

Figure S1-21. Visual approach slope indicator systems

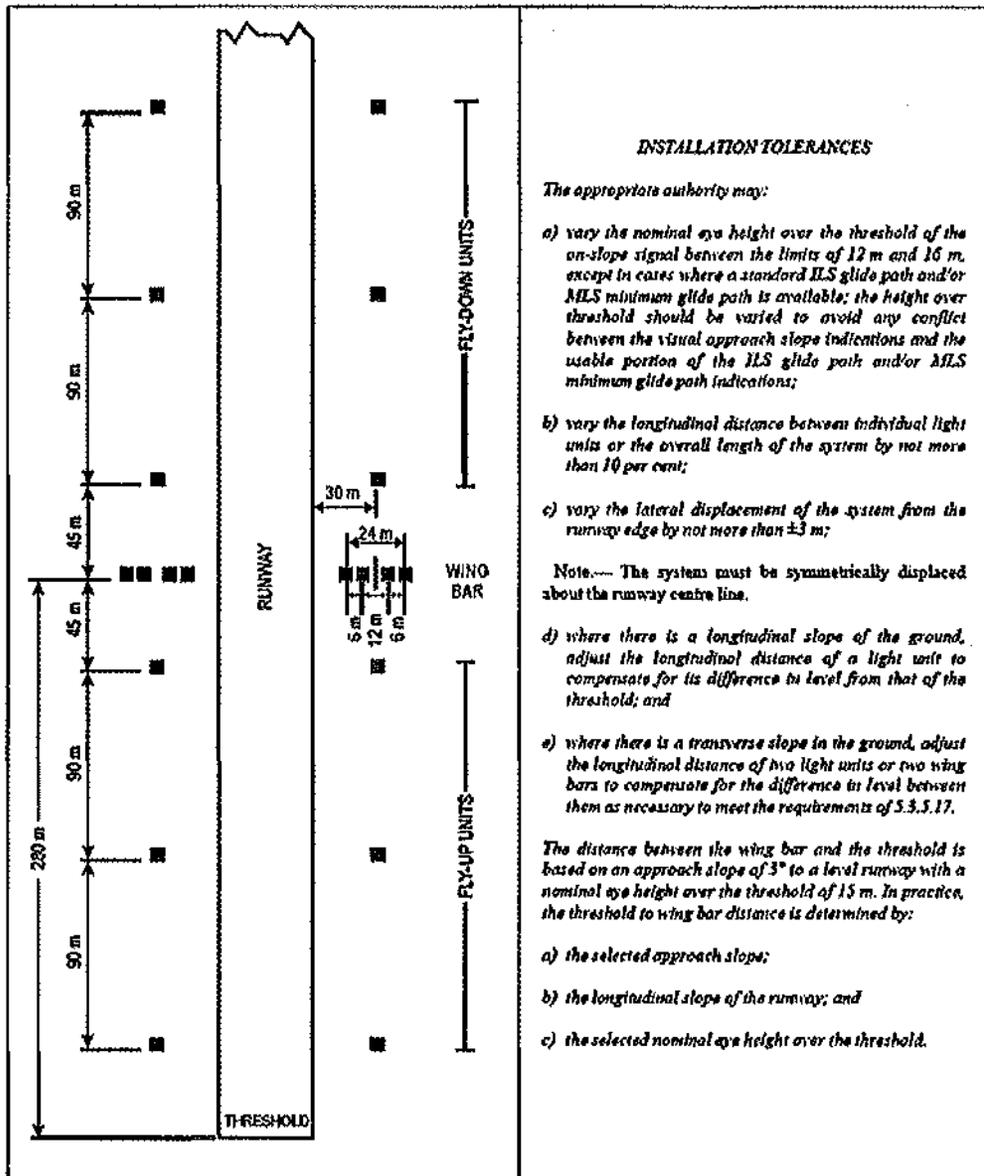


Figure SI-22. Siting of light units for T-VASIS

