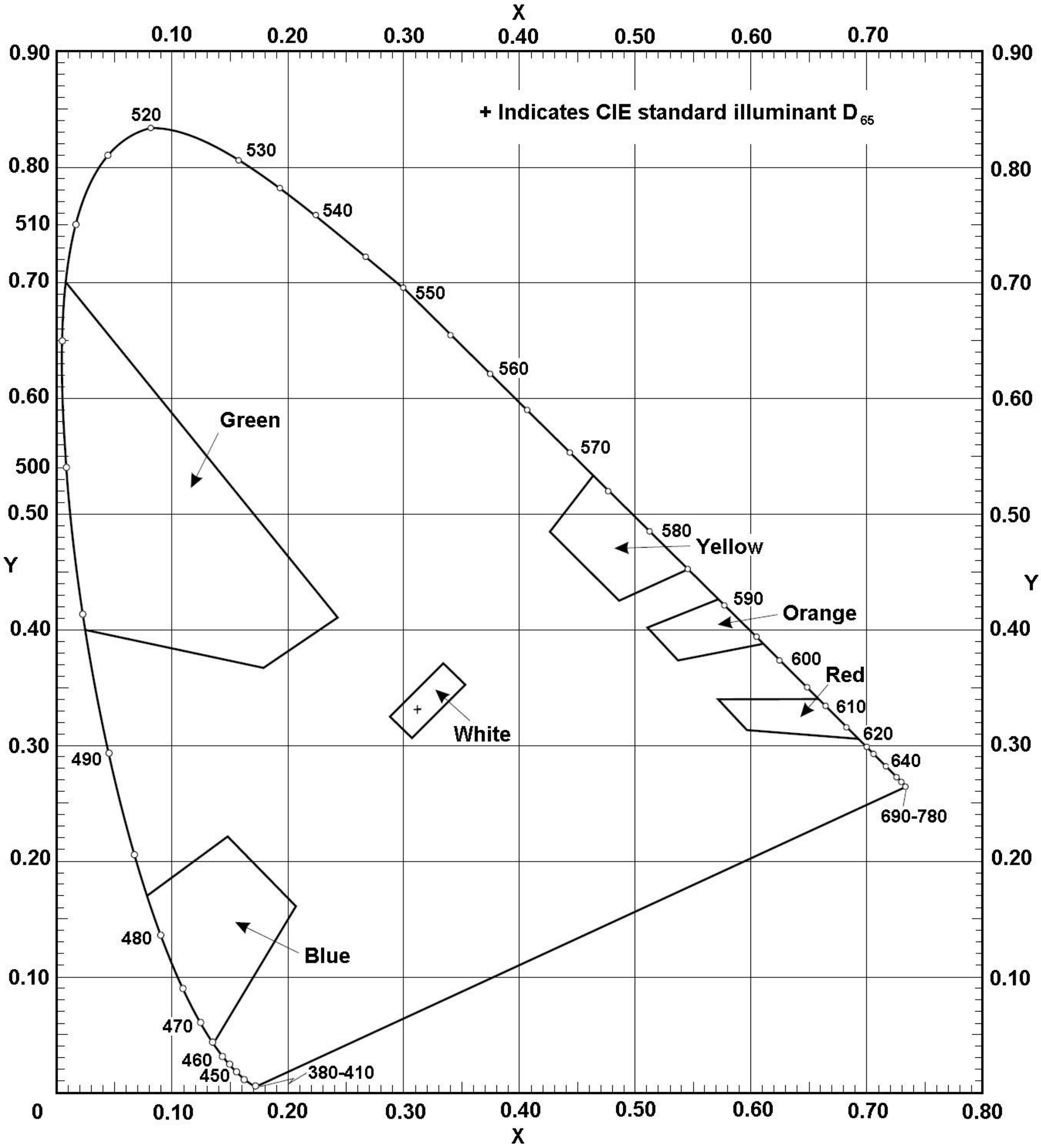


Figure A1-3. Colors of retro-reflective materials for markings, signs and panels

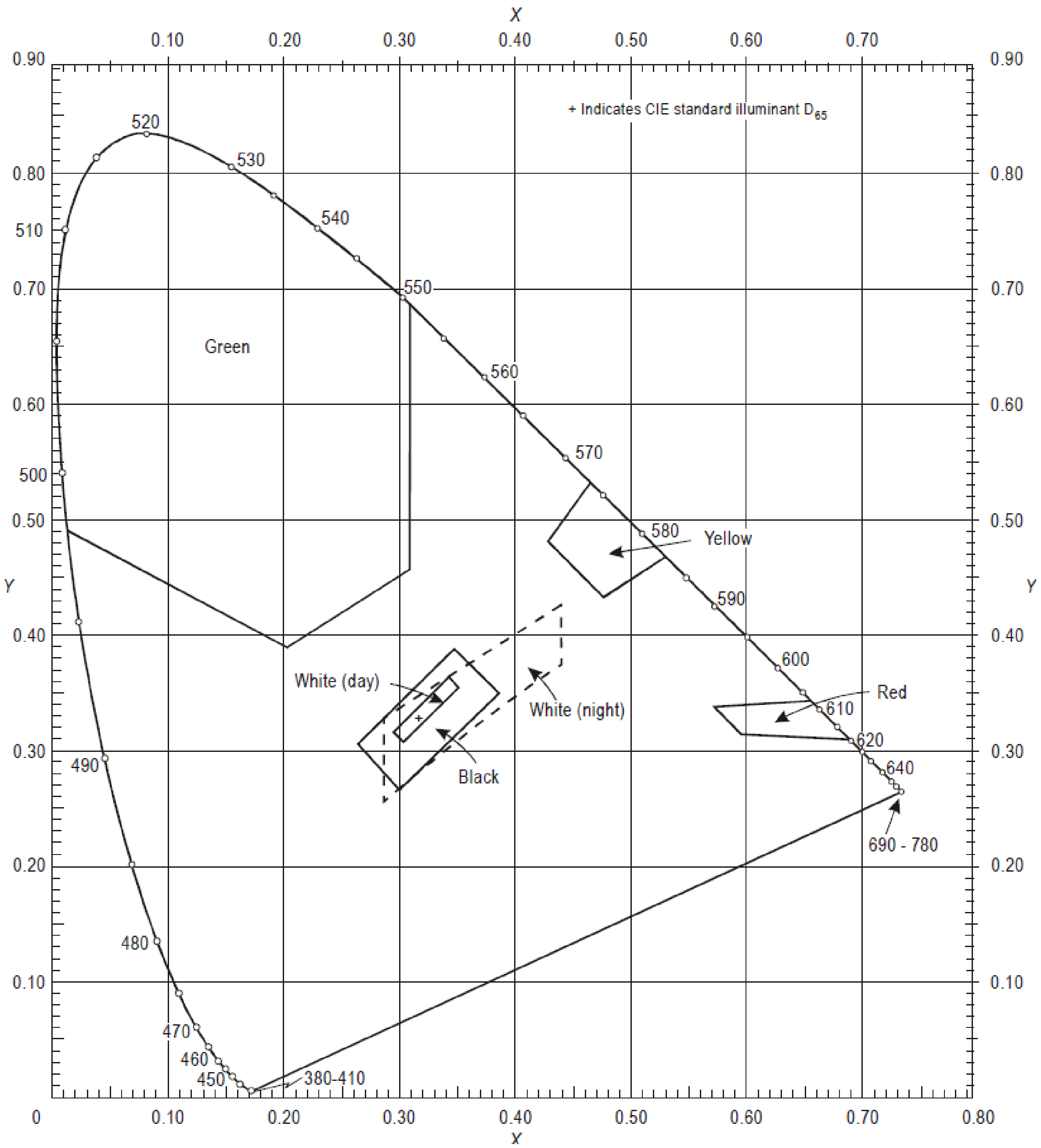
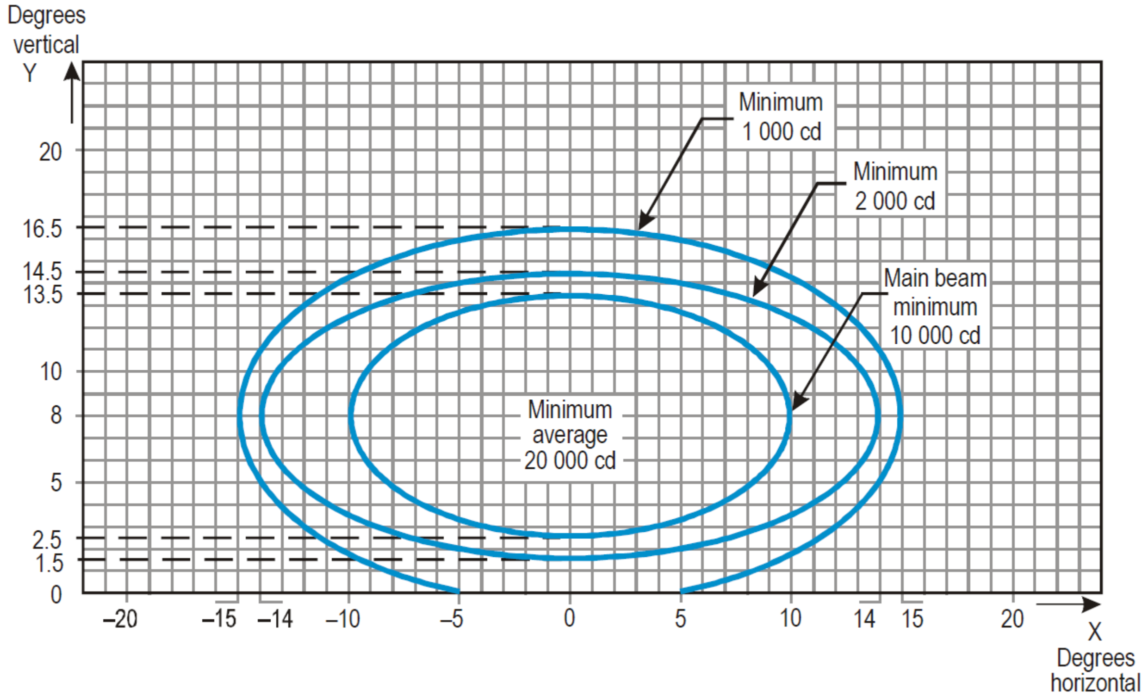


Figure A1-4. Colors of luminescent or trans-illuminated (internally illuminated) signs and panels

Appendix (2) Aeronautical Ground Light Characteristics



Notes:

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

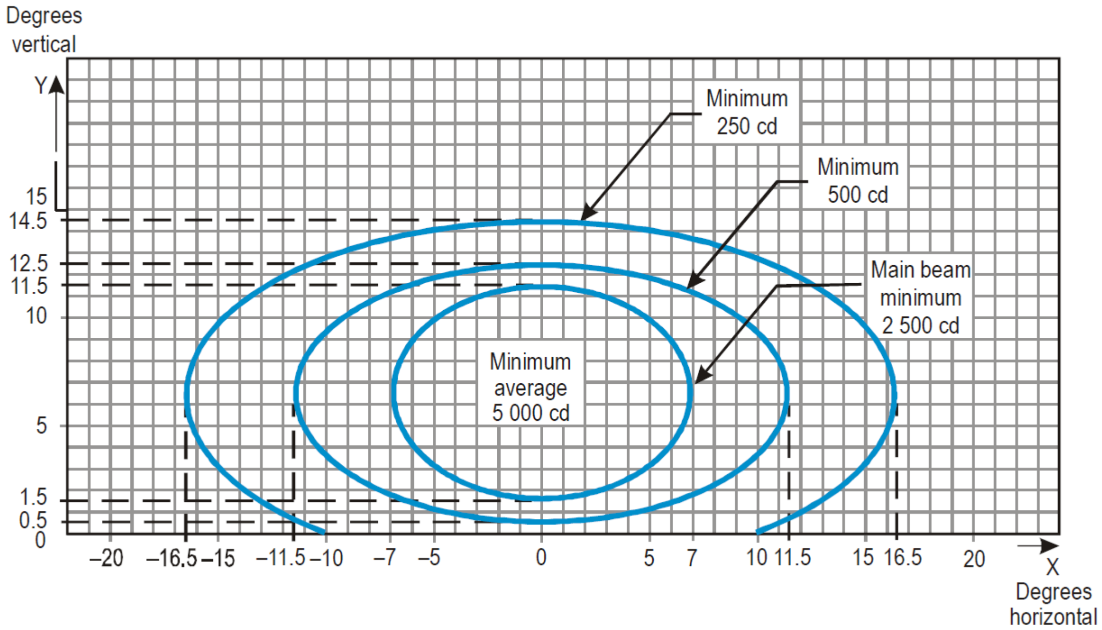
a	10	14	15
b	5.5	6.5	8.5

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

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

3. Lights in crossbars beyond 22.5 m from the center line shall be toed-in 2 degrees. All other lights shall be aligned parallel to the center line of the runway.
4. See collective notes for Figures A2-1 to A2-11, A2-26 and A2-27.

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



Notes:

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

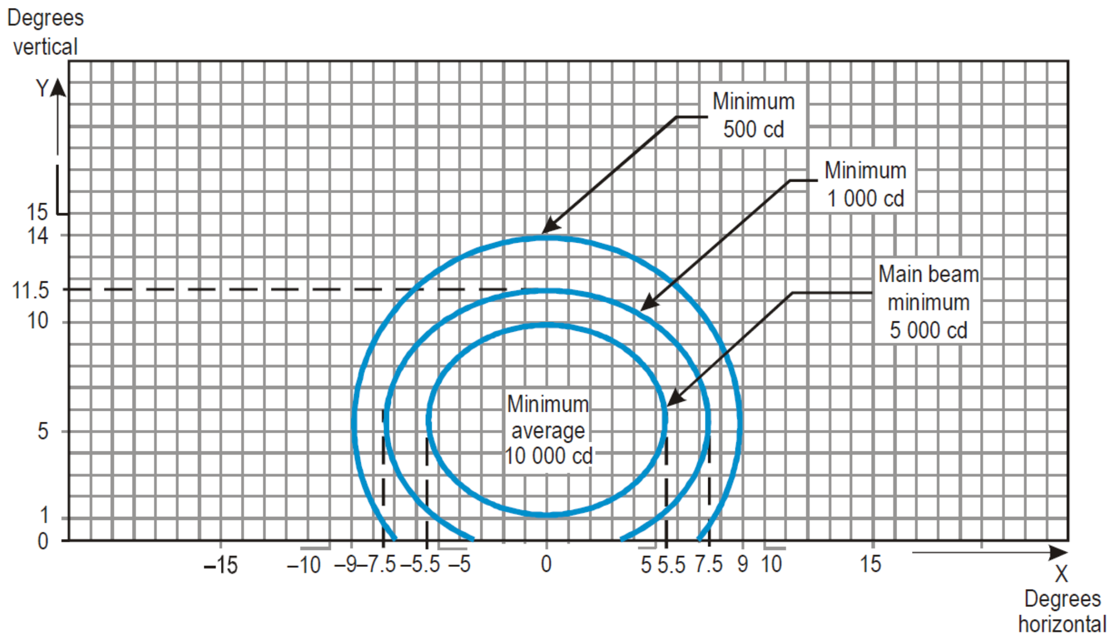
a	7.0	11.5	16.5
b	5.0	6.0	8.0

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

distance from threshold	vertical main beam coverage
threshold to 115 m	0.5°— 10.5°
116 m to 215 m	1°— 11°
216 m and beyond	1.5°— 11.5°

4. See collective notes for Figures A2-1 to A2-11, A2-26 and A2-27.

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



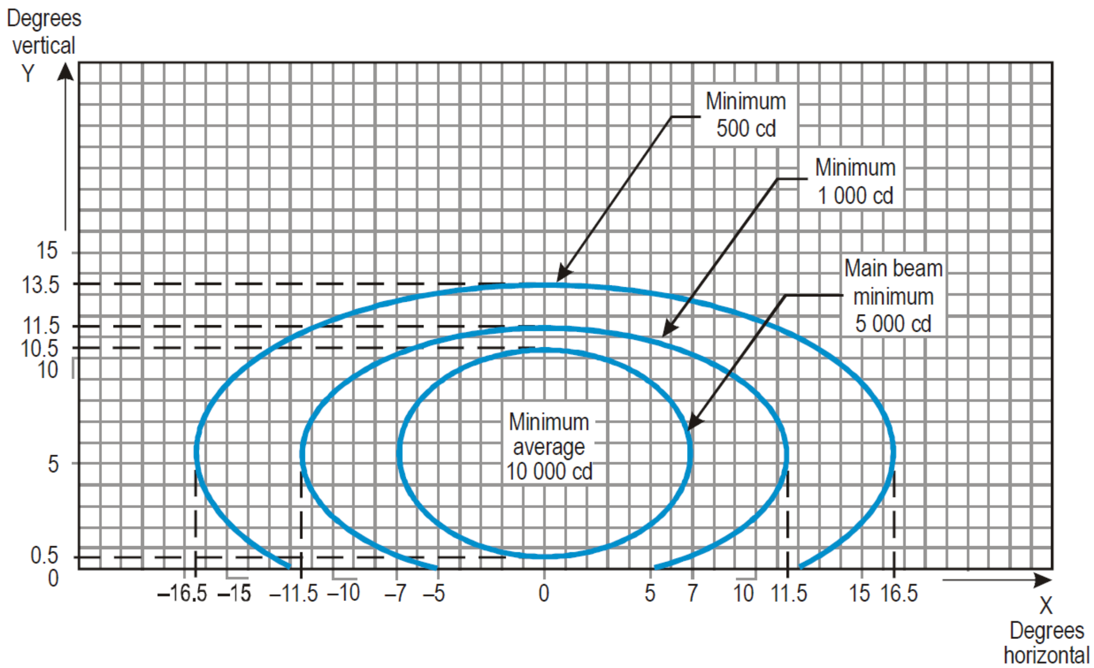
Notes:

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

a	5.5	7.5	9.0
b	4.5	6.0	8.5

2. Toe-in 3.5 degrees.
3. See collective notes for Figures A2-1 to A2-11, A2-26 and A2-27.

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



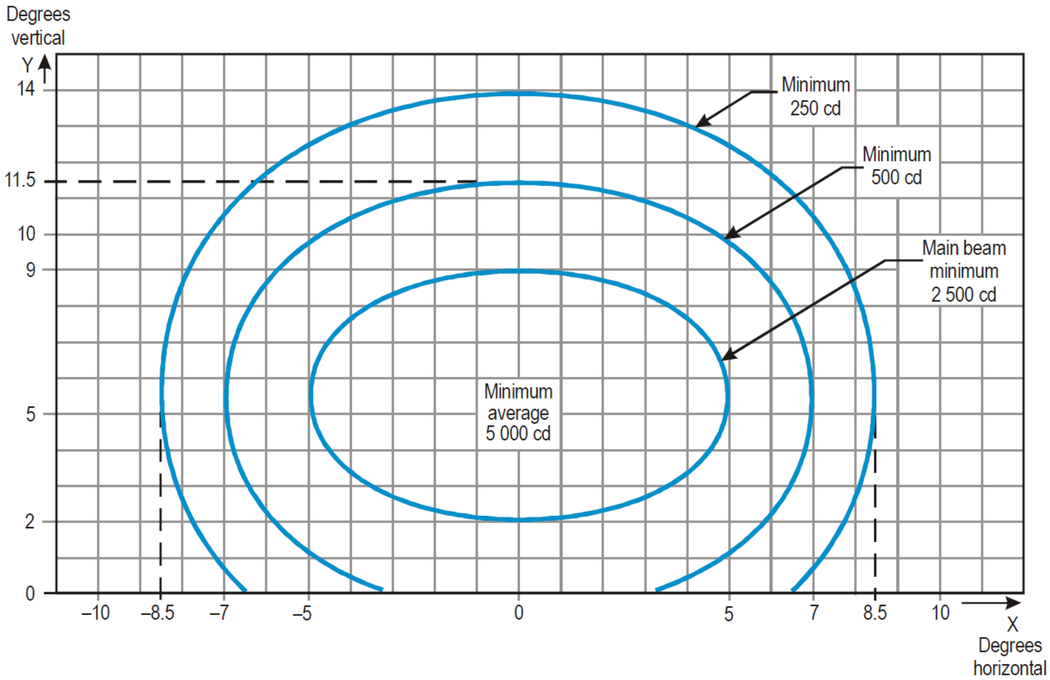
Notes:

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 2 degrees.
3. See collective notes for Figures A2-1 to A2-11, A2-26 and A2-27.