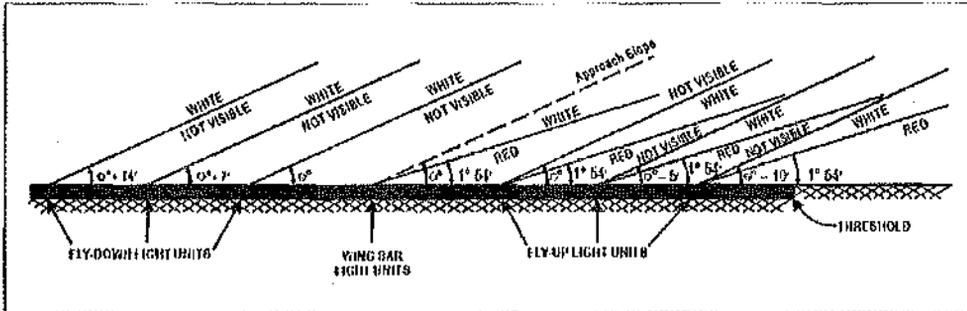


Figure S1-23. Light beams and elevation settings of T-VASIS and AT-VASIS

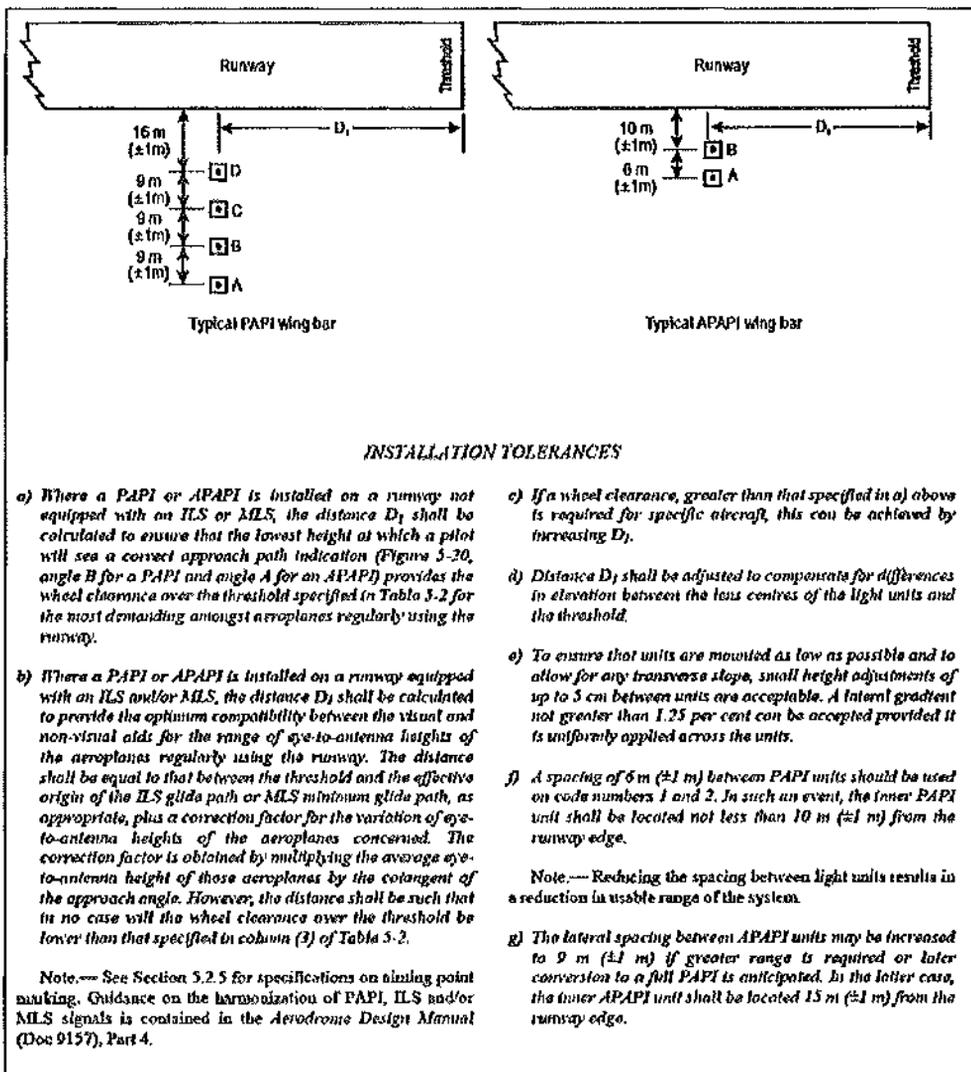


Figure S1-24. Siting of PAPI and APAPI

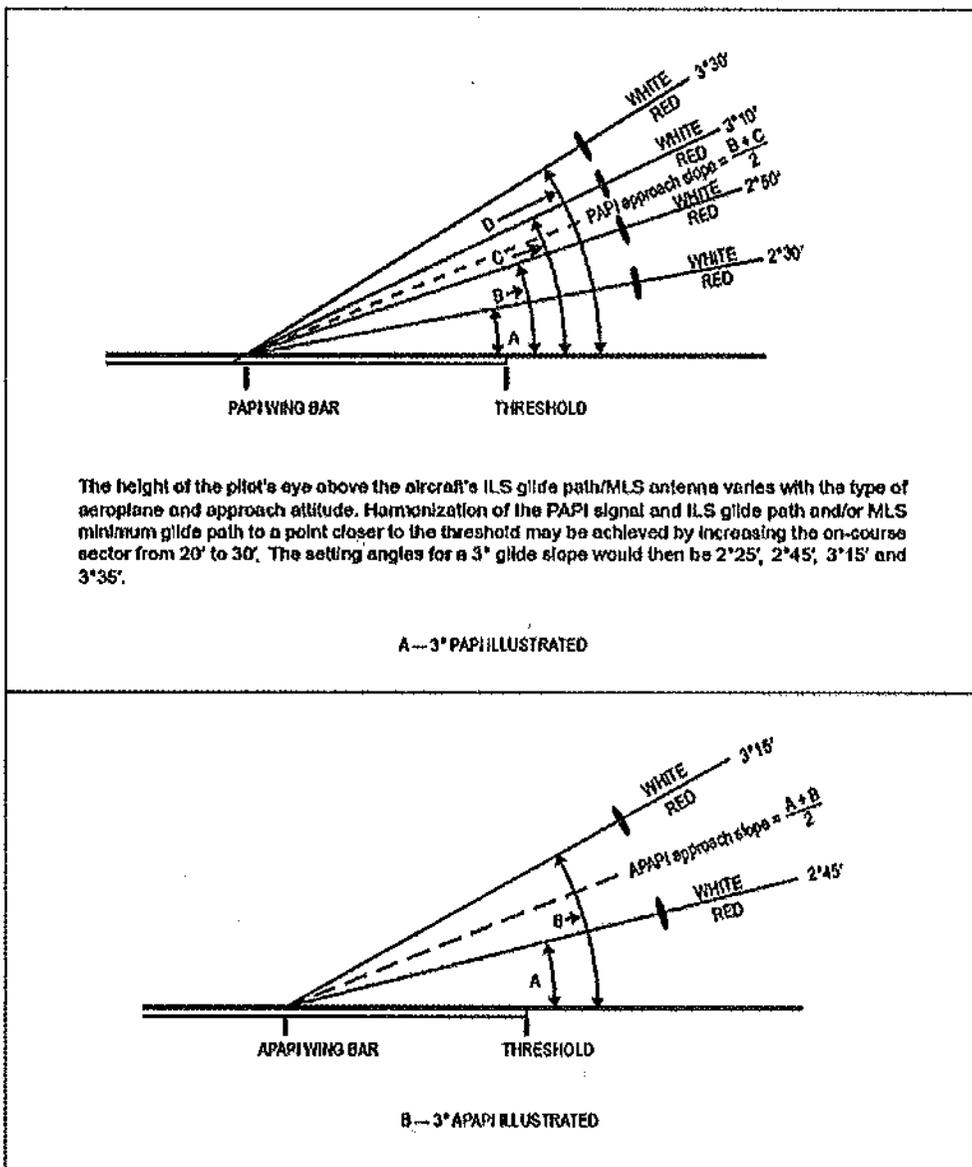
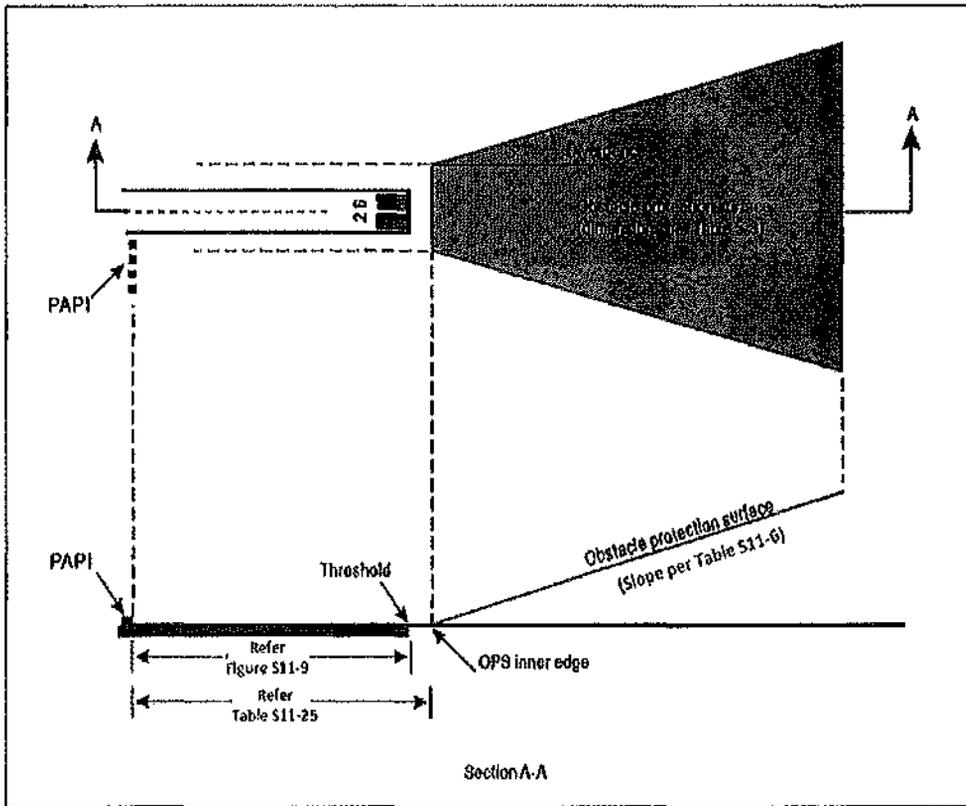