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



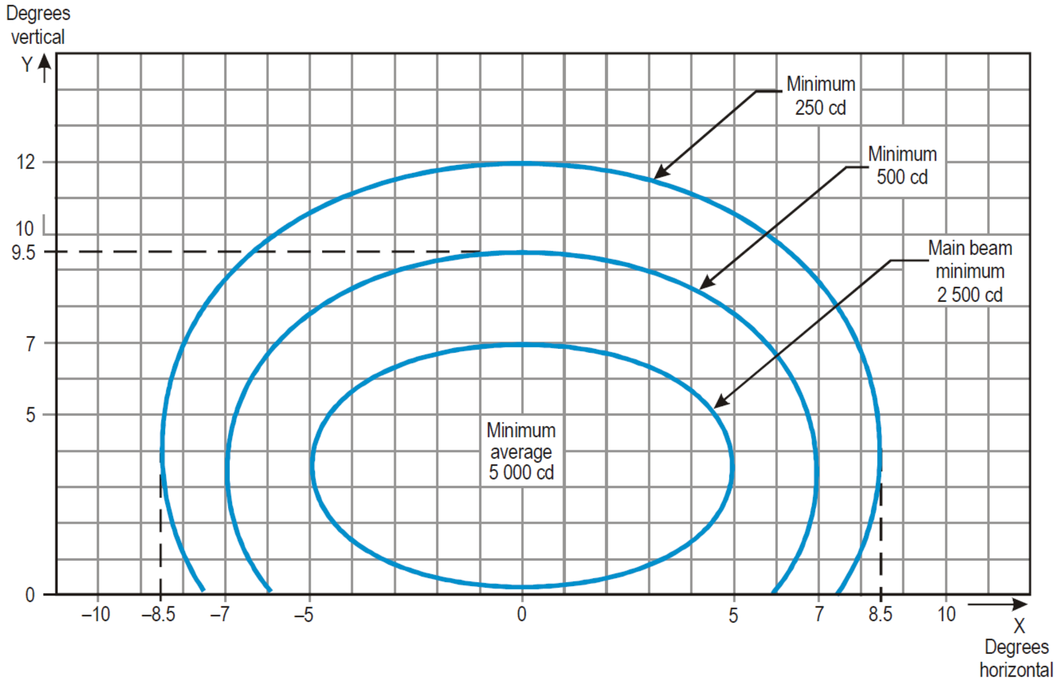
Notes:

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 4 degrees.
3. See collective notes for Figures A2-1 to A2-11, A2-26 and A2-27.

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



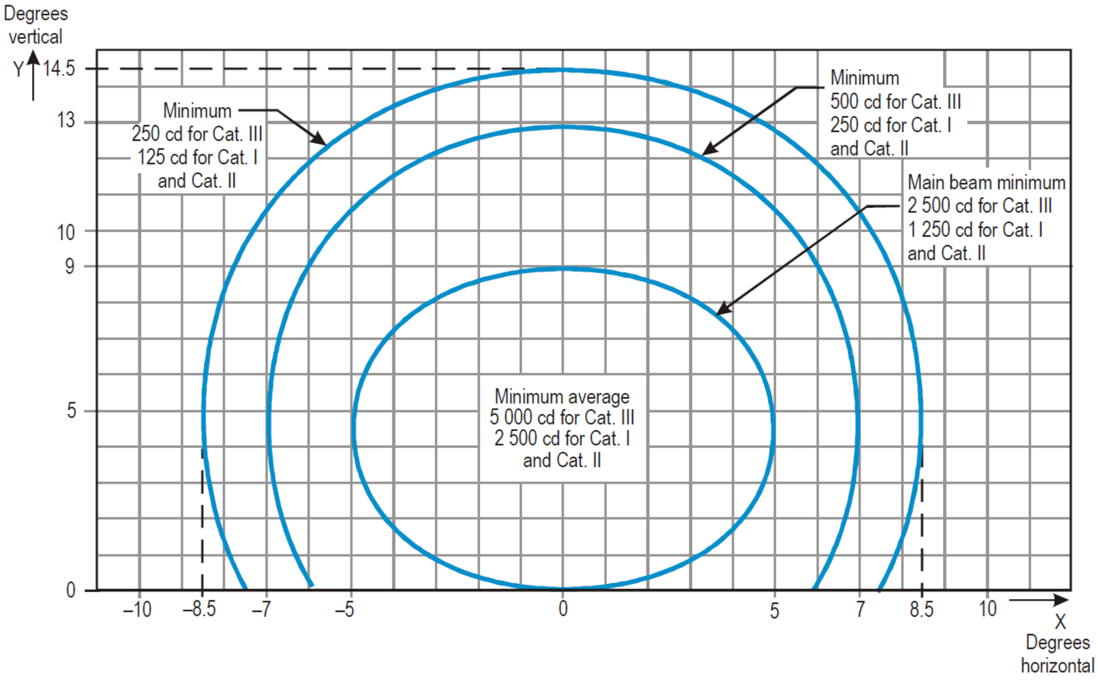
Notes:

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. For red light, multiply values by 0.15.
3. For yellow light, multiply values by 0.40.
4. See collective notes for Figures A2-1 to A2-11, A2-26 and A2-27.

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



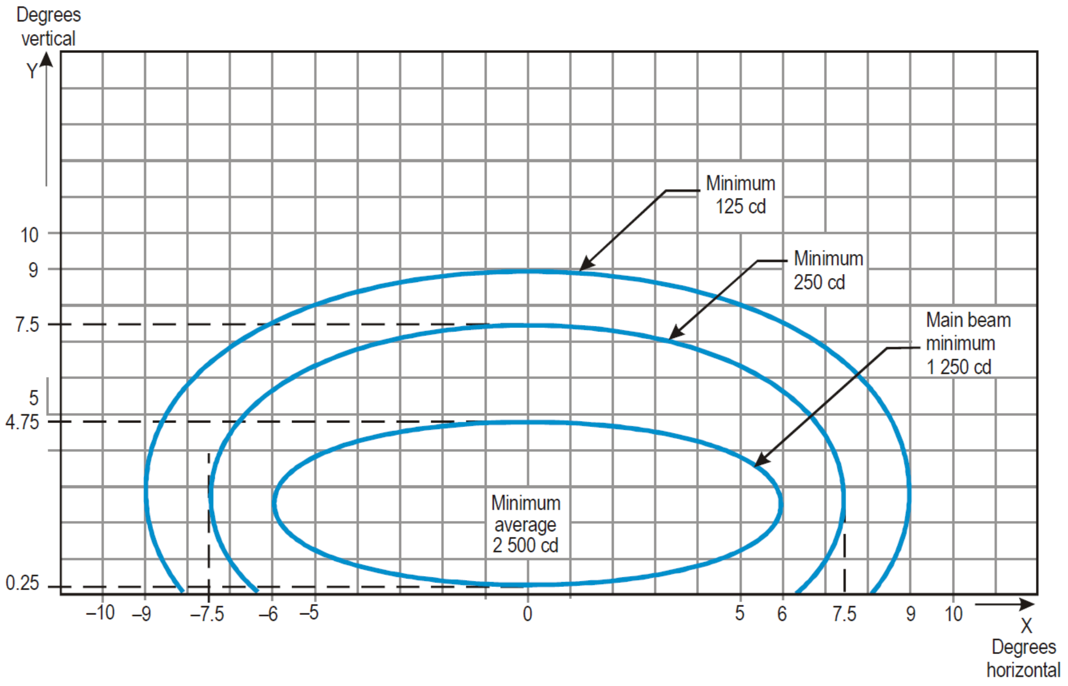
Notes:

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

a	5.0	7.0	8.5
b	4.5	8.5	10

2. For red light, multiply values by 0.15.
3. For yellow light, multiply values by 0.40.
4. See collective notes for Figures A2-1 to A2-11, A2-26 and A2-27.

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



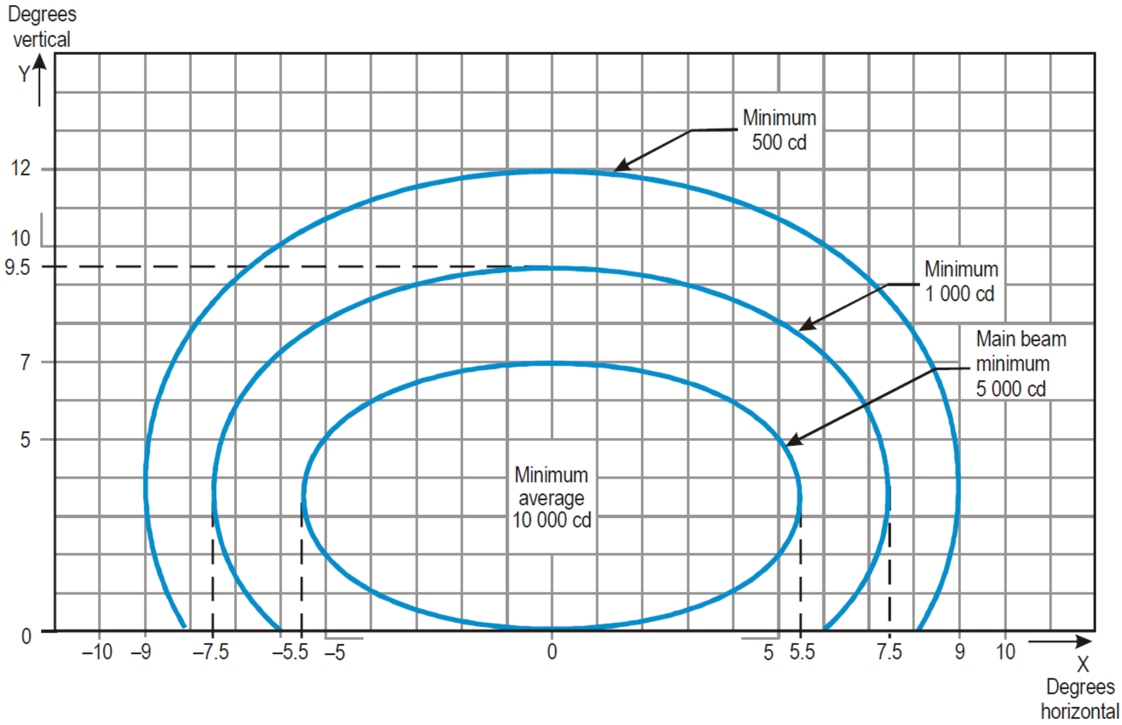
Notes:

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 for Figures A2-1 to A2-11, A2-26 and A2-27.

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



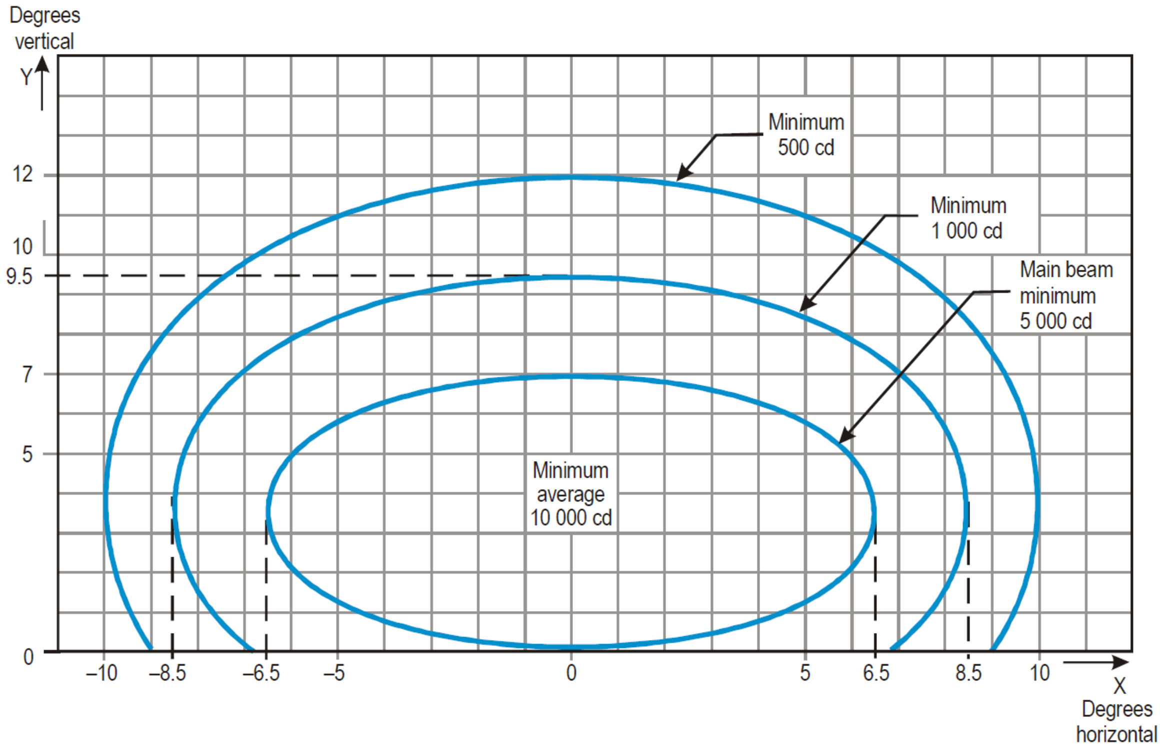
Notes:

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

a	5.5	7.5	9.0
b	3.5	6.0	8.5

2. Toe-in 3.5 degrees.
3. For red light, multiply values by 0.15.
4. For yellow light, multiply values by 0.40.
5. See collective notes for Figures A2-1 to A2-11, A2-26 and A2-27.

Figure A2-9. Isocandela diagram for runway edge light where width of runway is 45 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 degrees.
3. For red light, multiply values by 0.15.
4. For yellow light, multiply values by 0.40.
5. See collective notes for Figures A2-1 to A2-11, A2-26 and A2-27.

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

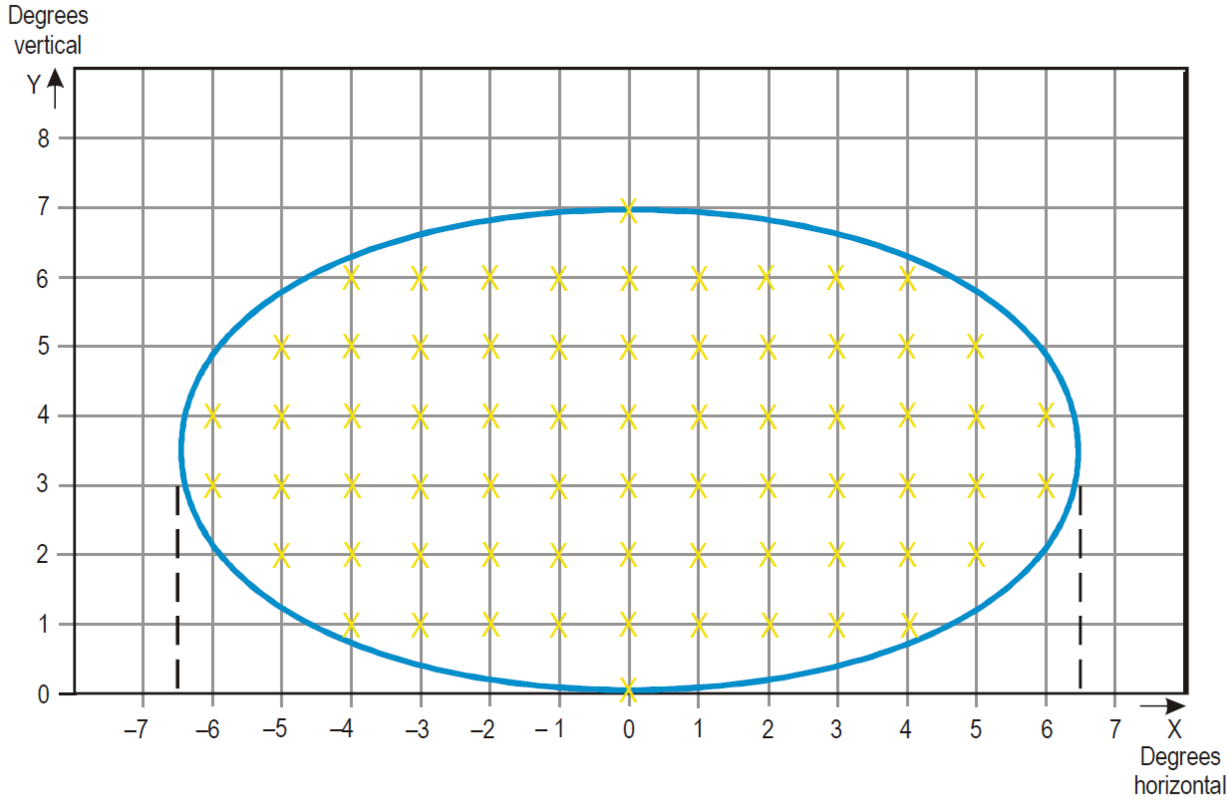


Figure A2-11. Grid points to be used for the calculation of average intensity of approach and runway lights

Collective notes to Figures A2-1 to A2-11

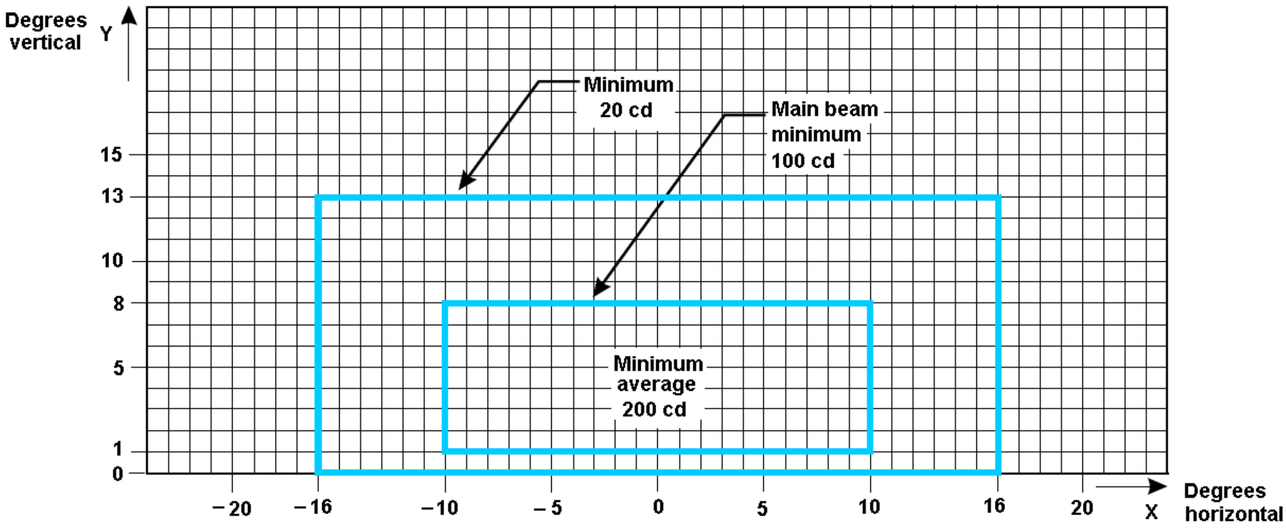
1. The ellipses in each figure are symmetrical about the common vertical and horizontal axes.
2. Figures A2-1 to A2-10 show the minimum allowable light intensities. The average intensity of the main beam is calculated by establishing grid points as shown in Figure A2-11 and using the intensity values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

The average intensity within the ellipse defining the main beam of a new light is established as a ratio of the minimum (1.0) average intensity of a new Runway edge light. The ratios also define the maximum allowed main beam average intensity for the lights in the lighting system supporting runway operations. Guidance on maintenance criteria for aeronautical ground lights and the use of a site standard is contained in the CARC Guidance Material 34-GM-17 Visual Aids for Navigation.