Figure S1-25. Light beams and angle of elevation setting of PAPI and APAPI



FigureS1-26. Obstacle protection surface for visual approach slope indicator systems

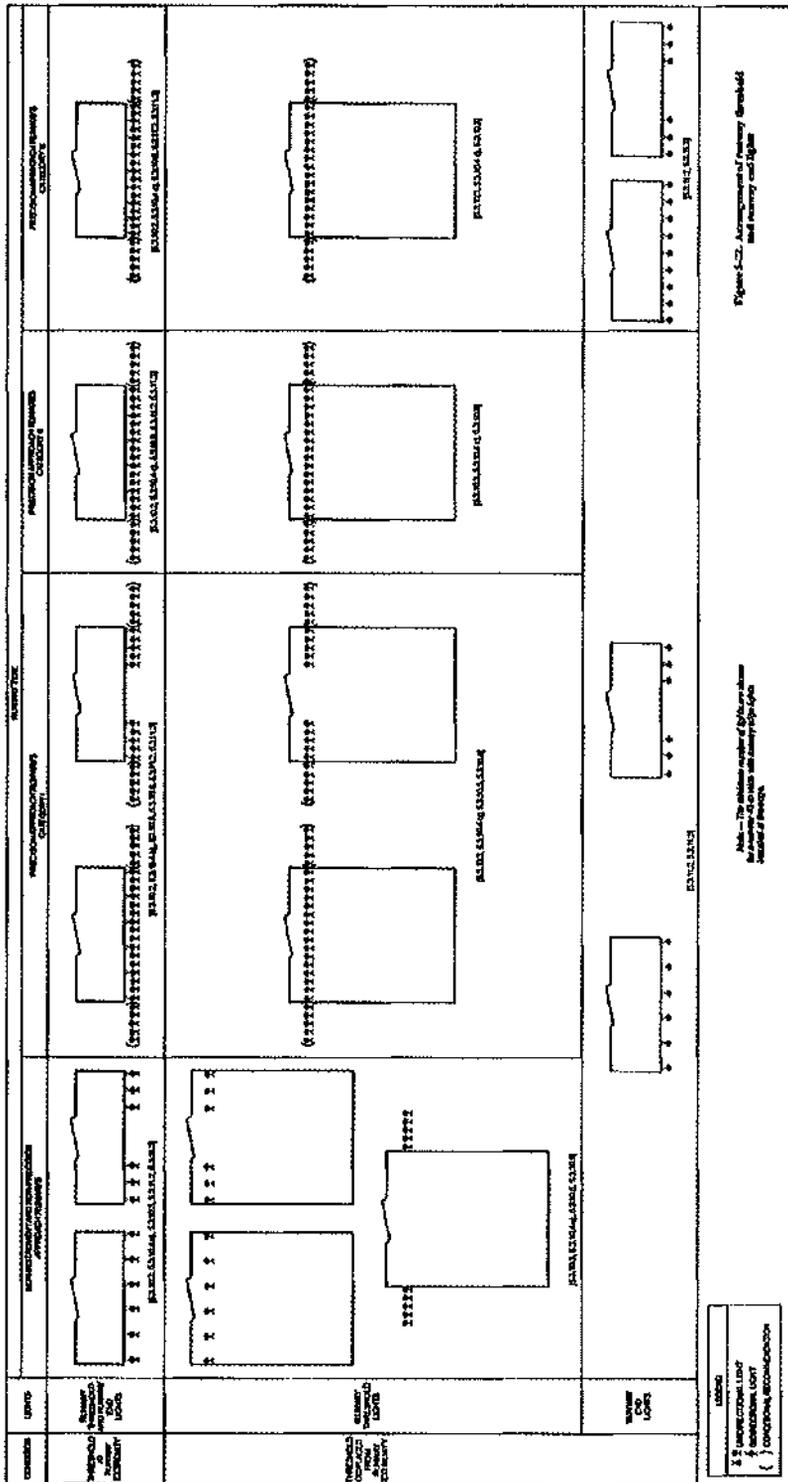
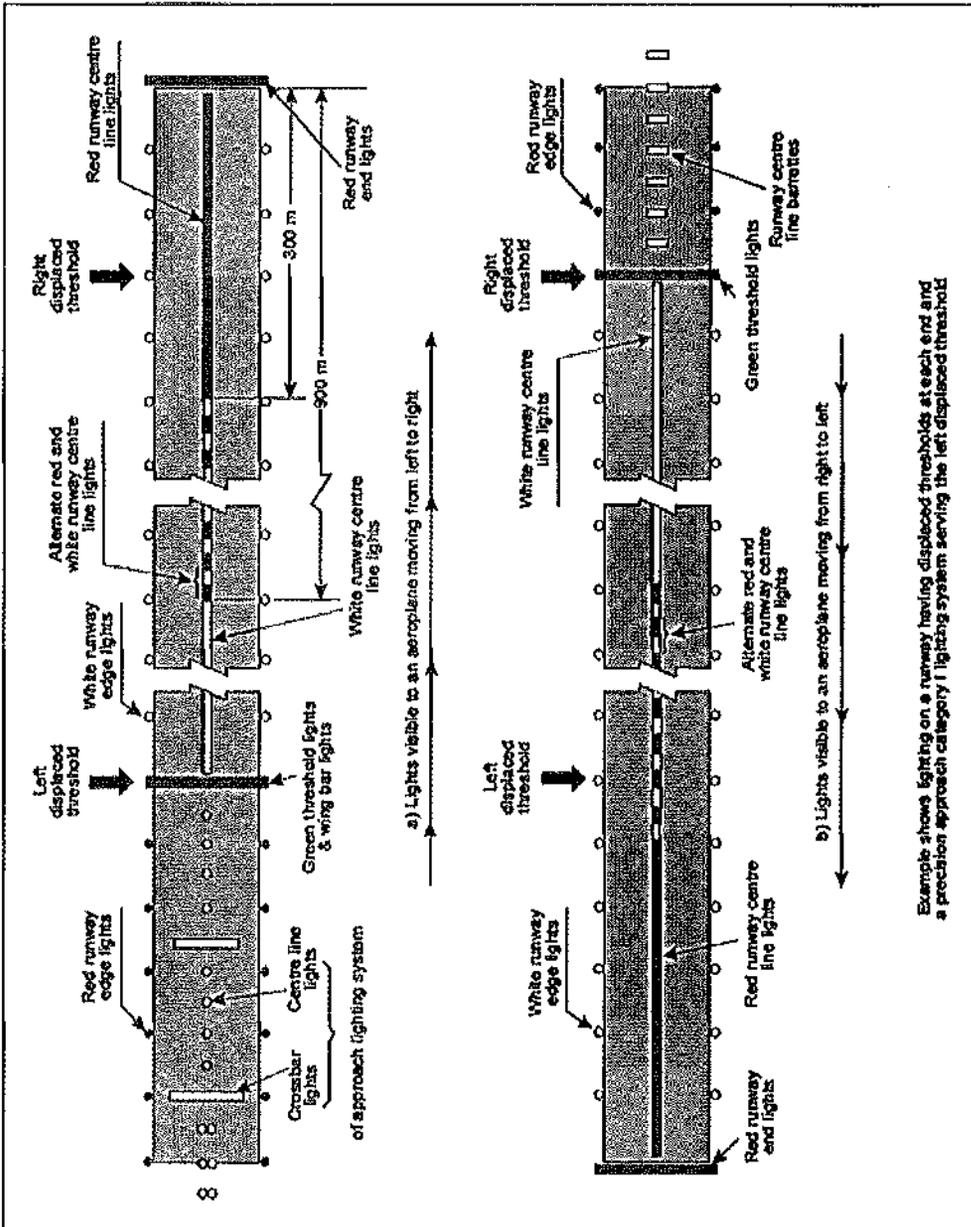


Figure 5-27. Arrangement of Primary Reinforcement

Note: The relative number of primary reinforcement bars is shown relative to the number of bars.

1. PERMANENTLY OCCURRING APPROXIMATELY PERMANENT
 2. PERMANENTLY OCCURRING APPROXIMATELY PERMANENT
 3. PERMANENTLY OCCURRING APPROXIMATELY PERMANENT



Example shows lighting on a runway having displaced thresholds at each end and a precision approach category I lighting system serving the left displaced threshold

Figure S1-28. Example of approach and runway lighting for runway with displaced thresholds