Figure A2-1	Approach center line and crossbars	2.0 to 3.0 (white light)
Figure A2-2	Approach side row	0.5 to 1.0 (red light)
Figure A2-3	Threshold	1.0 to 1.5 (green light)
Figure A2-4	Threshold wing bar	1.0 to 1.5 (green light)
Figure A2-5	Touchdown zone	0.5 to 1.0 (white light)
Figure A2-6	Runway center line (longitudinal spacing 30 m)	0.5 to 1.0 (white light)
Figure A2-7)	Runway center line (longitudinal spacing 15 m)	0.5 to 1.0 for CAT III (white light) 0.25 to 0.5 for CAT I, II (white light)
Figure A2-8	Runway end	0.25 to 0.5 (red light)
Figure A2-9	Runway edge (45 m runway width)	1.0 to 1.5 (white light)

Figure A2-10	Runway edge (60 m runway width)	1.0 to 1.5 (white light)

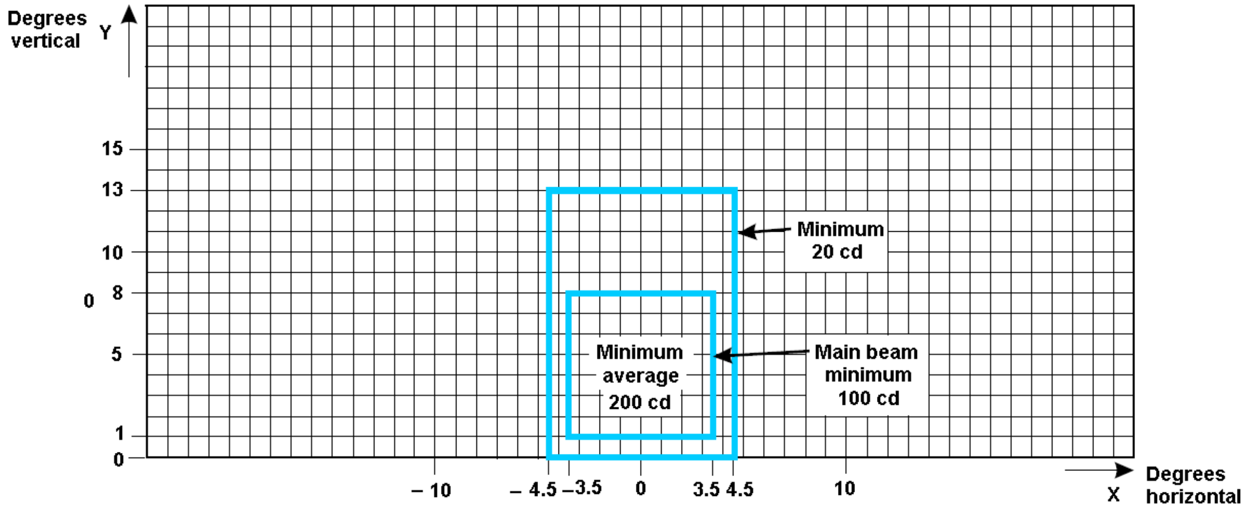
5. The beam coverages in the figures provide the necessary guidance for approaches down to an RVR of the order of 150 m and take-offs down to an RVR of the order of 100 m.
6. Horizontal angles are measured with respect to the vertical plane through the runway center line. For lights other than center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



Notes:

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

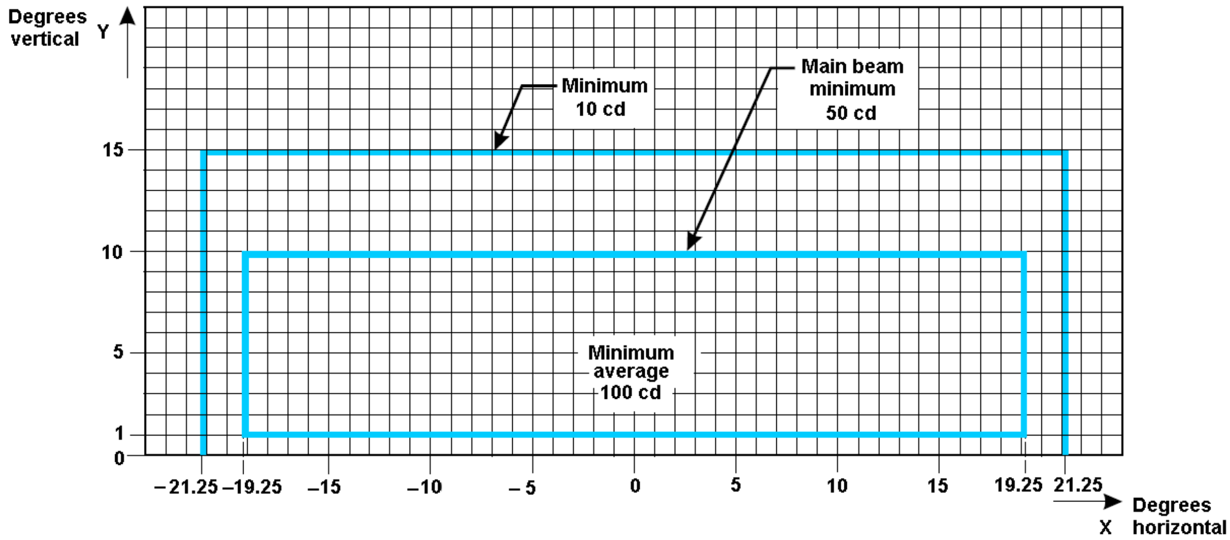
Figure A2-12. Isocandela diagram for taxiway centre line (15 m spacing), RELs, no entry bar and stop bar lights in straight sections intended for use in runway visual range conditions of less than a value of 300 m where large offsets can occur and for low-intensity runway guard lights, Configuration B



Notes:

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

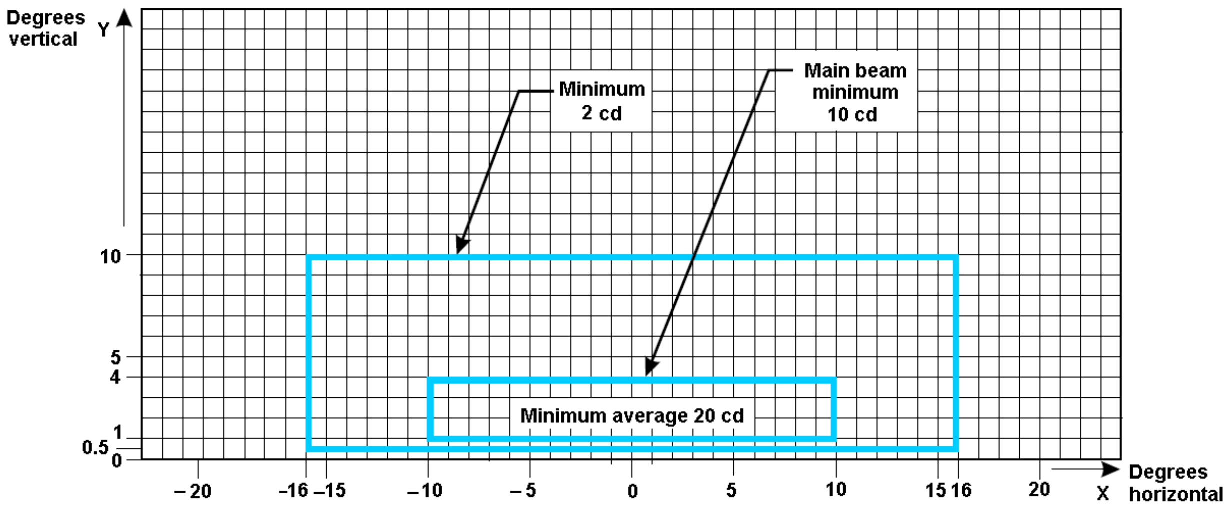
Figure A2-13. Isocandela diagram for taxiway center line (15 m spacing), no entry bar and stop bar lights in straight sections intended for use in runway visual range conditions of less than a value of 300 m



Notes:

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

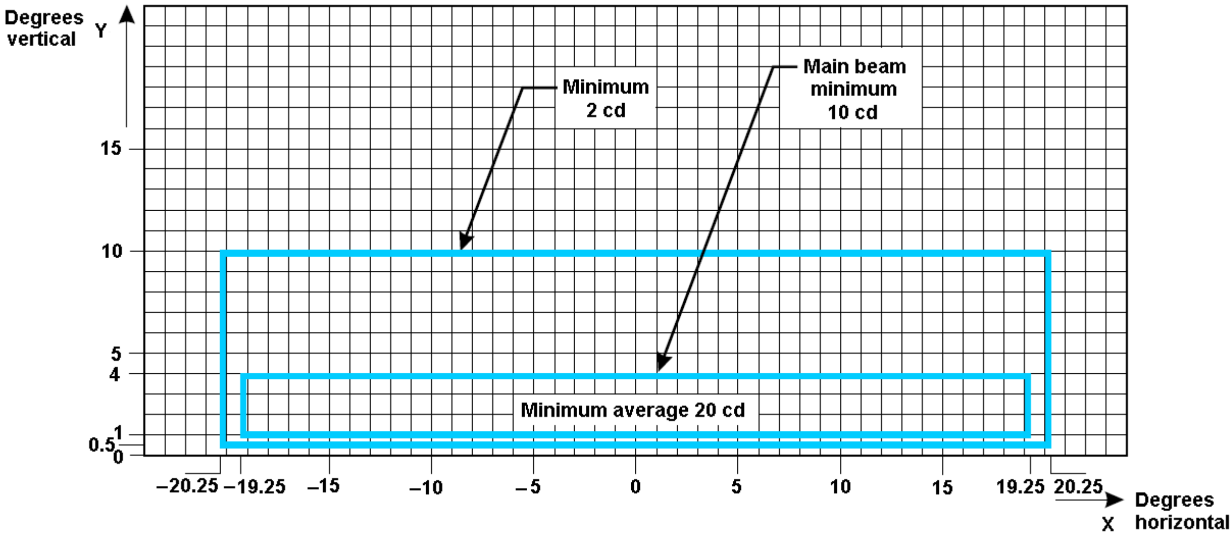
Figure A2-14. Isocandela diagram for taxiway center line (7.5 m spacing), RELs, no entry bar and stop bar lights in curved sections intended for use in runway visual range conditions of less than a value of 300 m



Notes:

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

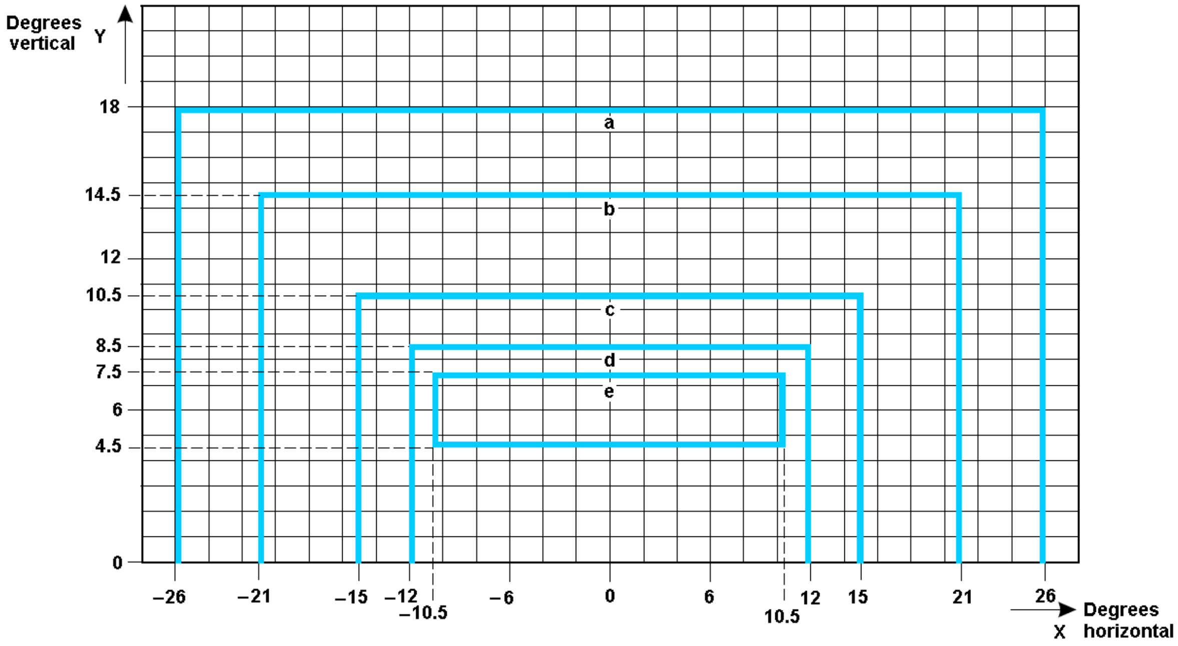
Figure A2-15. Isocandela diagram for taxiway center line (30 m, 60 m spacing), no entry bar and stop bar lights in straight sections intended for use in runway visual range conditions of **300 m** or greater



Notes:

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

Figure A2-16. Isocandela diagram for taxiway center line (7.5 m, 15 m, 30 m spacing), no entry bar and stop bar lights in curved sections intended for use in runway visual range conditions of 300 m or greater

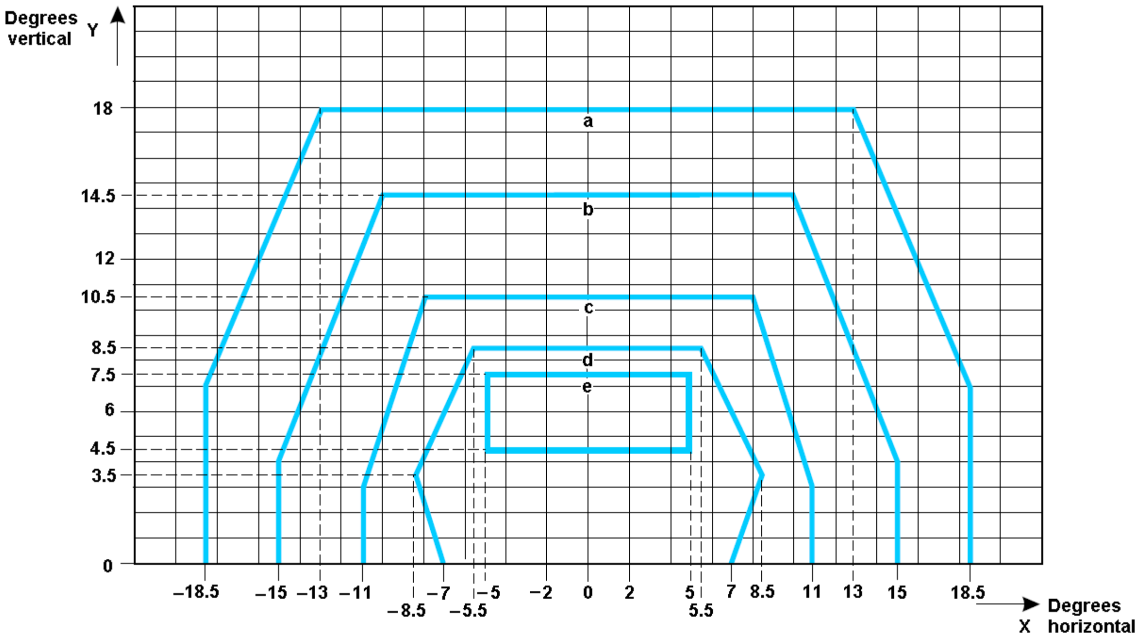


Curve	a	b	c	d	e
Intensity (cd)	8	20	100	450	1 800

Notes:

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

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

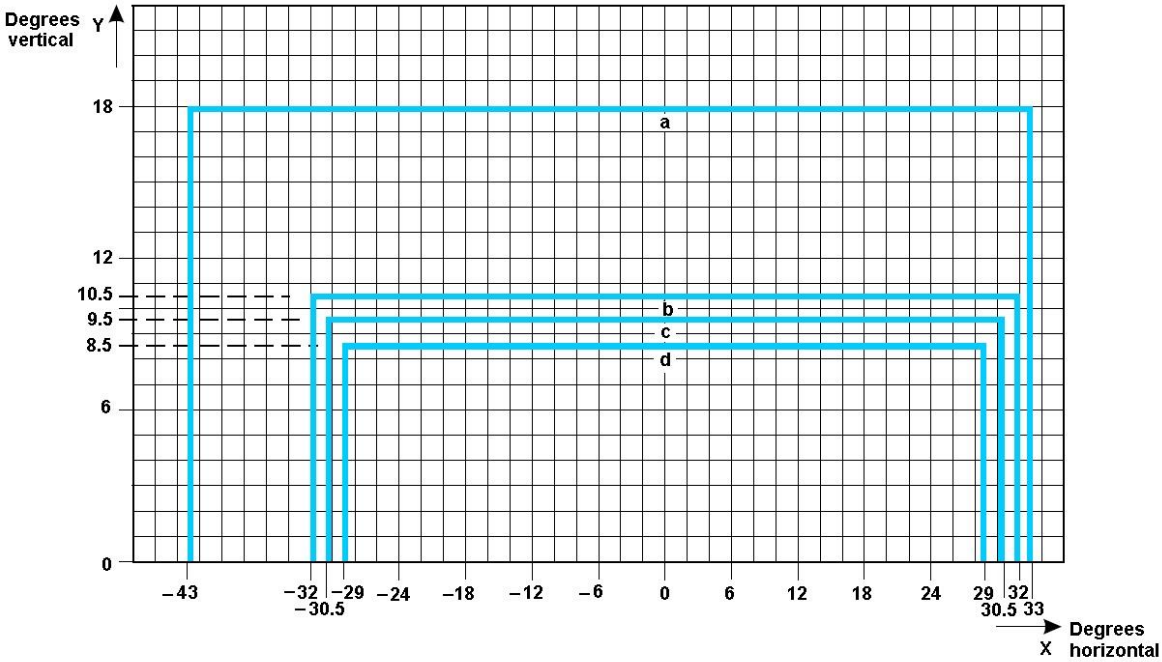


Curve	a	b	c	d	E
Intensity (cd)	8	20	100	450	1 800

Notes:

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

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

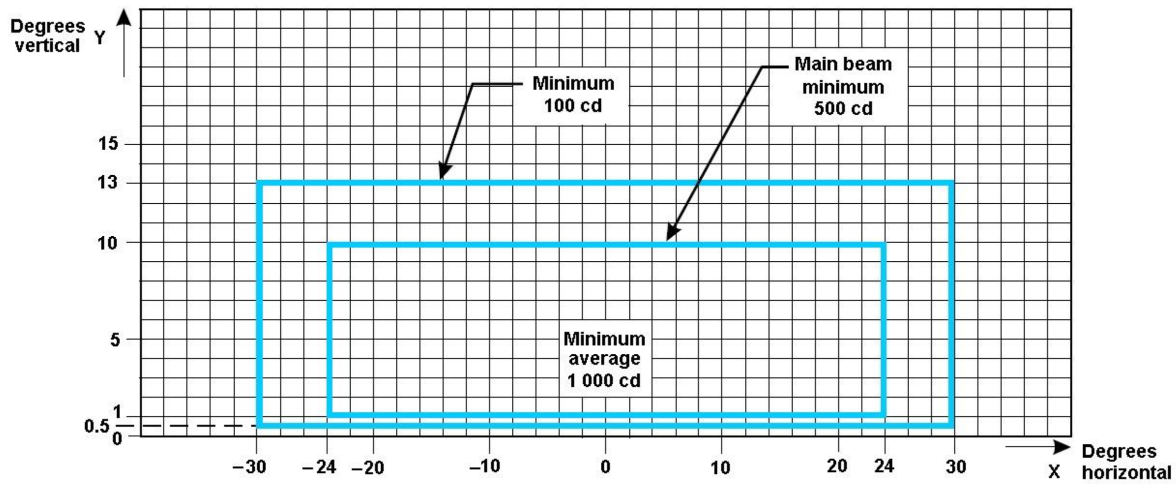


Curve	a	b	c	d
Intensity (cd)	8	100	200	400

Notes:

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

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



Notes:

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

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

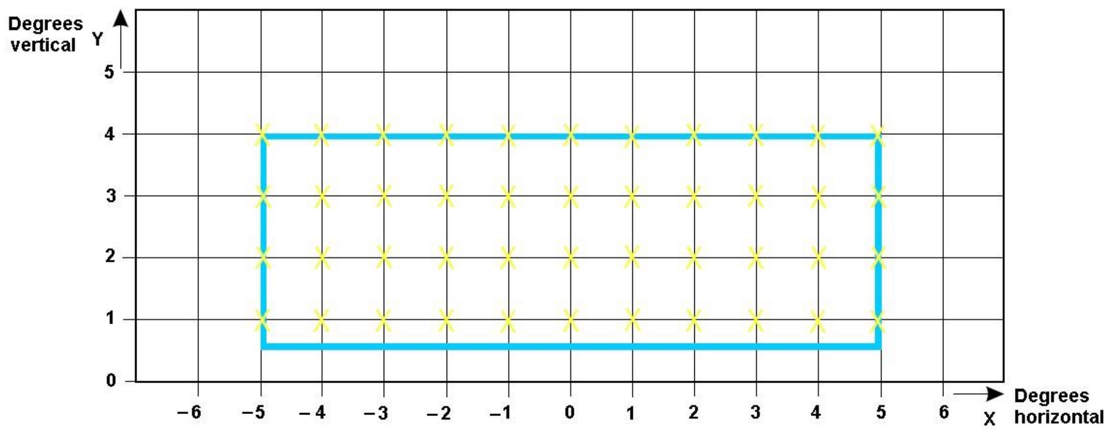


Figure A2-21. Grid points to be used for calculation of average intensity of taxiway center line and stop bar lights

1. The intensities specified in Figures A2-12 to A2-20 are in green and yellow light for taxiway center line lights, yellow light for runway guard lights and red light for stop bar lights.
2. Figures A2-12 to A2-20 show the minimum allowable light intensities. The average intensity of the main beam is calculated by establishing grid points as shown in Figure A2-21 and using the intensity values measured at all grid points located within and on the perimeter of the rectangle representing the main beam. The average value is the arithmetic average of the light intensities measured at all considered grid points.
3. No deviations are acceptable in the main beam or in the innermost beam, as applicable, when the lighting fixture is properly aimed.