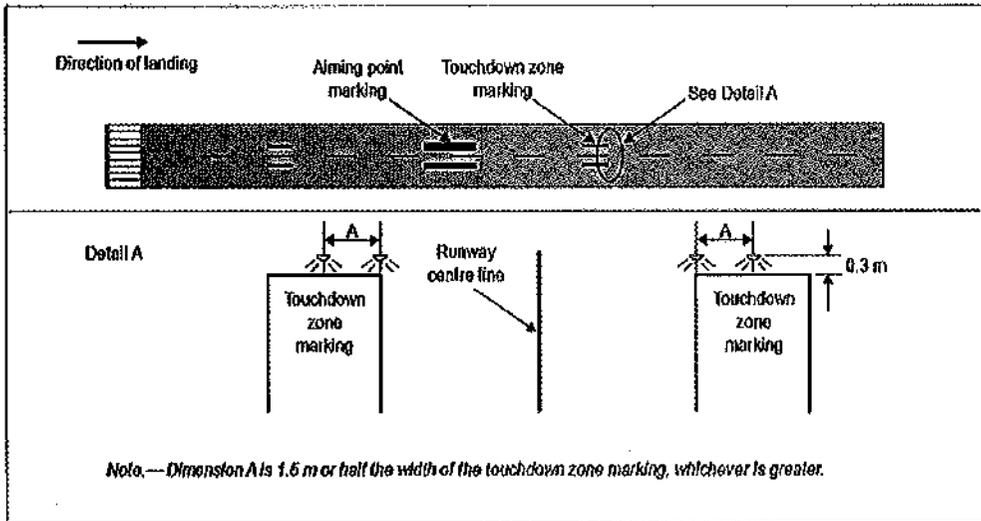


Figure S1-29. Simple touchdown zone lighting

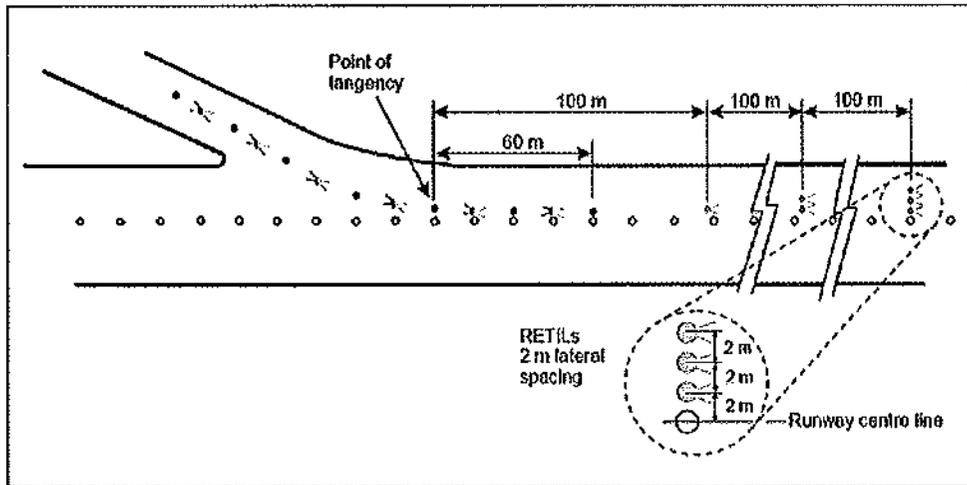


Figure S1-30. Rapid exit taxiway indicator lights (RETILs)