4. Horizontal angles are measured with respect to the vertical plane through the taxiway center line except on curves where they are measured with respect to the tangent to the curve.
5. Vertical angles are measured from the longitudinal slope of the taxiway surface.
6. The importance of adequate maintenance cannot be over-emphasized. The intensity, either average where applicable or as specified on the corresponding isocandela curves, shall never fall to a value less than 50 per cent of the value shown in the figures, and it shall be the aim of airport authorities to maintain a level of light output close to the specified minimum average intensity.
7. The light unit shall be installed so that the main beam or the innermost beam, as applicable, is aligned within one-half degree of the specified requirement.

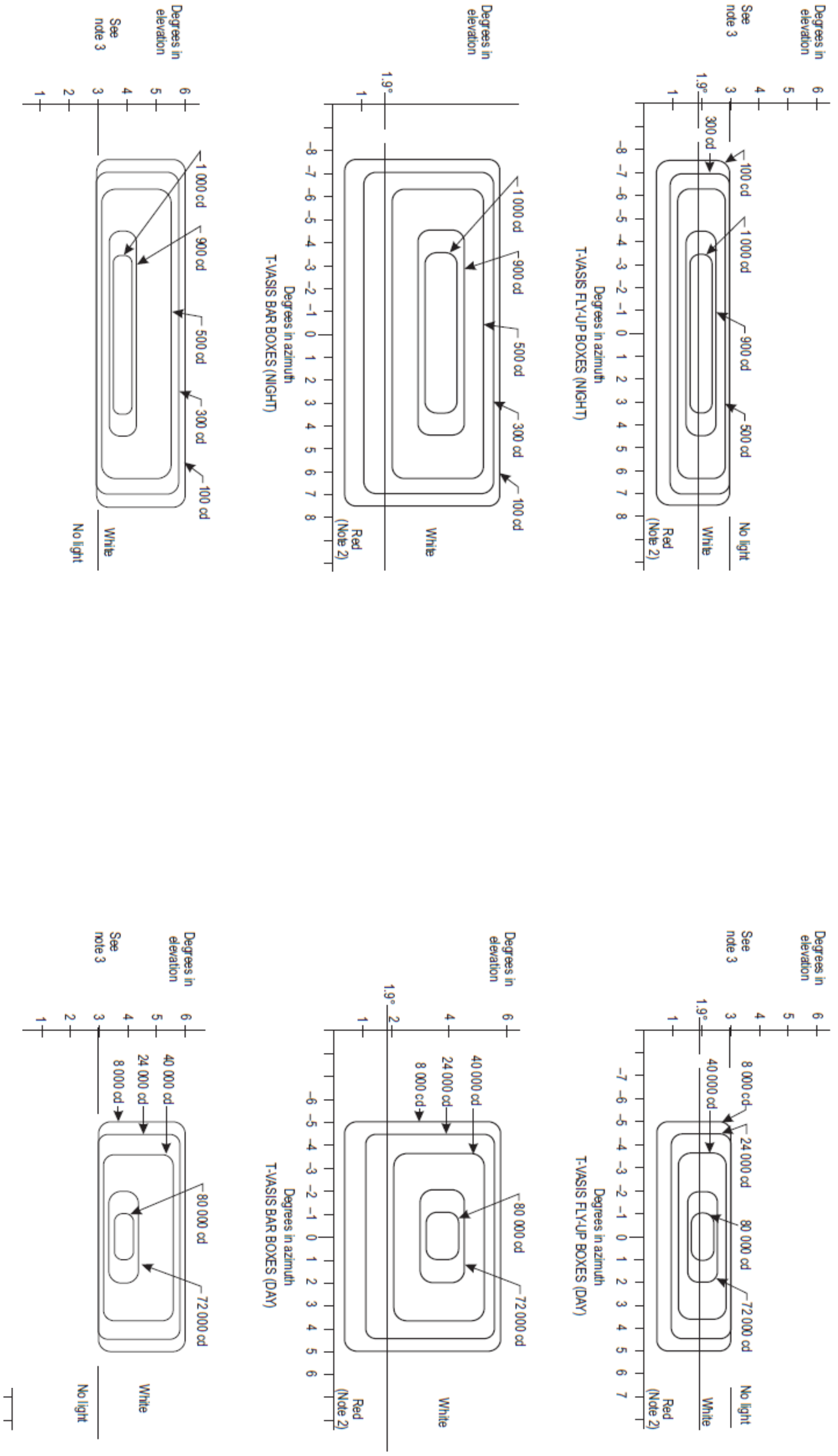
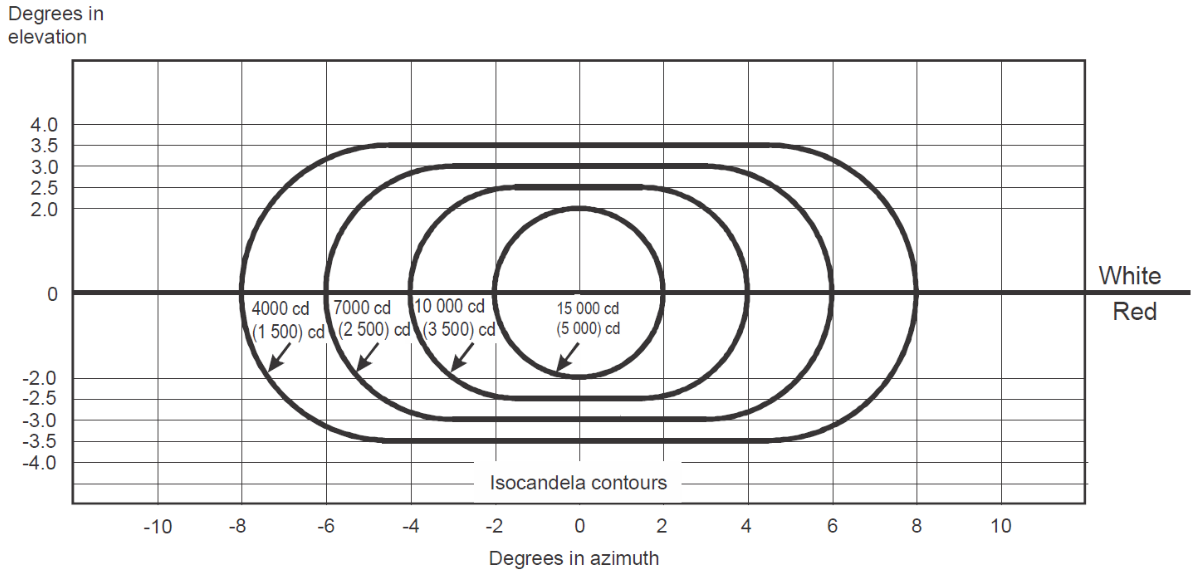


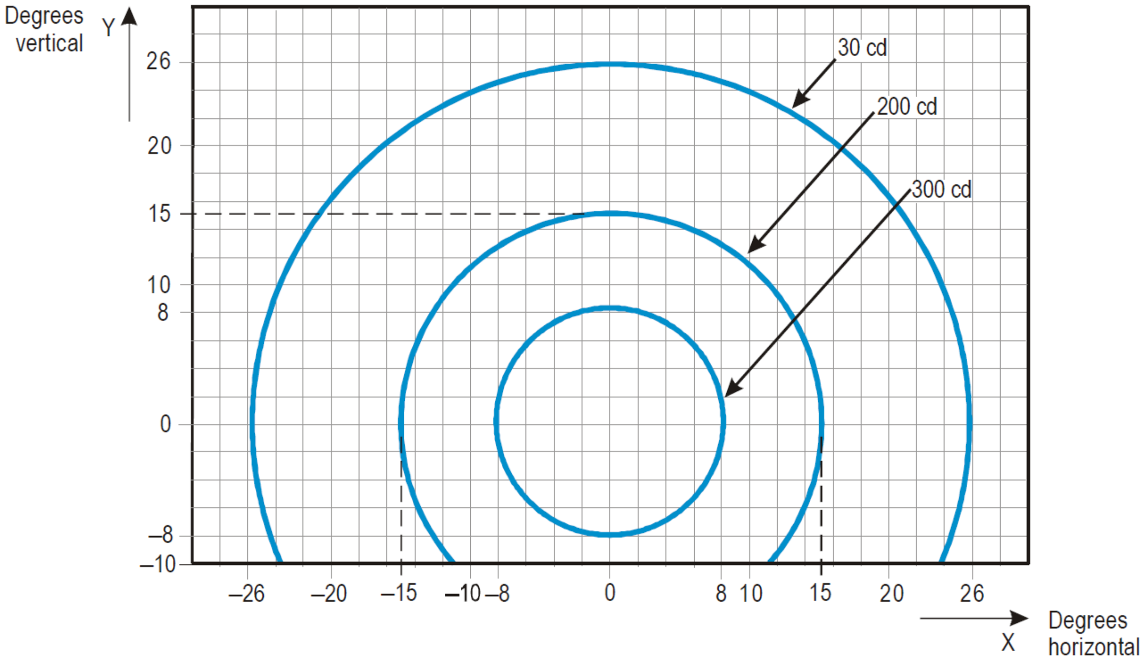
Figure A2-22
Light intensity distribution of T-VASIS and AT-VASIS



Notes:

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

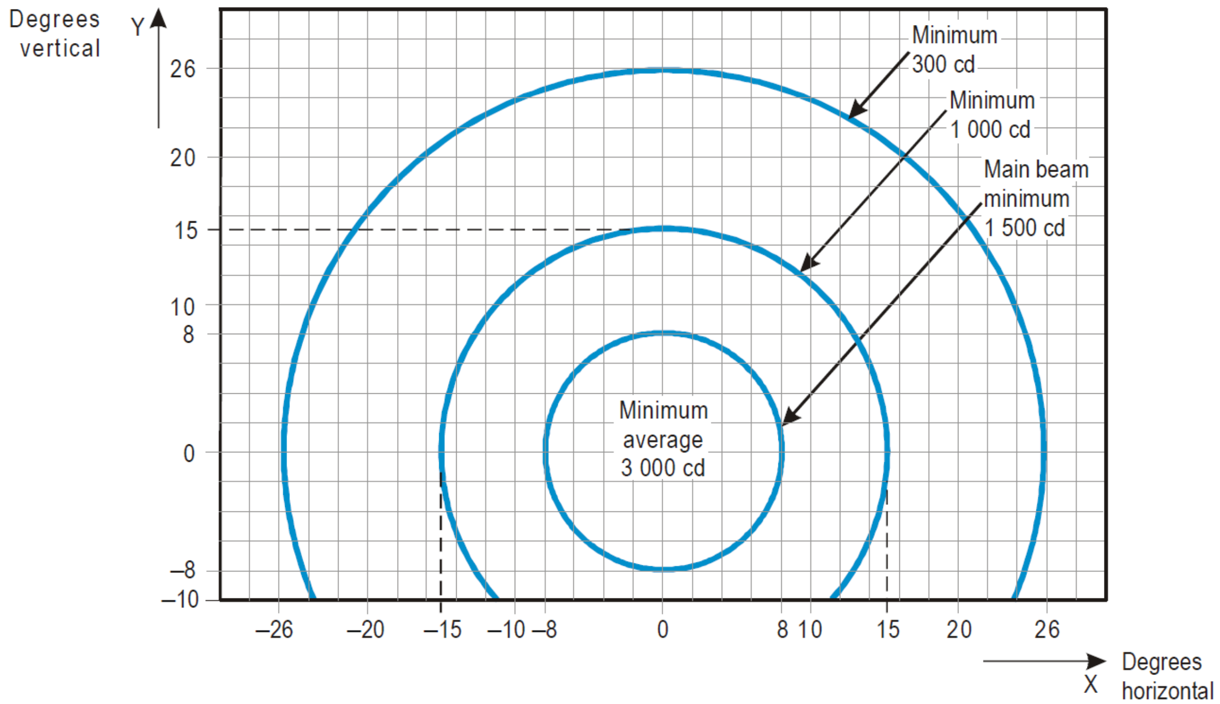
Figure A2-23. Light intensity distribution of PAPI and APAPI



Notes:

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

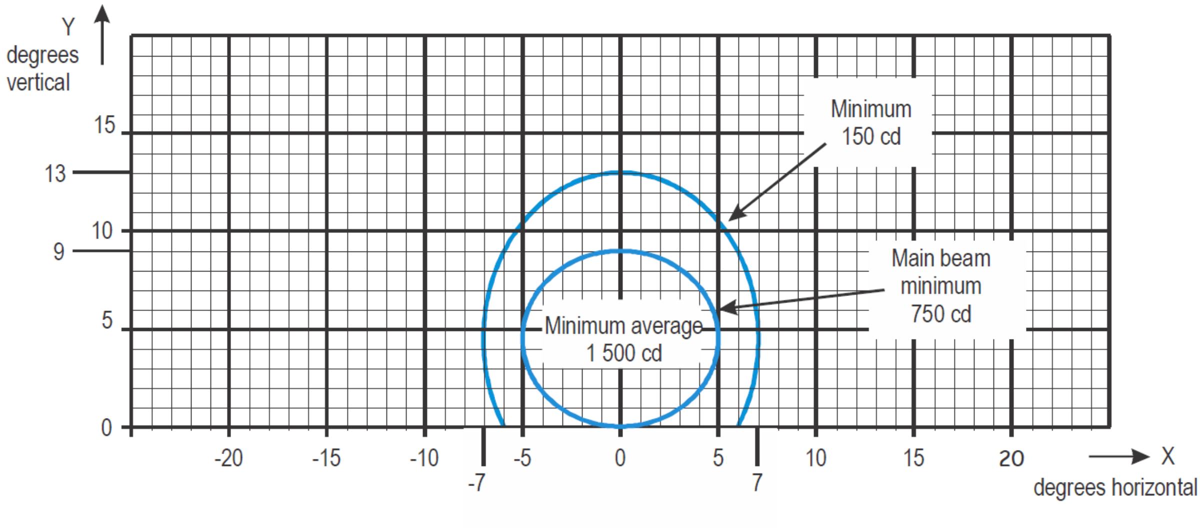
Figure A2-24. Isocandela diagram for each light in low-intensity runway guard lights, Configuration A



Notes:

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

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



Notes:

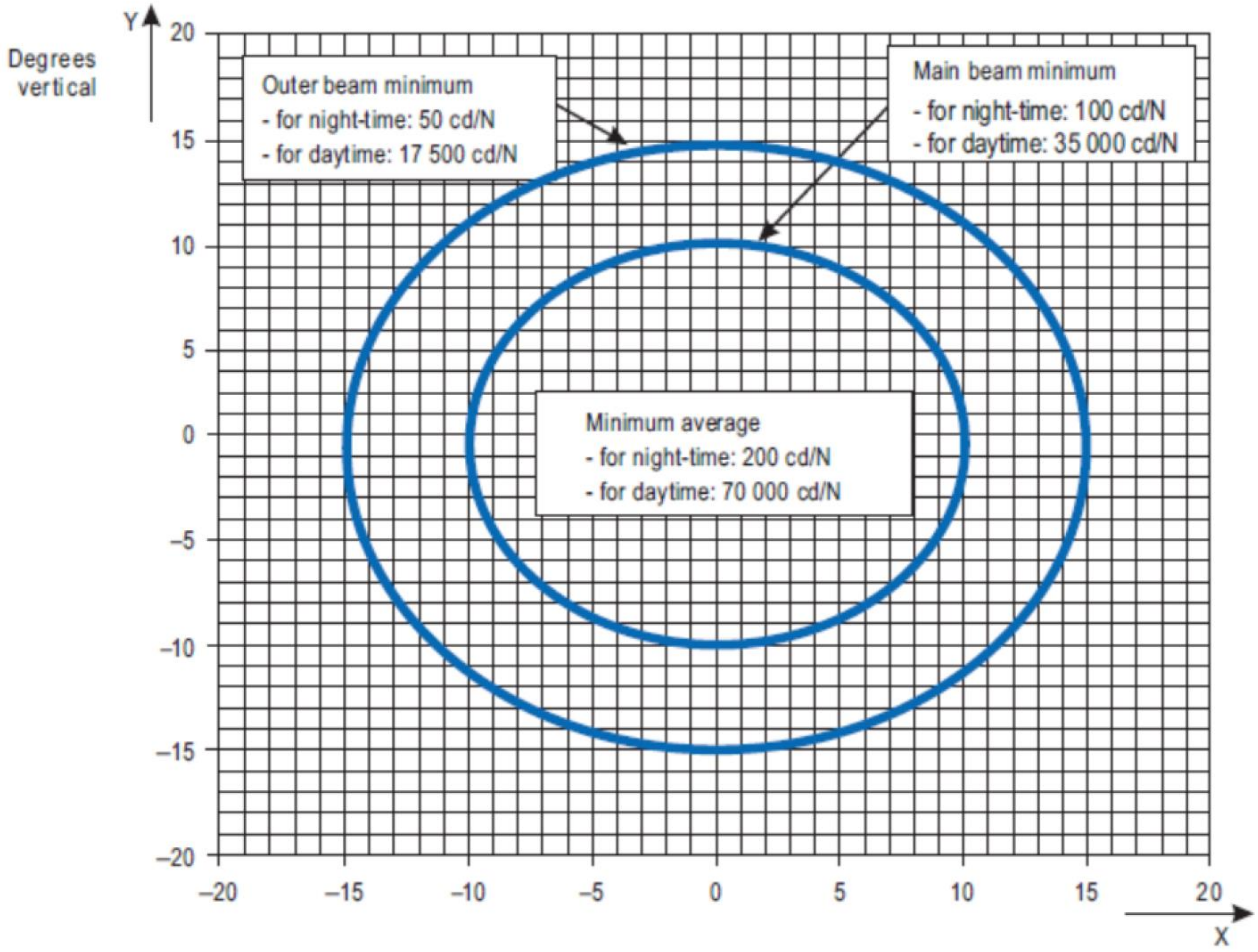
1. Curves calculated on formula x2.