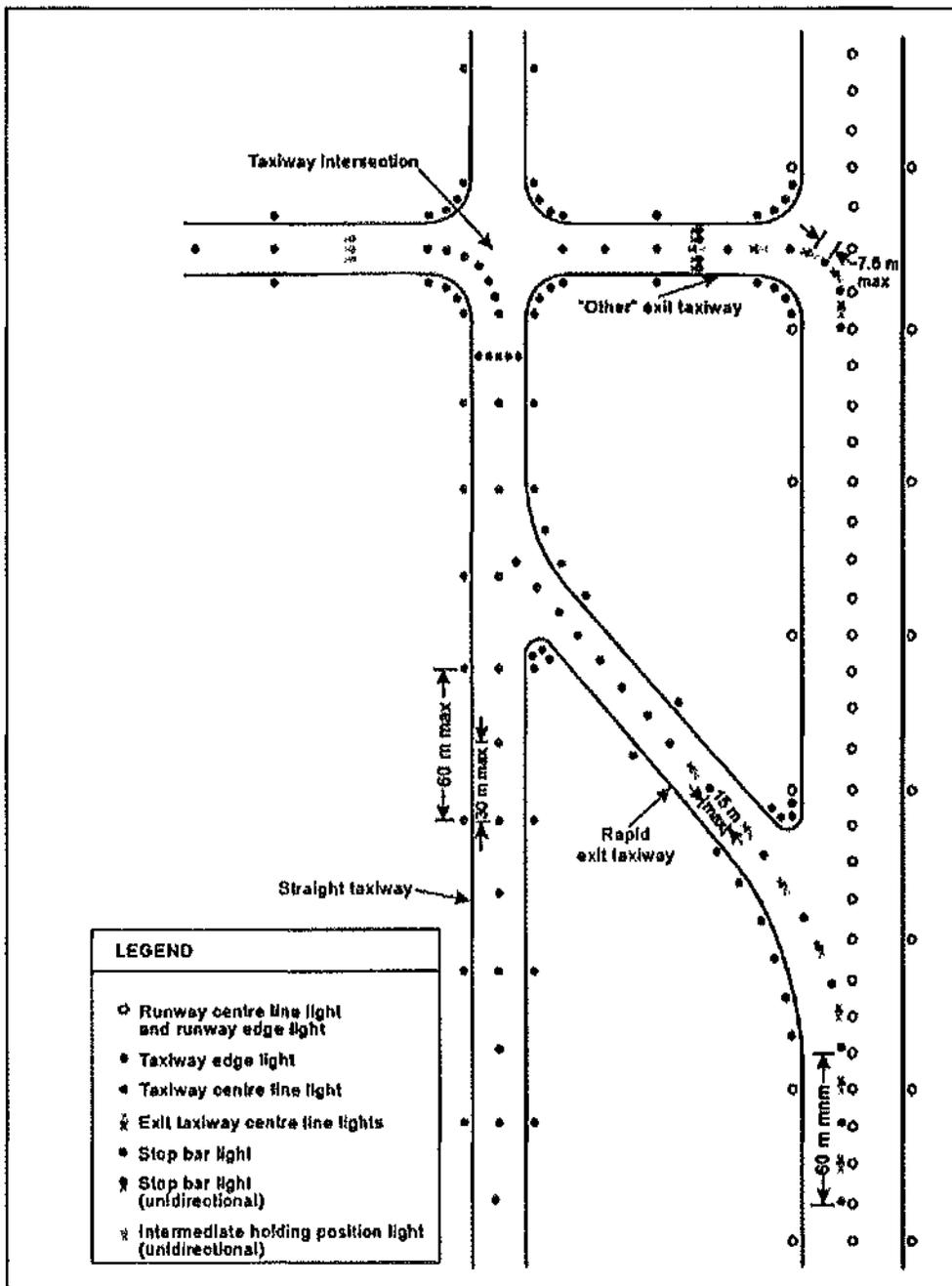


Figure S1-31. Taxiway lighting

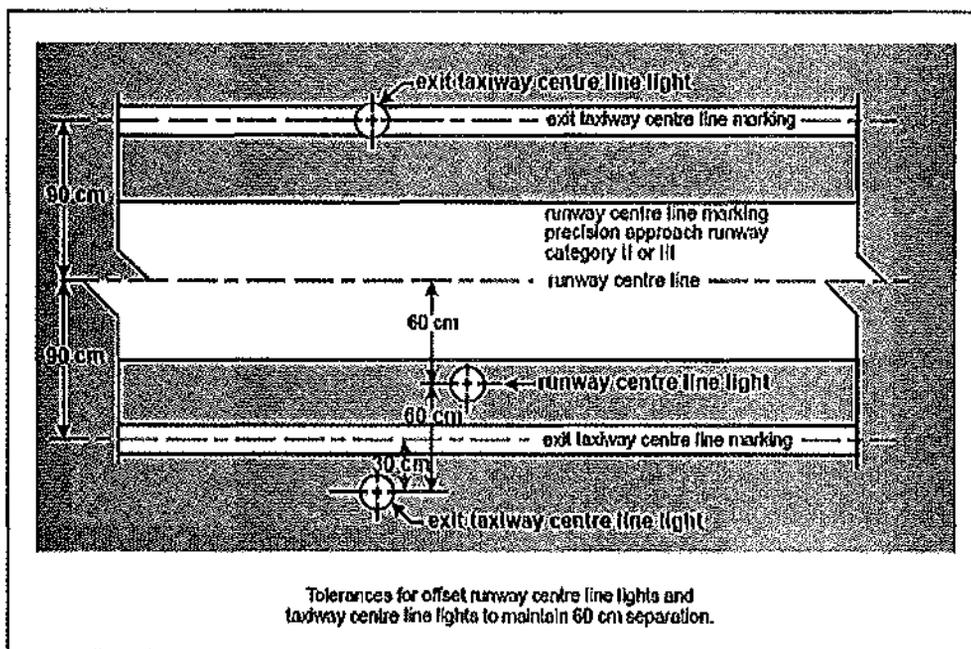


Figure S1-32. Offset runway and taxiway centre line lights

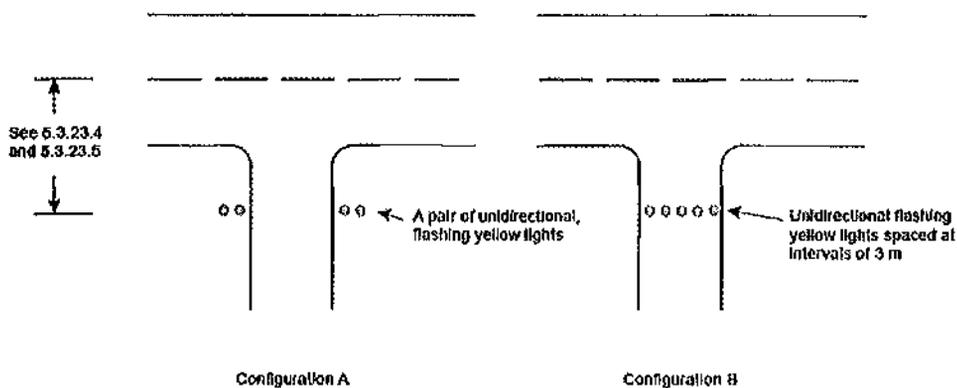


Figure S1-33. Runway guard lights

Runway designation of a runway extremity (Example)		Indicates a runway-holding position at a runway extremity
Runway designation of both extremities of a runway (Example)		Indicates a runway-holding position located at taxiway/runway intersection other than runway extremity
Category I hold position (Example)		Indicates a category I runway-holding position at the threshold of runway 25
Category II hold position (Example)		Indicates a category II runway-holding position at the threshold of runway 25
Category III hold position (Example)		Indicates a category III runway-holding position at the threshold of runway 25
Category II and III hold position (Example)		Indicates a joint category II and III runway-holding position at the threshold of runway 25
Category I, II and III hold position (Example)		Indicates a joint category I, II and III runway-holding position at the threshold of runway 25
NO ENTRY		Indicates that entry to an area is prohibited
Runway-holding position (Example)		Indicates a runway-holding position (in accordance with 3.12.3)