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

a	5.0	7.0
b	4.5	8.5

2. See collective notes for Figures A2-1 to A2-11, A2-26 and A2-27.

Figure A2-26. Isocandela diagram for take-off and hold lights (THL) (red light)



Notes:

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

a	10	15
b	10	15

2. N is the total number of lights of the closed runway lighting.
3. See collective notes for Figures A2-1 to A2-11, A2-26 and A2-27.

Figure A2-27. Isocandela diagram for closed runway lights (white light)

Appendix (3) Mandatory Instruction Markings and Information Markings

Note (1): Refer to Chapter 5, Sections 5.2.16 and 5.2.17 for specifications on the application, location and characteristics of mandatory instruction markings and information markings.

Note (2): This appendix details the form and proportions of the letters, numbers and symbols of mandatory instruction markings and information markings on a grid.

Note (3): The mandatory instruction markings and information markings on pavements are formed as if shadowed (i.e., stretched) from the characters of an equivalent elevated sign by a factor of 2.5 as shown in the figure below. The shadowing, however, only affects the vertical dimension. Therefore, the spacing of characters for pavement marking is obtained by first determining the equivalent elevated sign character height and then proportioning from the spacing values given in Table A4-1.

For example, in the case of the runway designator "10" which is to have a height of 4 000 mm (Hps), the equivalent elevated sign character height is 4 000/2.5=1 600 mm (Hes). Table A4-1(b) indicates numeral to numeral code 1 and from Table A4-1(c) this code has a dimension of 96 mm, for a character height of 400 mm. The pavement marking spacing for "10" is then (1 600/400) * 96=384 mm

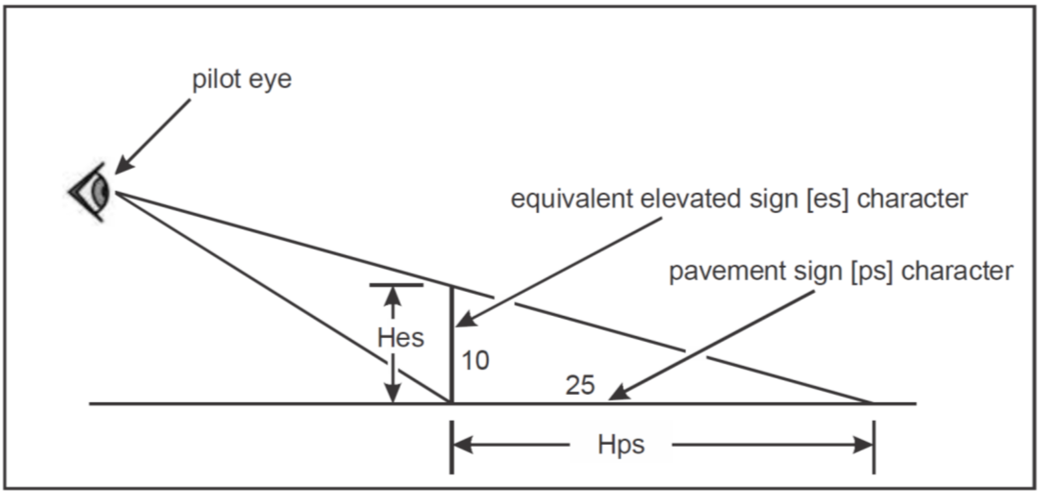
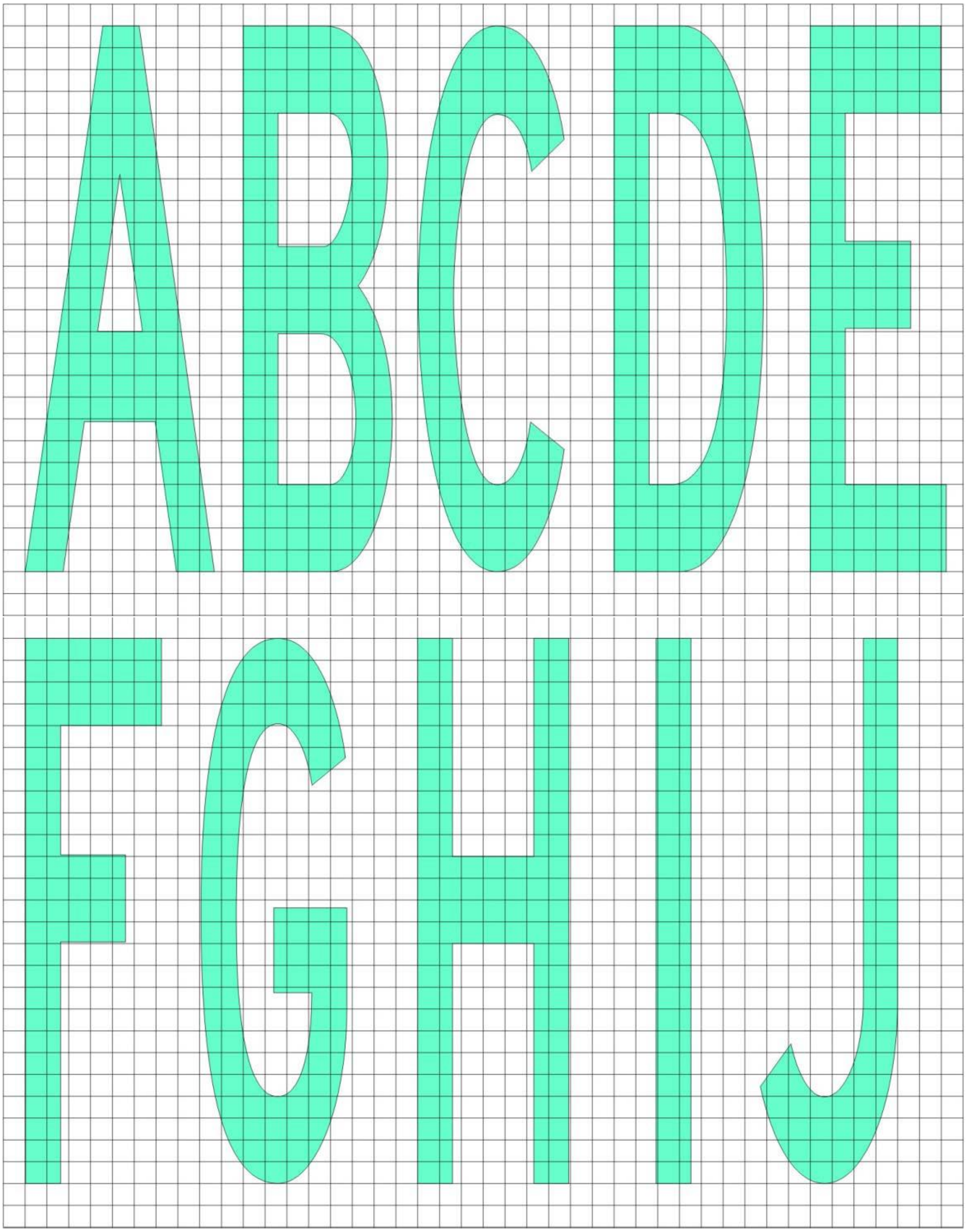
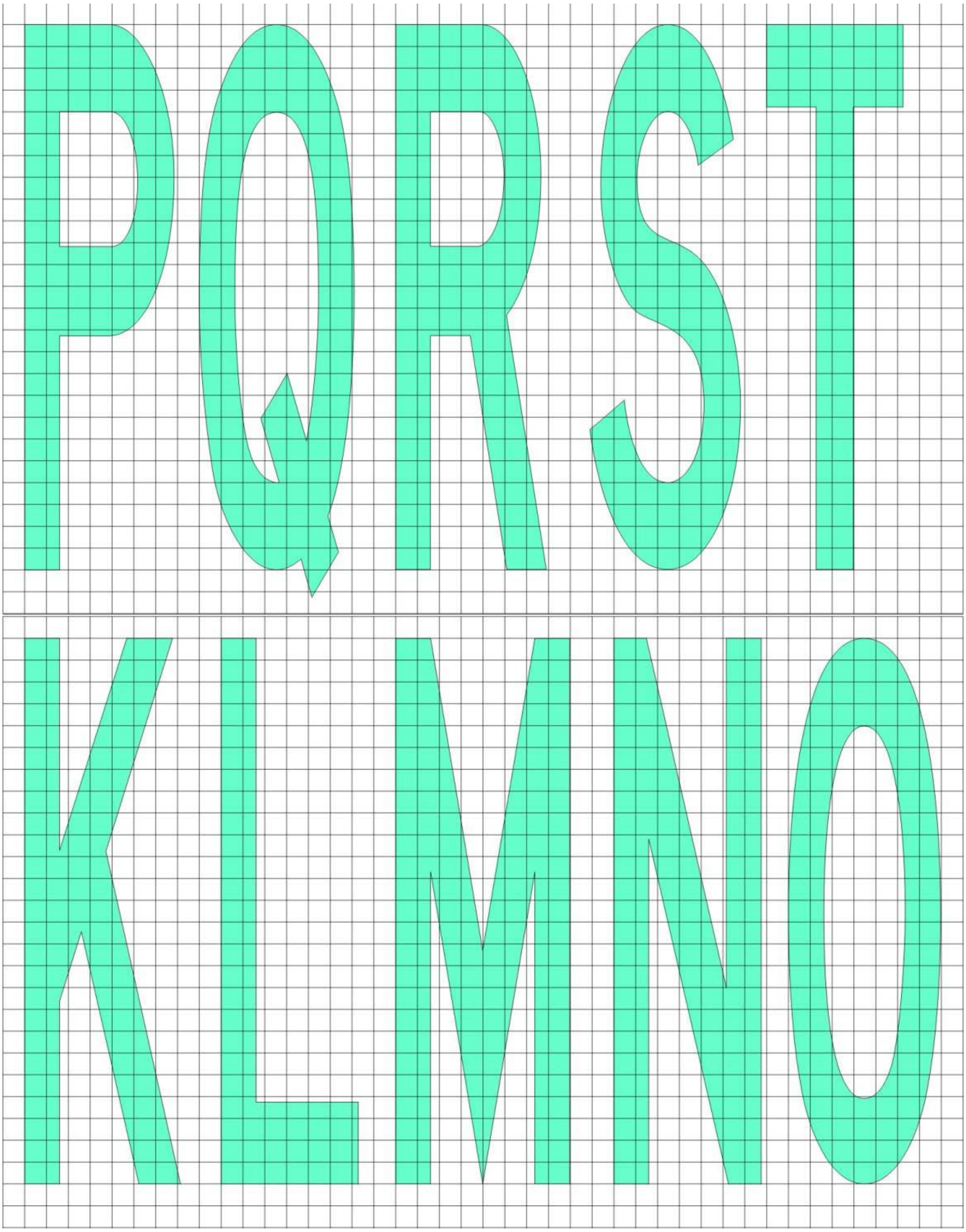
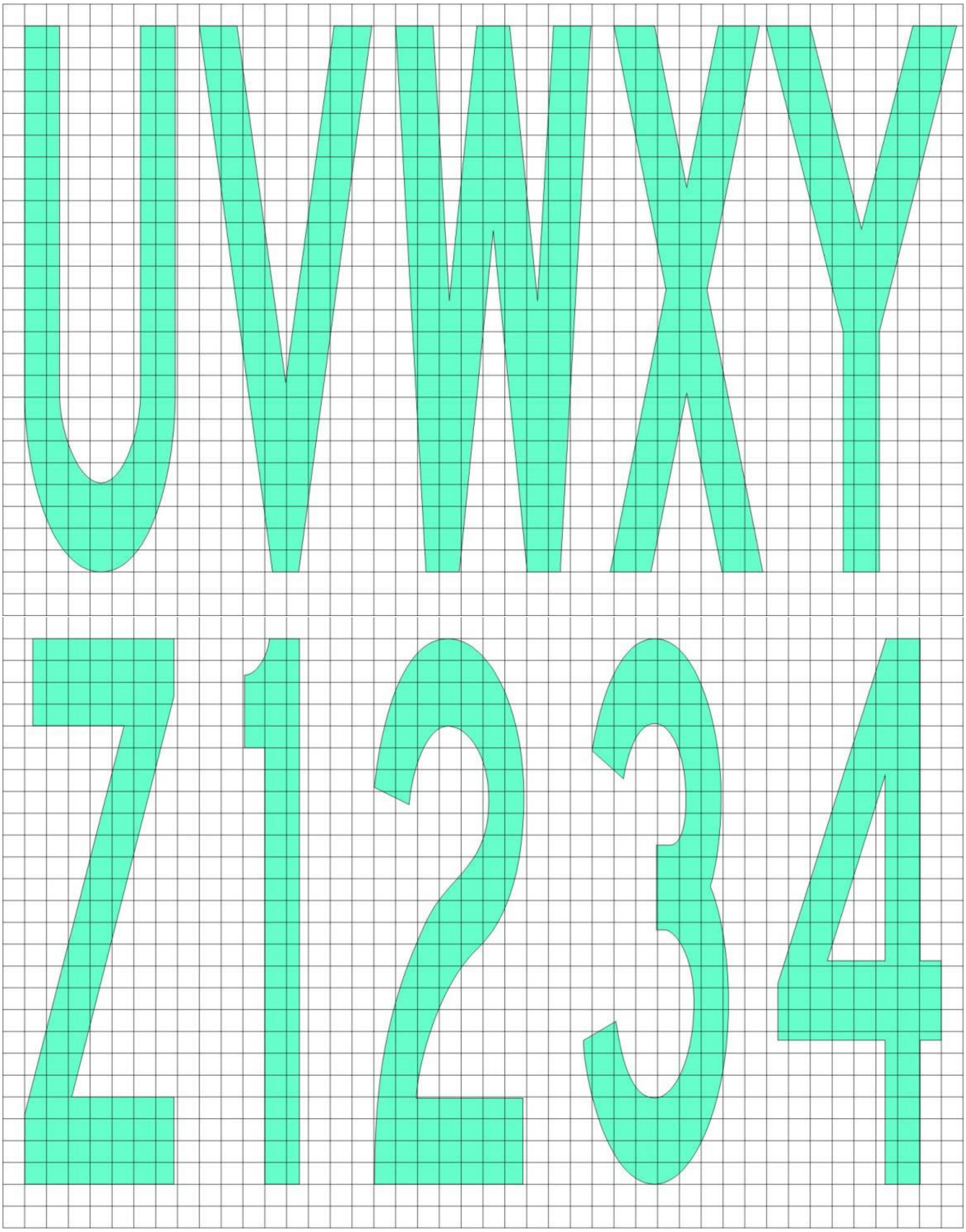
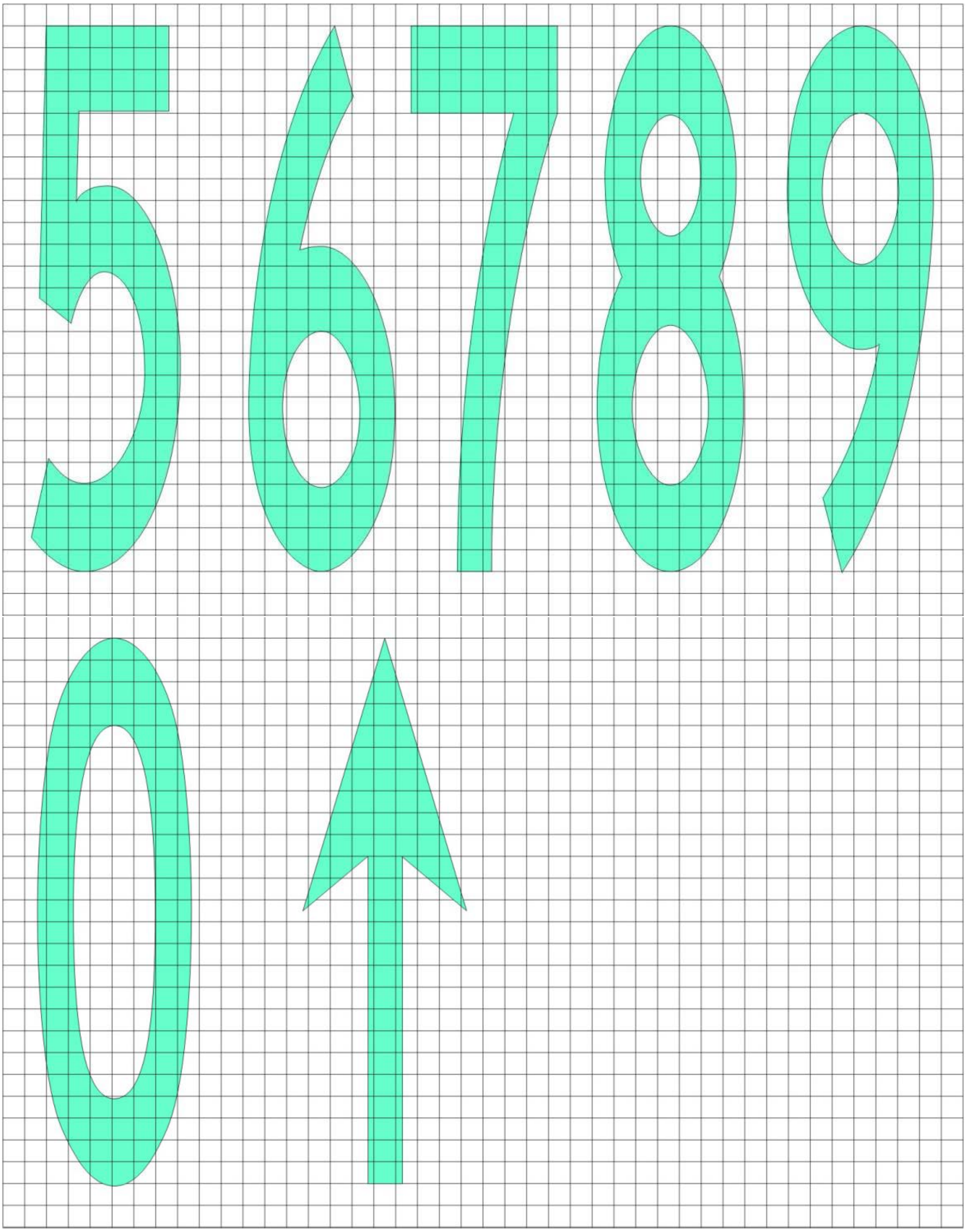


Figure A3-1


ABCDE
FGHIJ


PQRST
KLMNO


UVWXY
Z1234



Appendix (4) Requirements Concerning Design of Signs

1. Inscription heights shall conform to the following tabulation.

Runway code number	Minimum character height		
	Mandatory instruction sign	Information sign	
		Runway exit and runway vacated signs	Other signs
1 or 2	300 mm	300 mm	200 mm
3 or 4	400 mm	400 mm	300 mm

Note: Where a taxiway location sign is installed in conjunction with a runway designation sign (see Chapter 5 paragraph 5.4.3.22), the character size shall be that specified for mandatory instruction signs.

2. Arrow dimensions shall be as follows:

Legend height	**Stroke**
200 mm	32 mm
300 mm	48 mm
400 mm	64 mm

3. Stroke width for single letter shall be as follows:

Legend height	**Stroke**
200 mm	32 mm
300 mm	48 mm
400 mm	64 mm

4. Sign luminance shall be as follows:
   (a) Where operations are conducted in runway visual range conditions less than a value of 800 m, average sign luminance shall be at least:

Red	30 cd/m2
Yellow	150 cd/m2
White	300 cd/m2

(b) Where operations are conducted in accordance with Chapter 5 paragraph 5.4.1.7 b) and c) and paragraph 5.4.1.8, average sign luminance shall be at least:

Red	10 cd/m2
Yellow	50 cd/m2
White	100 cd/m2

Note: In runway visual range conditions less than a value of 400 m, there will be some degradation in the performance of signs.

5. The luminance ratio between red and white elements of a mandatory sign shall be between 1:5 and 1:10.
6. The average luminance of the sign is calculated by establishing grid points as shown in Figure A4-1 and using the luminance values measured at all grid points located within the rectangle representing the sign.
7. The average value is the arithmetic average of the luminance values measured at all considered grid points.

Note: Guidance on measuring the average luminance of a sign is contained in the CARC Guidance Material 34-GM-17 Visual Aids for Navigation.

8. The ratio between luminance values of adjacent grid points shall not exceed 1.5:1. For areas on the sign face where the grid spacing is 7.5 cm, the ratio between luminance values of adjacent grid points shall not exceed 1.25:1. The ratio between the maximum and minimum luminance value over the whole sign face shall not exceed 5:1.
9. The forms of characters, i.e. letters, numbers, arrows and symbols for mandatory instruction and information signs, shall conform to those shown in Figure A4-2. The width of characters and the space between individual characters shall be determined as indicated in Table A4-1.

Note: Guidance on the width of characters and the space between individual characters for RDRS is contained in the ***CARC Guidance Material 34-GM-17 Visual Aids for Navigation.***

10. The face height of signs shall be as follows:

Legend height	Face height (min)
200 mm	300 mm
300 mm	450 mm
400 mm	600 mm

11. The face width of mandatory instruction and information signs shall be determined using Figure A4-3 except that, where a mandatory instruction sign is provided on one side of a taxiway only, the face width shall not be less than:
    (a) 1.94 m where the code number is 3 or 4; and
    (b) 1.46 m where the code number is 1 or 2.

12. The face width of runway distance remaining sign (RDRS) shall be determined using Figure A4-5.

Note: Additional guidance on determining the face width of a sign is contained in the CARC Guidance Material 34-GM-17 Visual Aids for Navigation.

13. Borders
    (a) The black vertical delineator between adjacent direction signs shall have a width of approximately 0.7 of the stroke width.
    (b) The yellow border on a stand-alone location sign shall be approximately 0.5 stroke width.

14. The colors of signs shall be in accordance with the appropriate specifications in Appendix 1.

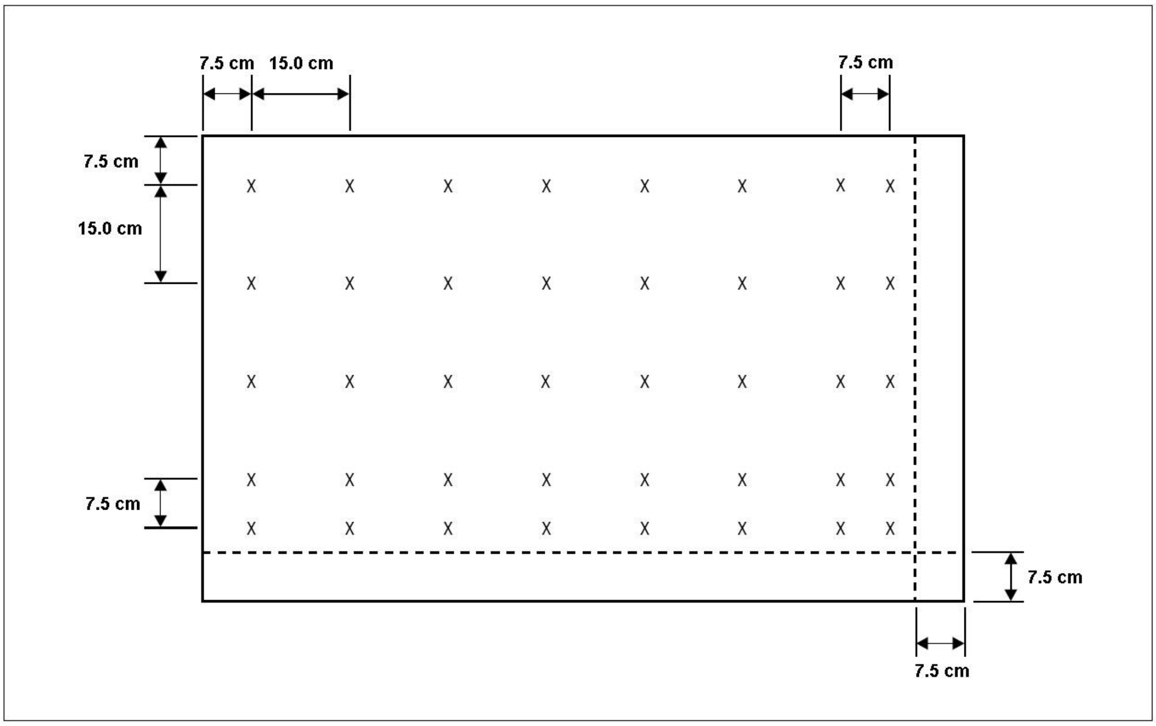


Figure A4-1. Grid points for calculating average luminance of a sign

Note (1): The average luminance of a sign is calculated by establishing grid points on a sign face showing typical inscriptions and a background of the appropriate color (red for mandatory instruction signs and yellow for direction and destination signs) as follows:

(a) Starting at the top left corner of the sign face, establish a reference grid point at 7.5 cm from the left edge and the top of the sign face.
(b) Create a grid of 15 cm spacing horizontally and vertically from the reference grid point. Grid points within 7.5 cm of the edge of the sign face shall be excluded.
(c) Where the last point in a row/column of grid points is located between 22.5 cm and 15 cm from the edge of the sign face (but not inclusive), an additional point shall be added 7.5 cm from this point.
(d) Where a grid point falls on the boundary of a character and the background, the grid point shall be slightly shifted to be completely outside the character.

Note (2): Additional grid points may be required to ensure that each character includes at least five evenly spaced grid points.

Note (3): Where one unit includes two types of signs, a separate grid shall be established for each type.

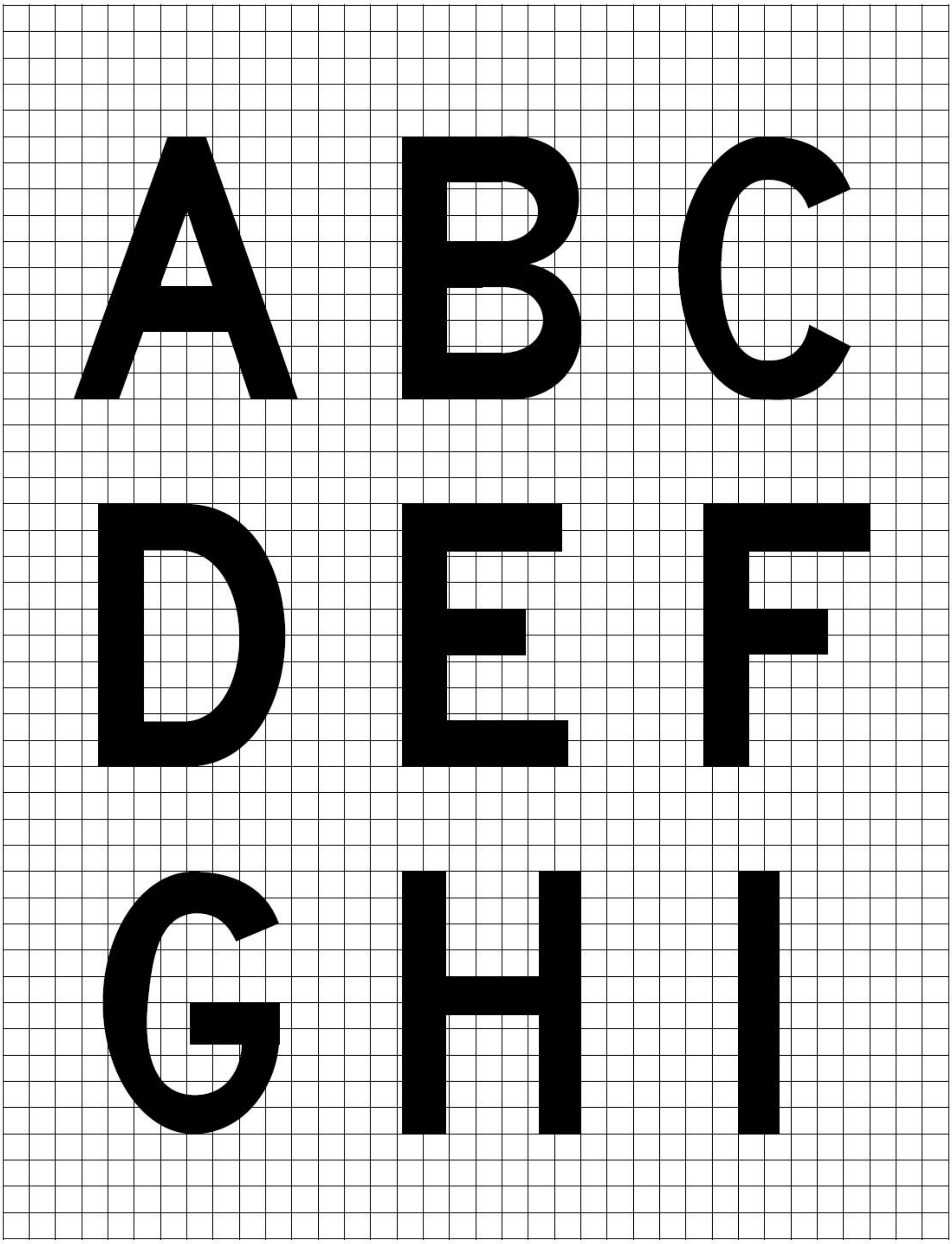


Figure A4-2. Forms of characters

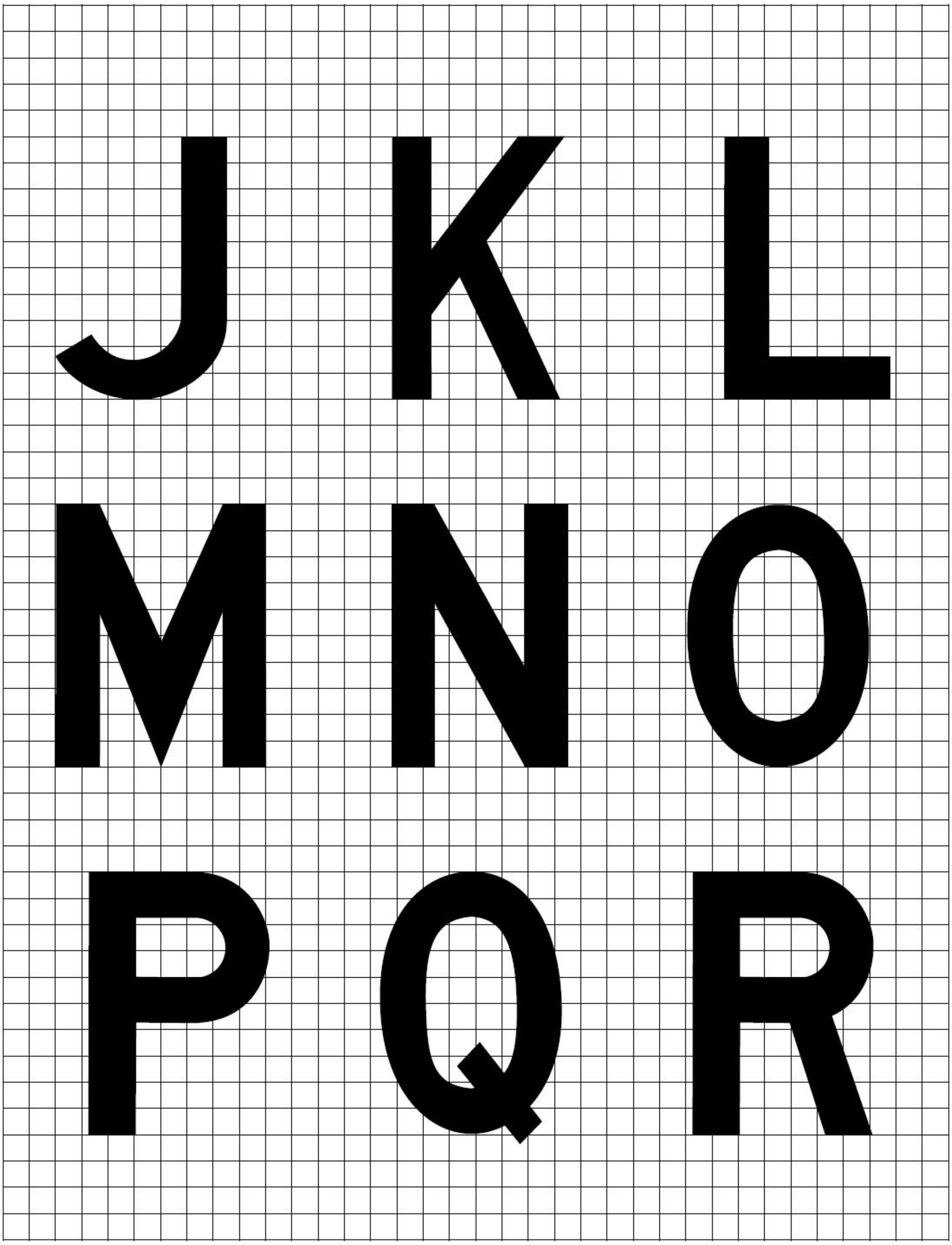


Figure A4-2. (cont.)

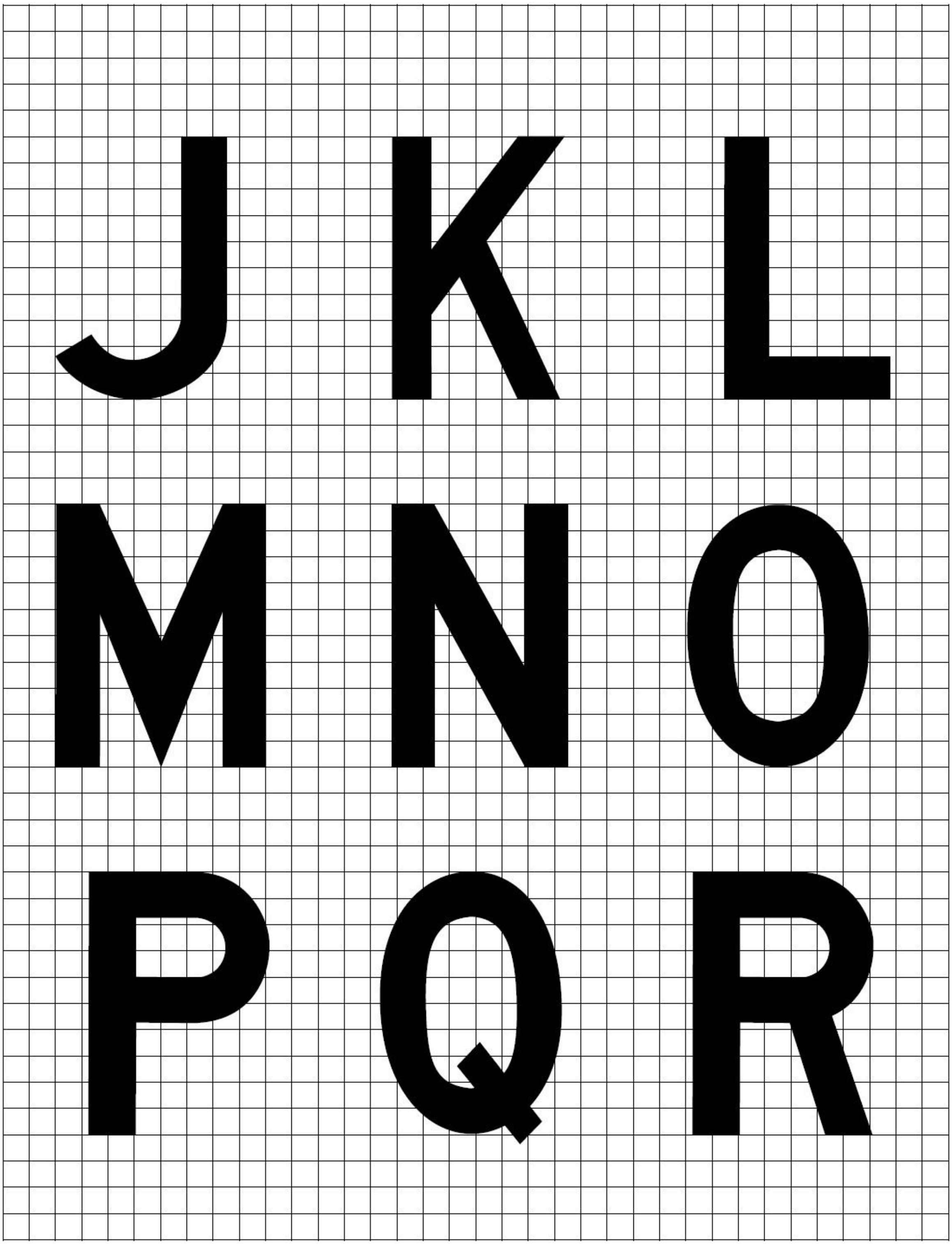


Figure A4-2. (cont.)

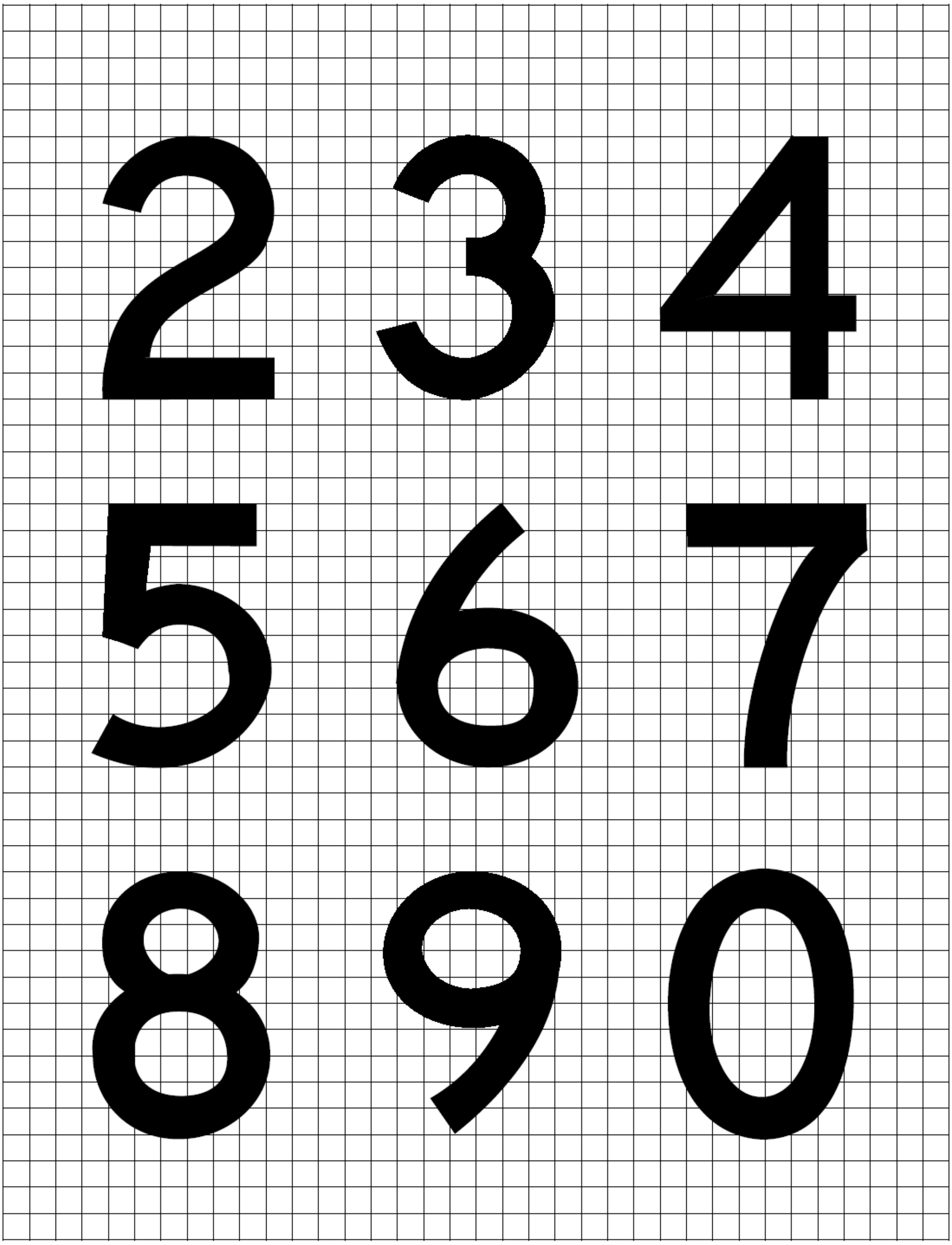


Figure A4-2. (cont.)