Figure S1-34. Mandatory instruction signs

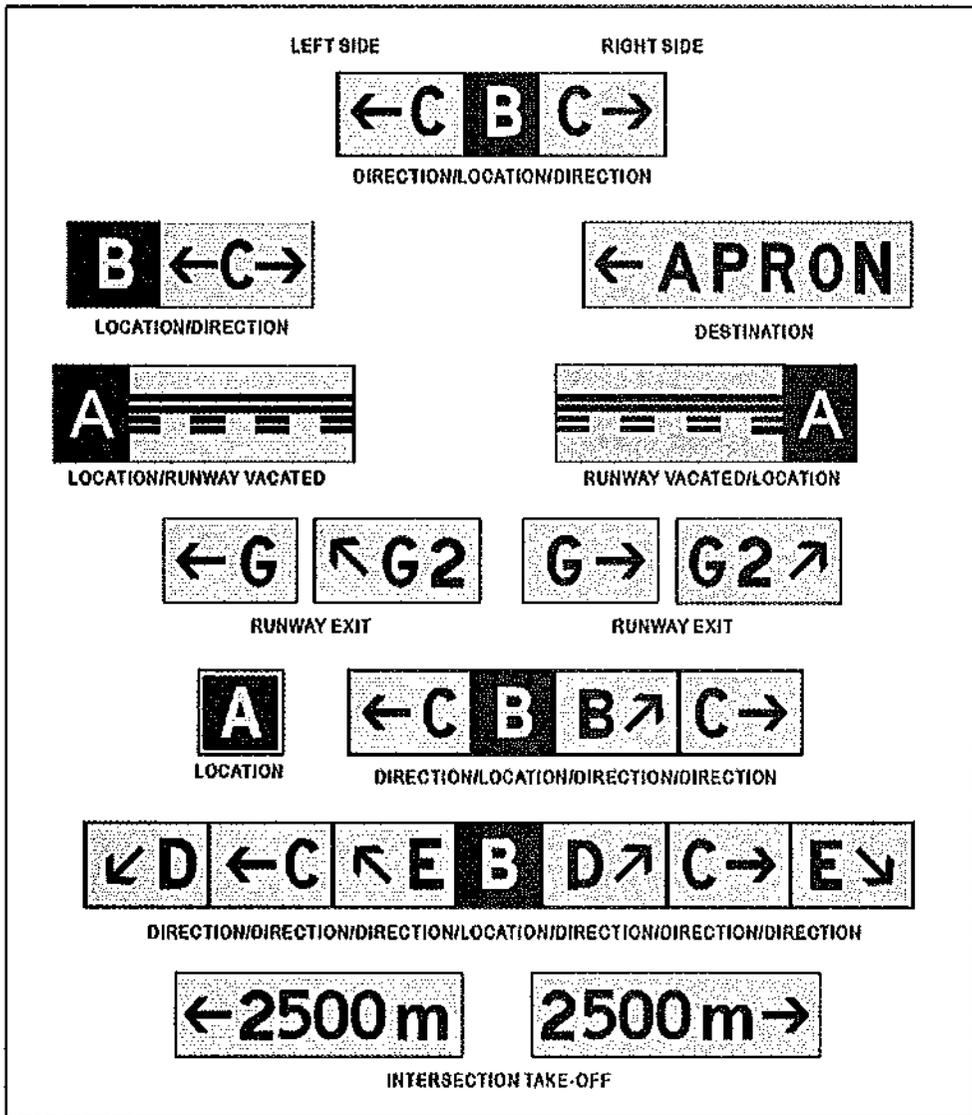


Figure S1-35. Information Signs

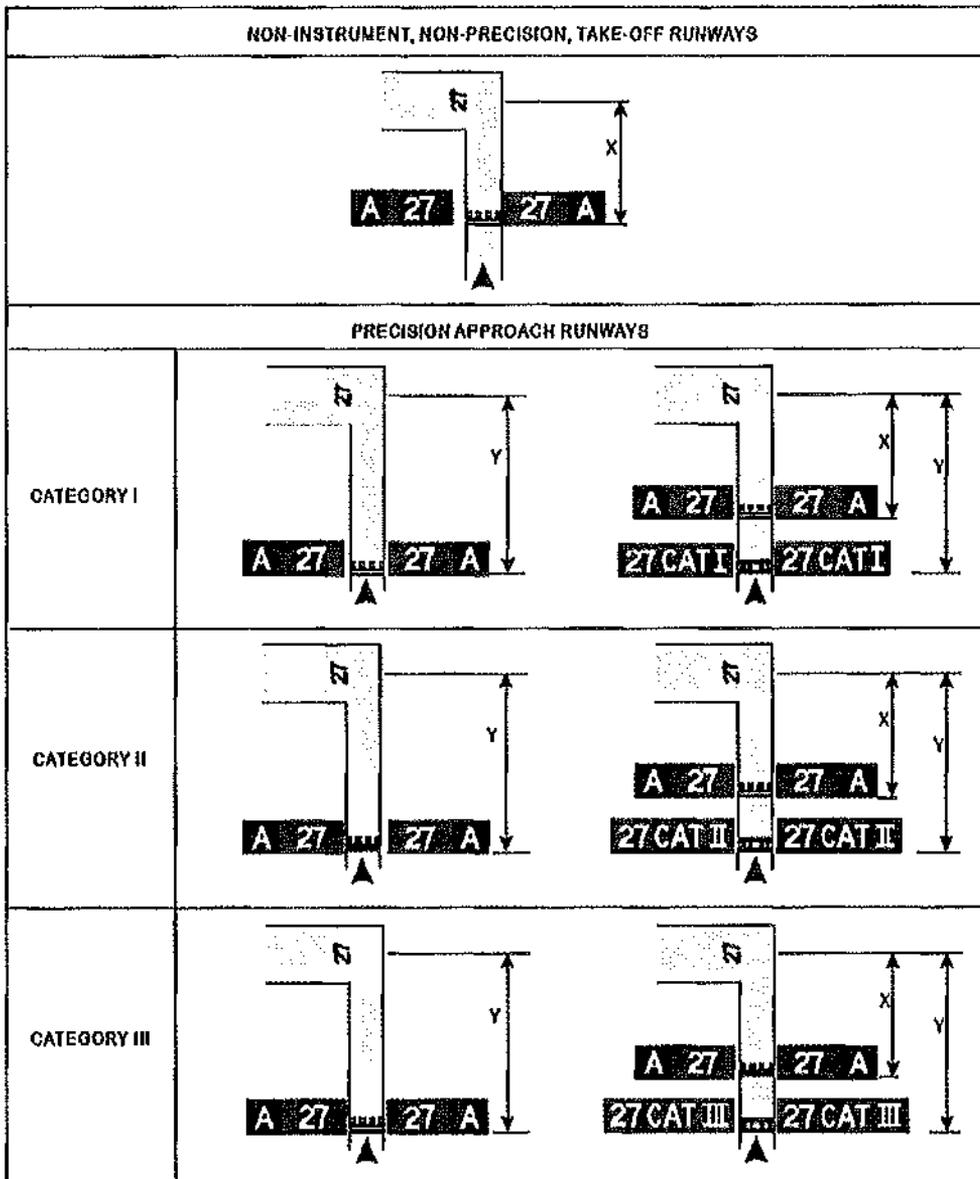


Figure S1-36. Examples of sign positions at taxiway/runway intersections

Note. To figure S1-36—Distance X is established in accordance with Table S1-4. Distance Y is established at the edge of the ILS/MLS critical/sensitive area.