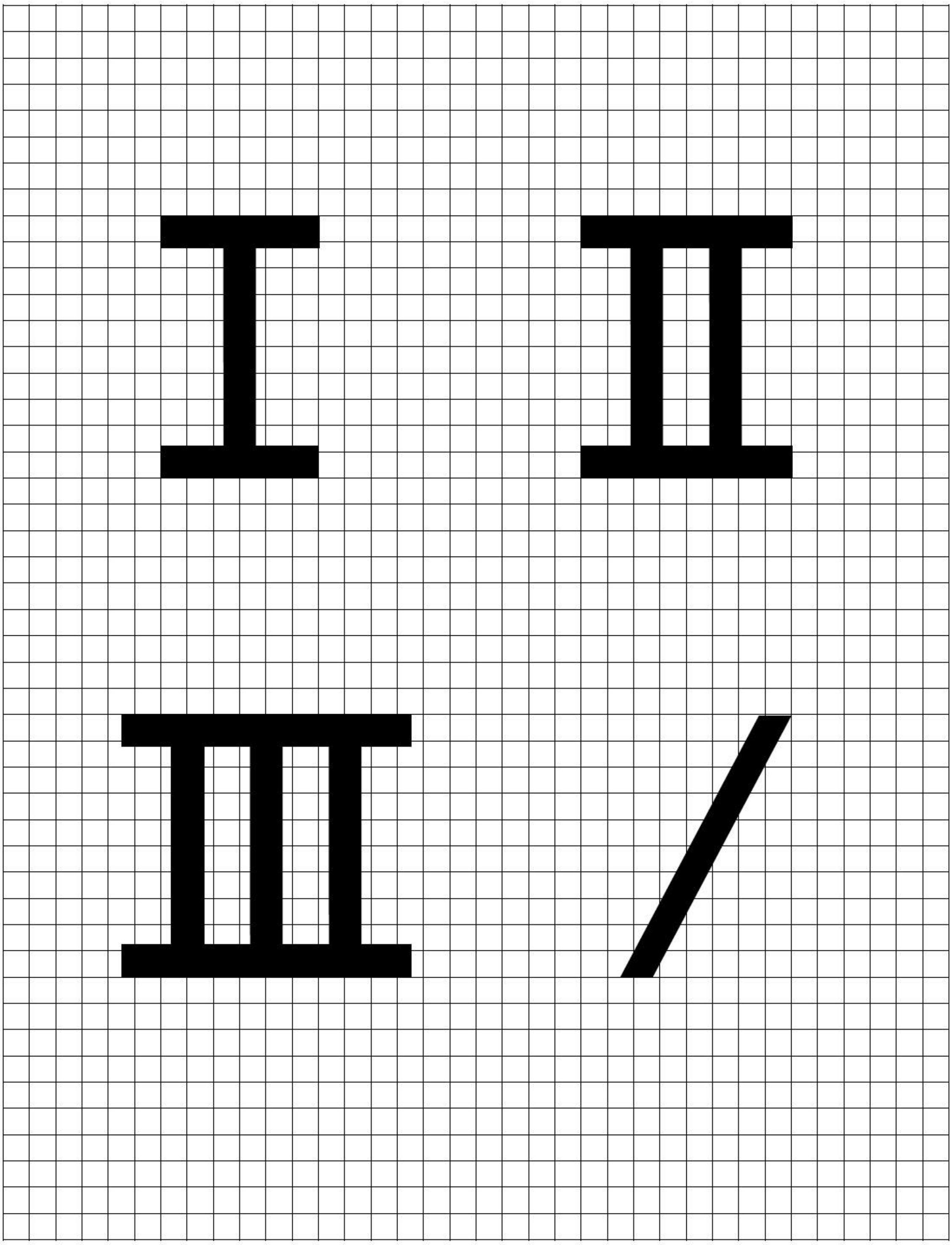
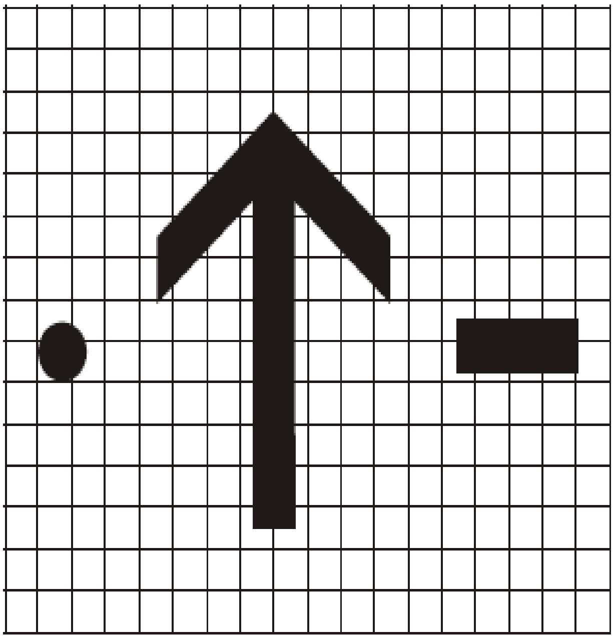


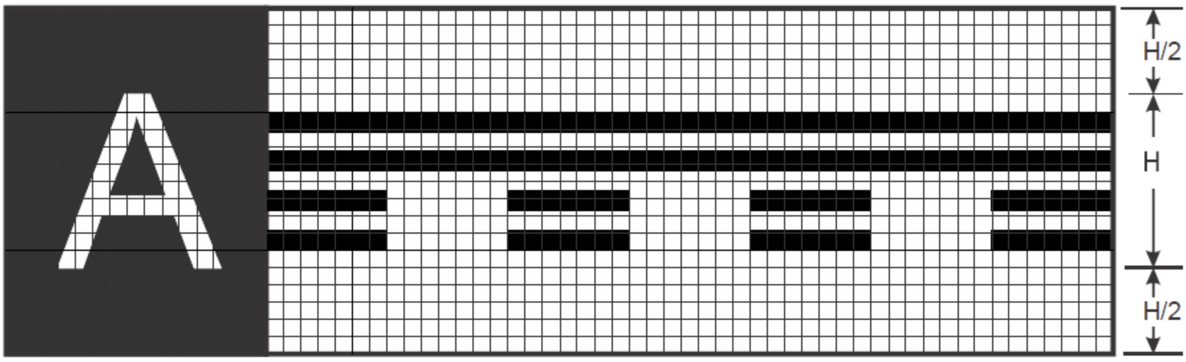
Figure A4-2. (cont.)



Arrow, dot and dash

Note (1): The arrow stroke width, diameter of the dot, and both width and length of the dash shall be proportioned to the character stroke widths.

Note (2): The dimensions of the arrow shall remain constant for a particular sign size, regardless of orientation.



Runway vacated sign (with typical location sign)

Figure A4-2. (cont.)

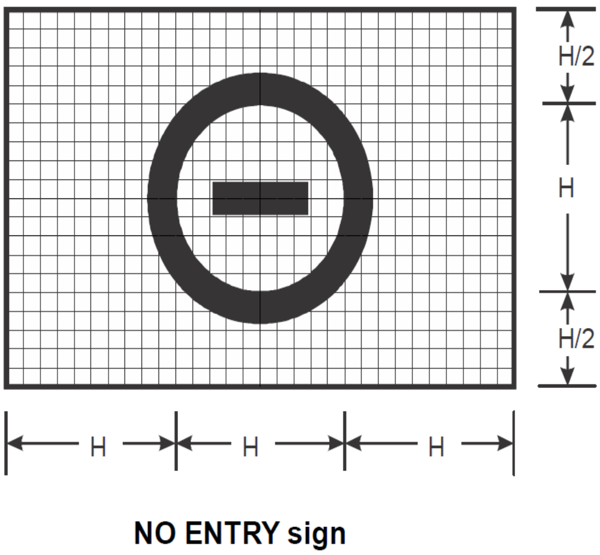
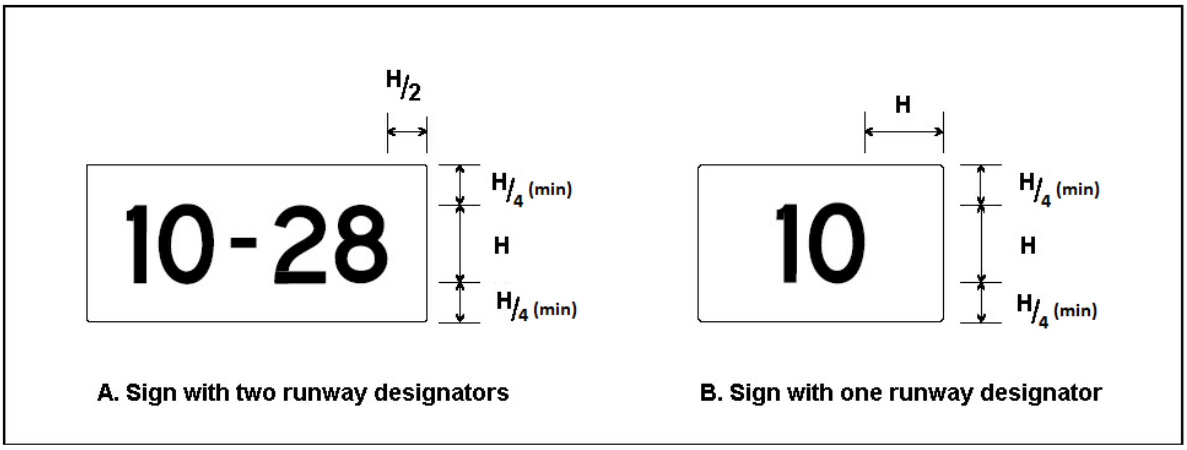
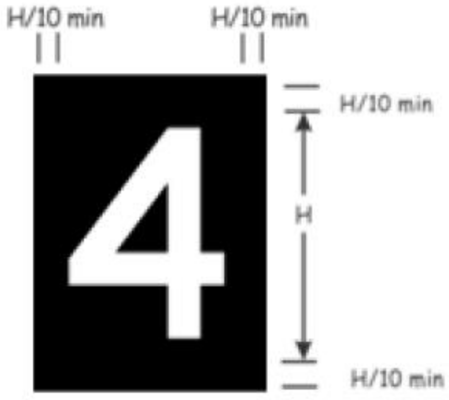


Figure A4-3. Runway vacated and NO ENTRY signs



H" stands for the inscription height

Figure A4-4. Sign dimensions



Explanatory Note to Figure A4-5: "H" stands for the inscription height.
Figure A4-5. Sign dimensions for RDRS

Table A4-1. Letter and numeral widths and space between letters or numerals

(a) Letter to letter code number			
Preceding Letter	Following Letter		
	B, D, E, F, H, I, K, L, M, N, P, R, U	C, G, O, Q, S, X, Z	A, J, T, V, W, Y
	Code number		
A	2	2	4
B	1	2	2
C	2	2	3
D	1	2	2
E	2	2	3
F	2	2	3
G	1	2	2
H	1	1	2
I	1	1	2
J	1	1	2
K	2	2	3
L	2	2	4
M	1	1	2
N	1	1	2
O	1	2	2
P	1	2	2
Q	1	2	2
R	1	2	2
S	1	2	2
T	2	2	4
U	1	1	2
V	2	2	4
W	2	2	4
X	2	2	3
Y	2	2	4
Z	2	2	3

(d) Width of letter			
Letter	Letter height (mm)		
	200	300	400
	Width (mm)		
A	170	225	340
B	137	205	274
C	137	205	274
D	137	205	274
E	124	186	248
F	124	186	248
G	137	205	274
H	137	205	274
I	32	48	64
J	127	190	254
K	140	210	280
L	124	186	248
M	157	236	314
N	137	205	274
O	143	214	286
P	137	205	274
Q	143	214	286
R	137	205	274
S	137	205	274
T	124	186	248
U	137	205	274
V	152	229	304
W	178	267	356
X	137	205	274
Y	171	257	342
Z	137	205	274

(b) Numeral to numeral code number			
Preceding Numeral	Following number		
	1, 5	2, 3, 6, 8, 9, 0	4, 7
	Code number		
1	1	1	2
2	1	2	2

(e) Width of numeral			
Letter	Numeral height (mm)		
	200	300	400
	Width (mm)		
1	50	74	98
2	137	205	274

3	1	2	2		3	137	205	274
4	2	2	4		4	149	224	298
5	1	2	2		5	137	205	274
6	1	2	2		6	137	205	274
7	2	2	4		7	137	205	274
8	1	2	2		8	137	205	274
9	1	2	2		9	137	205	274
0	1	2	2		0	143	214	286

(c) Space between characters			
Code No.	Character height (mm)		
	200	300	400
	Space (mm)		
1	48	71	96
2	38	57	76
3	25	38	50
4	13	19	26

INSTRUCTIONS

1. To determine the proper SPACE between letters or numerals, obtain the code number from table (a) or (b) and enter table c for that code number to the desired letter or numeral height.

2. The space between words or groups of characters forming an abbreviation or symbol shall be equal to 0.5 to 0.75 of the height of the characters used except that where an arrow is located with a single character such as ‘A→’, the space may be reduced to not less than one quarter of the height of the character in order to provide a good visual balance.
3. Where the numeral follows a letter or vice versa use Code 1.
4. Where a hyphen, dot, or diagonal stroke follows a character or vice versa use Code 1.
5. For the intersection take-off sign, the height of the lower case “m” is 0.75 of the height of the preceding “0” (zero) and spaced from the preceding “0” at code 1 for the character height of the numerals

Appendix (5) Aeronautical Data Quality Requirements

Table A5-1. Latitude and longitude

Latitude and longitude	Accuracy Data type	Integrity Classification
Aerodrome reference point	30 m surveyed/calculated	routine
Navaids located at the aerodrome	3 m surveyed	essential
Obstacles in Area 3	0.5 m surveyed	essential
Obstacles in Area 2 (the part within the aerodrome boundary)	5 m surveyed	essential
Runway thresholds	1 m surveyed	critical
Runway end (flight path alignment point)	1 m surveyed	critical
Runway centre line points	1 m surveyed	critical
Runway-holding position	0.5 m surveyed	critical
Taxiway centre line/parking guidance line points	0.5 m surveyed	essential
Intermediate holding position marking line	0.5 m surveyed	essential
Exit guidance line	0.5 m surveyed	essential
Apron boundaries (polygon)	1 m surveyed	routine
De-icing/anti-icing facility (polygon)	1 m surveyed	routine
Aircraft stand points/INS checkpoints	0.5 m surveyed	routine

Note (1): See ICAO Annex 15, Appendix 8, for graphical illustrations of obstacle data collection surfaces and criteria used to identify obstacles in the defined areas.

Note (2): Implementation of ICAO Annex 15, provisions 10.1.4 and 10.1.6, concerning the availability, as of 12 November 2015, of obstacle data according to Area 2 and Area 3 specifications would be facilitated by appropriate advance planning for the collection and processing of such data.

Table A5-2. Elevation/altitude/height

Elevation/altitude/height	Accuracy Data type	Integrity Classification
Aerodrome elevation	0.5 m surveyed	essential
WGS-84 geoid undulation at aerodrome elevation position	0.5 m surveyed	essential
Runway threshold, non-precision approaches	0.5 m surveyed	essential
WGS-84 geoid undulation at runway threshold, non-precision approaches	0.5 m surveyed	essential
Runway threshold, precision approaches	0.25 m surveyed	critical
WGS-84 geoid undulation at runway threshold, precision approaches	0.25 m surveyed	critical
Runway centre line points	0.25 m surveyed	critical
Taxiway centre line/parking guidance line points	1 m surveyed	essential
Obstacles in Area 2 (the part within the aerodrome boundary)	3 m surveyed	essential
Obstacles in Area 3	0.5 m surveyed	essential
Distance measuring equipment/precision (DME/P)	3 m surveyed	essential

Note (1): See ICAO Annex 15, Appendix 8, for graphical illustrations of obstacle data collection surfaces and criteria used to identify obstacles in the defined areas.

Note (2): Implementation of ICAO Annex 15, provisions 10.1.4 and 10.1.6, concerning the availability, as of 12 November 2015, of obstacle data according to Area 2 and Area 3b specifications would be facilitated by appropriate advance planning for the collection and processing of such data.

Table A5-3. Declination and magnetic variation

Declination/variation	Accuracy Data type	Integrity Classification
Aerodrome magnetic variation	1 degree surveyed	essential
ILS localizer antenna magnetic variation	1 degree surveyed	essential
MLS azimuth antenna magnetic variation	1 degree surveyed	essential

Table A5-4. Bearing

Bearing	Accuracy Data type	Integrity Classification
ILS localizer alignment	1/100 degree surveyed	essential
MLS zero azimuth alignment	1/100 degree surveyed	essential
Runway bearing (True)	1/100 degree surveyed	routine

Table A5-4. Length/distance/dimension

Length/distance/dimension	Accuracy Data type	Integrity Classification
Runway length	1 m surveyed	critical
Runway width	1 m surveyed	essential
Displaced threshold distance	1 m surveyed	routine
Stopway length and width	1 m surveyed	critical
Clearway length and width	1 m surveyed	essential
Landing distance available	1 m surveyed	critical
Take-off run available	1 m surveyed	critical
Take-off distance available	1 m surveyed	critical
Accelerate-stop distance available	1 m surveyed	critical
Runway shoulder width	1 m surveyed	essential
Taxiway width	1 m surveyed	essential
ILS localizer antenna-runway end, distance	3 m calculated	essential
ILS glide slope antenna-threshold, distance along centre line	3 m calculated	routine
ILS marker-threshold distance	3 m calculated	routine
ILS DME antenna-threshold, distance along centre line	3 m calculated	essential
MLS azimuth antenna-runway end, distance	3 m calculated	routine
MLS elevation antenna-threshold, distance along centre line	3 m calculated	routine
MLS DME/P antenna-threshold, distance along centre line	3 m calculated	essential

Appendix (6) Guidance Material on Personnel Requirements

Note: this Appendix is in support of the Personnel Requirements included in JCAR Part 139 Paragraph 139.301.

1. Nominated Persons

1.1 Acceptance from CARC will be required for all persons nominated as Aerodrome Post Holders.

1.2 CARC acceptance of nominated Aerodrome Post Holders is based on the applicable Assessment Criteria in Tables 1 through 4 and the applicant's demonstration of knowledge of the applicable regulations and an understanding of the proposed position.

1.3 Selection of the Post Holder is the responsibility of the applicable Aerodrome Operator. The revised regulation and Guidance Material aims to assist Aerodrome Operators to be satisfied that persons within the management structure possess the relevant operational safety competence, and be able to identify any gaps that may exist in the areas of competence for their particular aerodrome. The size, complexity and scale of operations of an aerodrome will be a component of the Operator's assessment process. The detailed scope of Post Holders accountabilities and responsibilities are likely to be affected by this assessment, which shall be aligned with the aerodrome's SMS.

1.4 Cases for interviews with nominated Aerodrome Post Holders include the following:

(a) start of operations before issuing the first Aerodrome Certificate; or
(b) change of Aerodrome Post Holders at a Certified Aerodrome.

1.5 Purpose of the interview between CARC and the nominated Aerodrome Post Holder is as follows:

(a) exchange of information between the intended nominated persons and CARC for the latter to acquire information on the intended work areas and the applicant's competence level so as to verify their suitability for the post(s); and
(b) to create good contact and understanding between the both parties, and to come to a mutual conclusion on, if necessary, possible solutions for training and personal development over time.
(c) CARC process in acceptance of Post Holders is based on the applicant demonstrating knowledge of the applicable regulations, having an understanding of the role applied for and of the standards required by CARC. The process includes a review of the submitted details to determine the suitability of the person for the role.

1.6 Possible agenda items include:

(a) information from CARC on organization and mission of CARC, the regulatory framework and specifically Safety Management System requirements;
(b) information from the nominated person concerning the intended work area;
(c) enforcement methodology of CARC;
(d) the role and responsibility of the Aerodrome Post Holder;
(e) expected competence requirement of the nominated person in relation to present personal status and experience presented in their curriculum vitae or equivalent documentation;
(f) discussion concerning depth of knowledge and understanding of the applicable legislation and regulations;
(g) the role and responsibility of CARC and of the nominated person;
(h) understanding of aviation in general and for the specific nominated post, how operators/activities at the aerodrome including Air Navigation Service Providers, and other aviation activities can impact aircraft safety; and
(i) distribution of delegated powers depending on the organizational situation.

2. Competence of Personnel

With focus on the competency of Aerodrome Post Holders, Assessment Criteria as included in Tables App-S - 1 through 5 have been designed.

Determination of Personnel Needs and Qualifications

(a) The Aerodrome Operator shall determine the number of required personnel for the planned tasks.
(b) The Aerodrome Operator shall determine the required personnel qualifications, in accordance with the applicable requirements. A documented system with defined responsibilities shall be in place, in order to identify any need for changes with regard to personnel qualifications.
(c) Documentation shall define the method by which staffing levels are determined in relation to the operation, maintenance and management of the aerodrome.
(d) Documentation shall define the training requirements and training program to ensure that personnel are adequately trained.
(e) Procedures shall include the mechanisms that ensure only trained and competent personnel undertake the planned tasks and activities assigned to them.

3. Distribution of Rules and Procedures

The Aerodrome Operator shall have a system in place to distribute the rules and procedures to personnel to enable them to exercise their duties and responsibilities safely and effectively.

Gap Analysis: Personnel Requirements

The Aerodrome Operator shall conduct gap analysis in order to provide an assessment and demonstration of the following:

(a) That the Aerodrome Operator has a sufficient number of qualified personnel for the planned tasks and activities being performed.

(b) That there are a sufficient number of supervisors assigned to defined duties and responsibilities, taking into account the structure of the organization and the number of personnel employed.

(c) Those personnel involved in the operation, maintenance and safety management of the aerodrome are adequately trained in accordance with the organization's training program.

Gap Analysis: Minimum Number of Personnel, Personnel Requirements and Training Needs Analysis

(a) A gap analysis shall be used as a tool to compare existing operations with the requirement to provide sufficient numbers of trained personnel appropriate for the scale and complexity of the aerodrome and its operations.

(b) As part of the gap analysis process, each assessment shall refer to the following categorization of "High" "Medium" or "Low" in relation to the scale, complexity and demands of the operation and for the provision of a dedicated aerodrome operations team:

High	One or more runways Complex in nature Significant developments Instrument runway Traffic density of ATS unit: high/medium	Dedicated operations team No extraneous or ancillary duties (Other than AEP response tasks)
Medium	One runway Instrument runway Traffic density of ATS unit: medium	Dedicated operations team Extraneous or ancillary duties allowable under assessment (Other than AEP response tasks)
Low	One runway Non-instrument runway No shift patterns Traffic density of ATS unit: low	Option to have a multi-tasked team allowable under assessment

(c) Once the gap analysis has been completed and fully documented, the staffing levels, resources and processes that have been identified as missing or inadequate will form the basis for an implementation plan, in order to become compliant with the regulations.

(d) An example of elements to consider for the gap analysis, as part of the aerodrome Safety Management System process, is as follows:

(i) Aerodrome inspection requirements appropriate to the operational use of runway(s) and taxiways;

(ii) Complexity of aerodrome layout, for example:

(1) Scale of aerodrome (geographical)

(2) Scale of aerodrome (number of runways and taxiways)

(3) Scale of aerodrome (number of aprons and stands);

(iii) complexity of operations i.e. CAT I, CAT II, CAT III, number of runways, movement rates;

(iv) Low visibility operations;

(v) Day and night use;

(vi) Duty hours for operational staff with reference to the following list:

(1) Compliance with the maximum allowable working hours as defined within the Jordan Labour Law;

(2) Sufficient break periods / rest time;

(3) An awareness of the problematic fatigue issues relating to the circadian body clock, to ensure so far as is reasonably possible, fatigue does not impair operational safety;

(4) Environmental factors, such as extensive time spent in warm and hot weather conditions;

(5) Operational duties required (day);

(6) Operational duties required (night);

(7) Handover time;

(8) Shift patterns;

(9) Maximum consecutive hours for both day and night duties (not exceeded); and

(10) Maximum numbers of night duties worked in immediate succession (i.e. four);

(vii) The number and complexity of aerodrome development projects – inspections and oversight of contractors;

(viii) Aerodrome operations procedural requirements and activities, for example:

(1) Aerodrome inspection requirements;

(2) Marshaling duties;

(3) Wildlife hazard control duties;

(4) FOD management duties;
(5) Follow-me requirements;
(6) Fuel management; and
(7) Control and management of aeronautical data;

(ix) Pavement maintenance, duties and inspections;
(x) Visual aids maintenance (signs, markings and markers), duties and inspections;
(xi) AGL maintenance, duties and inspections;
(xii) Allowance for annual leave, public holidays (in lieu), training, OJT training, special leave and sickness; and
(xiii) Sufficient operational administrative support staff (the number of support staff will depend on the complexity of the operations).

4. Qualification of Personnel.

(a) The term 'qualified' denotes fitness or fit for the purpose. This may be achieved through fulfillment of the necessary conditions such as completion of required training, or acquisition of a diploma or degree, or through the gaining of suitable experience. It, also, includes the ability, capacity, knowledge or skill that matches or suits an occasion, or makes someone eligible for a duty, office, position, privilege or status.

(b) Certain posts may, by nature, be associated with the possession of certain qualifications in a specific field (e.g. rescue and firefighting, civil, mechanical or electrical engineering, wildlife biology, etc.). In such cases, the person occupying such a post is expected to possess the necessary qualifications.

Table A7-1

Assessment Criteria for Aerodrome Post Holder

Accountable Manager

Performance Criteria

- Full control of the human resources required for the operations authorized to be conducted under the Aerodrome Certificate;
- Full control of the technical resources required for the operations authorized to be conducted under the Aerodrome Certificate;
- Full control of the financial resources required for the operations authorized to be conducted under the Aerodrome Certificate;
- Final CARC over operations authorized to be conducted under the Aerodrome Certificate;
- Ultimate responsibility and accountability for the establishment, implementation and maintenance of the Safety Management System;
- CARC and accountability for establishment, implementation, communication and promotion of the safety policy;
- CARC and accountability for establishment of the organization’s safety objectives and safety targets;
- Final responsibility for the resolution of all safety issues;
- CARC and accountability for establishment, implementation and maintenance of the organization’s competence to learn from the analysis of data collected through its safety reporting system and others Safety Data Collection and Processes Systems (SDCPS) in place; and
- CARC and accountability for establishment of a just culture which encourages safety reporting.

Knowledge Criteria

- Knowledge and understanding of the documents that prescribe relevant aerodrome safety standards;
- Understanding of the requirements for competence of aerodrome management personnel, so as to ensure that competent persons are in place;
- Knowledge and understanding of safety, quality, and security management systems related principles and practices, and how these are applied within the organization;
- Knowledge and understanding of the key issues of risk management within the aerodrome;
- Jordan regulatory framework (Civil Aviation Law No. 41-2017);
- Jordan State Safety Program and Aerodrome SMS (JCAR Part 19);
- CARC Aerodrome Certification Process;
- CARC Enforcement Process.

Supporting Documents

- Organizational Structure; and
- Other relevant documents if requested by CARC

Table App A7-2
Assessment Criteria for Aerodrome Post Holder

Aerodrome Safety

Performance Criteria

- Responsible individual and focal point for the development and maintenance of an effective Safety Management System;
- Ensure that processes needed for the SMS are established, implemented and maintained;
- Reportable directly to the Accountable Manager on the performance of the SMS and on any need for improvement;
- Ensure safety promotion throughout the organization; and
- The role of the safety manager shall be to:
  (1) facilitate hazard identification, risk analysis, and management;
  (2) monitor the implementation and functioning of the Safety Management System, including the necessary safety actions;
  (3) manage the safety reporting system of the aerodrome;
  (4) provide periodic reports on safety performance;
  (5) ensure maintenance of safety management documentation;
  (6) ensure that there is safety management training available, and that it meets acceptable standards;
  (7) provide advice on safety matters; and
  (8) initiate and participate in internal occurrence/accident investigations.

Knowledge Criteria

- Practical experience and expertise in aerodrome operations, maintenance or similar area;
- Knowledge of the Aerodrome Manual;
- Knowledge of safety management;
- Comprehensive knowledge of the applicable requirements in the area of aerodromes;
- CARC Regulatory framework; and
- CARC State Safety Program / Aerodrome SMS /Aerodrome Certification Process.

Supporting Documents

- Curriculum Vitae, Job Description and proof of relevant Training and Qualifications Other relevant documents if requested by CARC.

Table App A7-3

Assessment Criteria for Aerodrome Post Holder

Aerodrome Operations

Performance Criteria

- Ensure that aerodrome certification requirements are met, and that the aerodrome operates in accordance with certificate conditions and regulatory requirements;
- Accountable for day-to-day aerodrome operations;
- Ensure an understanding by the aerodrome management of the certification requirement for and status of the Aerodrome Manual;
- Responsible for the management of the operational services of the aerodrome;
- Analyse auditing findings and inspections to CARC, and initiate actions;
- Use feedback from auditing and inspections to recommend appropriate changes to airside safety management procedures and ensure implementation;
- Monitor airside planning and development for compliance; and
- Develop proactive working relationships with aerodrome users.

Knowledge Criteria

- Practical experience and expertise in aerodrome operations or maintenance (or similar area) respectively;
- Comprehensive knowledge of the applicable requirements in the area of aerodromes;
- Appropriate level of knowledge of safety and quality management;
- Knowledge of the Aerodrome Manual;
- CARC Regulatory Framework /State Safety Program / SMS;
- CARC Aerodrome Certification Process; and
- CARC Enforcement Process.

Supporting Documents;

- Curriculum Vitae, Job Description and proof of relevant Training and Qualifications Other relevant documents if requested by CARC.

Table App A7-4

Assessment Criteria for Aerodrome Post Holder

Aerodrome Maintenance

Performance Criteria

- Ensure that aerodrome certificating requirements are met, and that the aerodrome facilities are accurately reported (Aerodrome Manual/AIP) and in accordance with the regulatory requirements;
- Ensure aerodrome facilities are compatible with sizes, types and frequency of aircraft in accordance with company and legislative requirements;
- Ensure that maintenance policies, procedures and training fulfil the aims of the aerodrome and meet regulatory requirements;
- Ensure understanding of regulatory requirements specific to electrical systems;
- Ensure understanding of regulatory requirements specific to aeronautical ground lighting and other visual aids such as markings;
- Ensure understanding of regulatory requirements specific to aerodrome pavements;
- Ensure understanding of role as related to aerodrome reporting systems to include hazard identification, defect identification and reporting of safety critical information to the aerodrome Air Traffic Service Unit;
- Ensure basic understanding of aerodrome bird and wildlife hazard management program;
- Ensure understanding of requirement for corrective and preventive maintenance program; and
- Ensure understanding of competency standards and evaluation program for maintenance staff maintaining safety critical assets or working in safety critical areas (including both technical and operational (RT/Driving) competencies as necessary).

Knowledge Criteria

- Qualified in the role with appropriate education, experience and/or certification;
- Practical experience and expertise in aerodrome maintenance;
- Comprehensive knowledge of the applicable requirements in the areas of electrical systems, aeronautical ground lighting and pavements;
- Knowledge of the Aerodrome Manual;
- Knowledge of applicable guidance materials such as Aerodrome Design Manual;
- CARC Regulatory framework / State Safety Program / Aerodrome MS; and
- CARC Process for the reporting and follow-up of accidents, incidents and emergencies on the aerodrome.

Supporting Documents

- Curriculum Vitae, Job Description and proof of relevant Training and Qualifications Other relevant documents if requested by CARC.

Table App A7-5

Assessment Criteria for Aerodrome Post Holder

Aerodrome Quality

Performance Criteria

- define the quality policy in such a way as to meet the needs of different users as closely as possible;
- set up a quality assurance program that contains procedures designed to verify that all operations are being conducted in accordance with the applicable requirements, standards and procedures, including the relevant requirements of JCAR Part 139;
- provide evidence of the functioning of the quality system by means of manuals and monitoring documents;
- Ensure that processes needed for the QMS are established, implemented and maintained;
- Reportable directly to the Accountable Manager on the performance of the QMS and on any need for improvement;

Knowledge Criteria

- Practical experience and expertise in aerodrome data, as well as its quality management system with regard to aeronautical data and aeronautical information provision activities.;
- Knowledge of the Aerodrome Manual;
- Knowledge of safety management;
- Comprehensive knowledge of the applicable requirements in the area of aerodromes;
- CARC Regulatory framework; and

Supporting Documents

- Curriculum Vitae, Job Description and proof of relevant Training and Qualifications Other relevant documents if requested by CARC.

Appendix (7) Aerodrome Management – Safety Programs

1. The Aerodrome Operator shall:

1.1 The Aerodrome Operator shall establish a safety management system acceptable to CARC that includes the requirement to participate in relevant Aerodrome - Safety Management Programs such as:

(a) Runway safety teams;
(b) Apron safety;
(c) FOD prevention; and
(d) Low visibility operations programs.

1.2 Coordinate and promote the exchange of information and the joint investigation of occurrences, serious incidents and accidents, with organizations operating or providing services at the aerodrome.

1.3 The Aerodrome Operator shall establish, coordinate and lead local safety committees, including a Local Runway Safety Team, dealing in particular with runway safety, apron safety, and the safety of the operations at the aerodrome in general. All relevant organizations operating or providing services at the aerodrome shall participate in such safety committees.

1.4 The local safety committees shall be supported by Terms of Reference and convene regularly, identify and review local safety issues, examine possible solutions and need for action. Minutes of such meetings shall be kept. Details relevant to the composition, structure, function, purpose and output of local safety committees should be included in the Aerodrome Manual.

2. Aerodrome Management Safety Programs

The Aerodrome Operator should:

2.1 Identify Hot Spots or potential Hot Spots at the aerodrome.

Note: See Definitions, paragraph 139.3 definitions for definition of Hot Spot.

2.2 Once Hot Spots have been identified at an aerodrome, suitable strategies should be implemented to remove the hazard or when this is not immediately possible, to manage and mitigate the risk, including the publication of hot spot charts in the Aeronautical Information Publication.

3. Maneuvering Area/Apron Safety Committee

3.1 The Aerodrome Operator shall establish a Maneuvering Area/Apron Safety Committee(s);

3.2 The Maneuvering Area/Apron Safety Committee(s) shall have an advisory role to the Aerodrome Operator;

3.3 Management of Maneuvering Area/Apron Safety Committee(s):
The Maneuvering Area/Apron Safety Committee(s) shall be:
(a) chaired by an Aerodrome Operator’s official, responsible for aerodrome operations; and
(b) be attended by the Aerodrome Operator’s Safety Manager.

3.4 Composition of Maneuvering Area/Apron Safety Committee(s)
Participation shall include, but not limited to representatives of:
(a) aerodrome users active in flight operations;
(b) aircraft ground handling services providers;
(c) rescue firefighting services;
(d) aerodrome emergency services;
(e) aerodrome operations;
(f) aerodrome wildlife management;
(g) aerodrome maintenance; and
(h) air navigation service provider(s).

3.5 Tasks of Maneuvering Area/Apron Safety Committee(s)
The tasks of the Maneuvering Area /Apron Safety Committee(s) shall be:
(a) to receive and evaluate reports on operational safety issues;
(b) to receive reports and statistical information on accidents and incidents, and propose solutions;
(c) to advise on Movement Area/apron safety issues such as:
- promotion of apron safety discipline;
- FOD prevention;
- developing measures for safety operations;
- considering actions to resolve Movement Area safety problems;
- apron equipment issues;
- attention to vehicle traffic issues;
- new and/or updated safety instructions;
- personal protective clothing/equipment issues;
- methods to develop and promote apron safety awareness initiatives;
- proposed aerodrome works;
- proposed changes/developments to the Movement Area;
- standard operating procedures; and
- heat, stress and fatigue, etc.

4. Local Runway Safety Team
4.1 Context
As part of its runway safety program, the Aerodrome Operator shall establish and

lead a Local Runway Safety Team and act on local runway safety issues, including runway incursion prevention.

4.2 Local Runway Safety Team Composition

Participation shall include representatives from all interested parties with direct involvement in runway operations at the aerodrome, including, but is not limited, to:

(a) aerodrome operations;
(b) aerodrome engineering and maintenance;
(c) air navigation service providers;
(d) aircraft operators that operate on the aerodrome;
(e) rescue firefighting services;
(f) aerodrome emergency services; and
(g) drivers having access on the maneuvering area.

4.3 Local Runway Safety Team Role

The role of the Local Runway Safety Team should be to advise the appropriate management on potential runway safety issues and to recommend mitigating measures.

4.4 Local Runway Safety Team Tasks

The Local Runway Safety Team may have the following tasks:

(a) Identification of potential runway safety issues, including the need for the establishment of hot spots or other problem areas at the aerodrome and the review of the relevant entries of the AIP. This may be undertaken through the assessment of hazards and past events;
(b) developing and running local awareness campaigns that focus on local issues, for example, producing and distributing local hot spot maps, or other guidance material considered as necessary;
(c) assisting in verifying that communications between air traffic controllers, pilots and vehicle drivers are satisfactory and recommend educational training or procedural initiatives as required;
(d) making observations on a regular basis in different weather and light conditions to assess whether all visual aids are adequate and understandable by all parties concerned, or identify potential aerodrome design issues;
(e) understanding the operating difficulties of personnel working in other areas, and recommending areas for improvement;
(f) development of joint training programs on runway incursion prevention;
(g) provide advice prior to the implementation of changes to the aerodrome to identify potential for runway incursion;
(h) review and implement recommendations as appropriate from CARC Guidance Material Runway Incursions Prevention Program.
(i) monitor the number, type and severity of runway safety events including incursions and excursions; and

(j) periodically review airfield compliance issues, alternative means of compliance or deviations related to the runway.

4.5 Strategies to manage and mitigate the risk from hot spots, depending on the case, may include, but are not limited to:

(a) awareness campaigns;
(b) additional visual aids (signs, markings, and lighting);
(c) establishment of alternative routings;
(d) introducing changes to the design of parts of the aerodrome; and
(e) the mitigation of blind spots in the aerodrome control tower.

4.6 Aerodrome charts showing hot spots should be produced locally, checked regularly for accuracy, revised as needed, distributed locally, and published in the AIP.