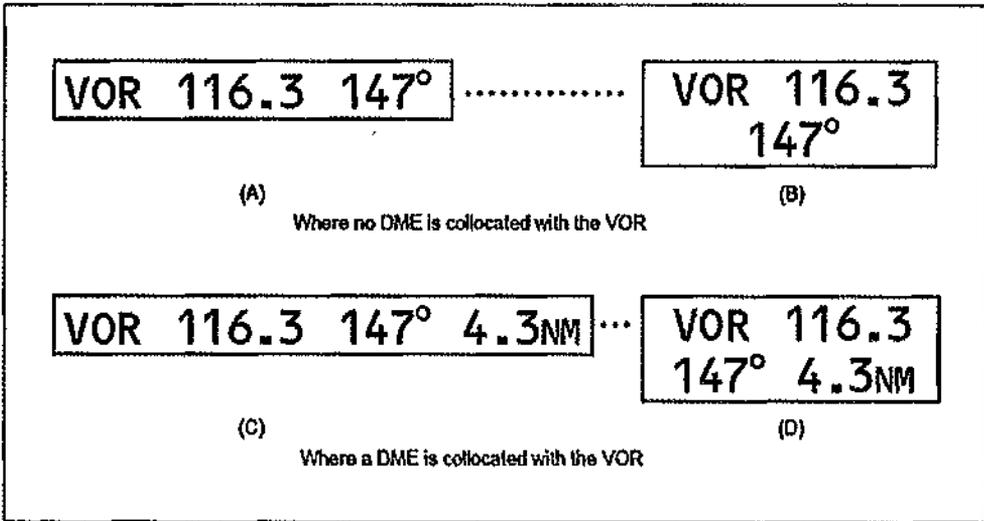


Figure S1-37. - VOR aerodrome checkpoint sign

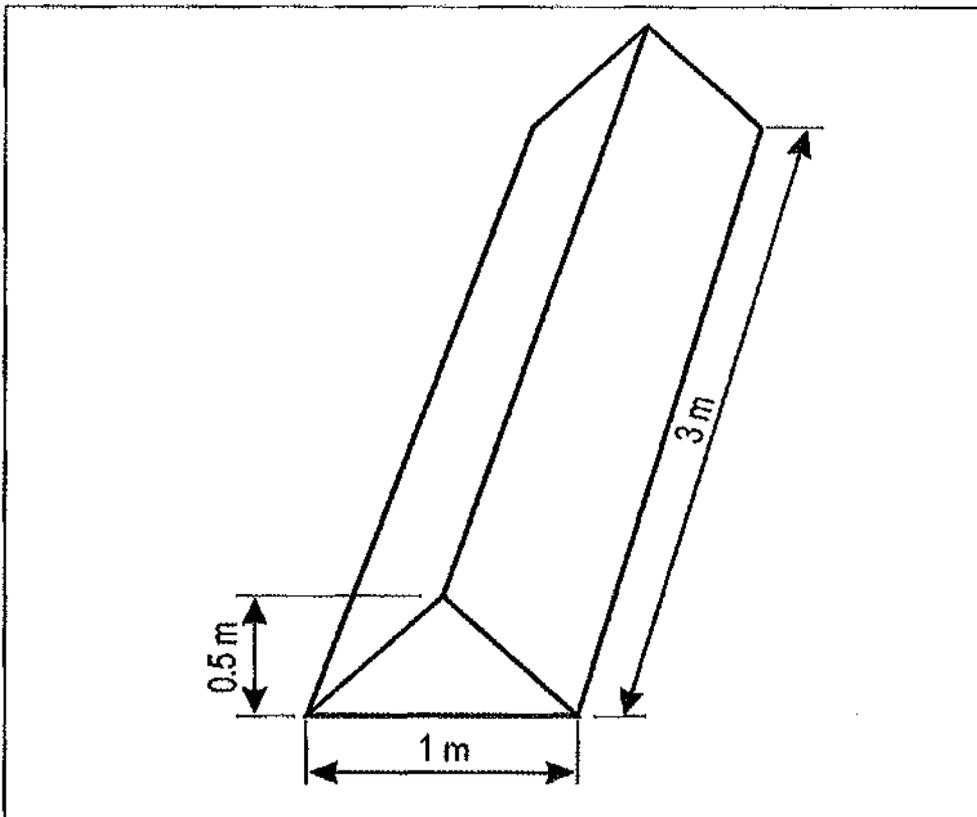


Figure S1-38. Boundary Markers

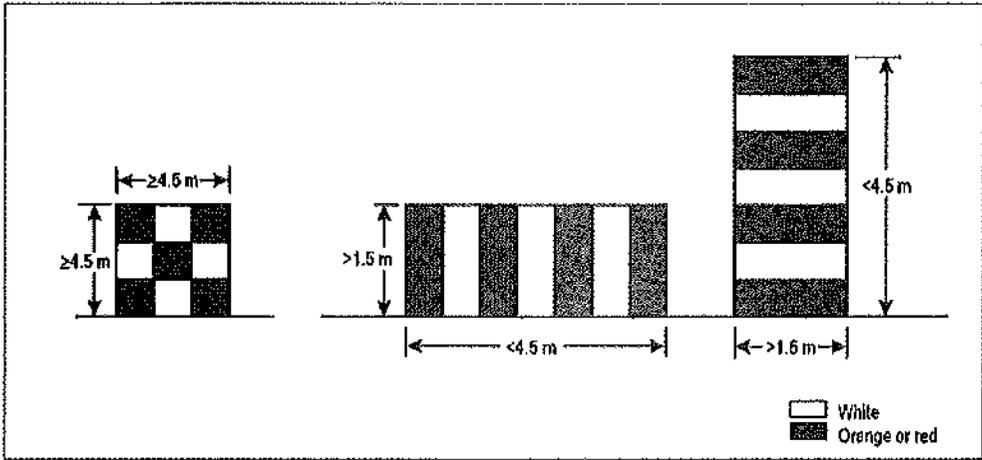


Figure S1-39. Basic marking patterns

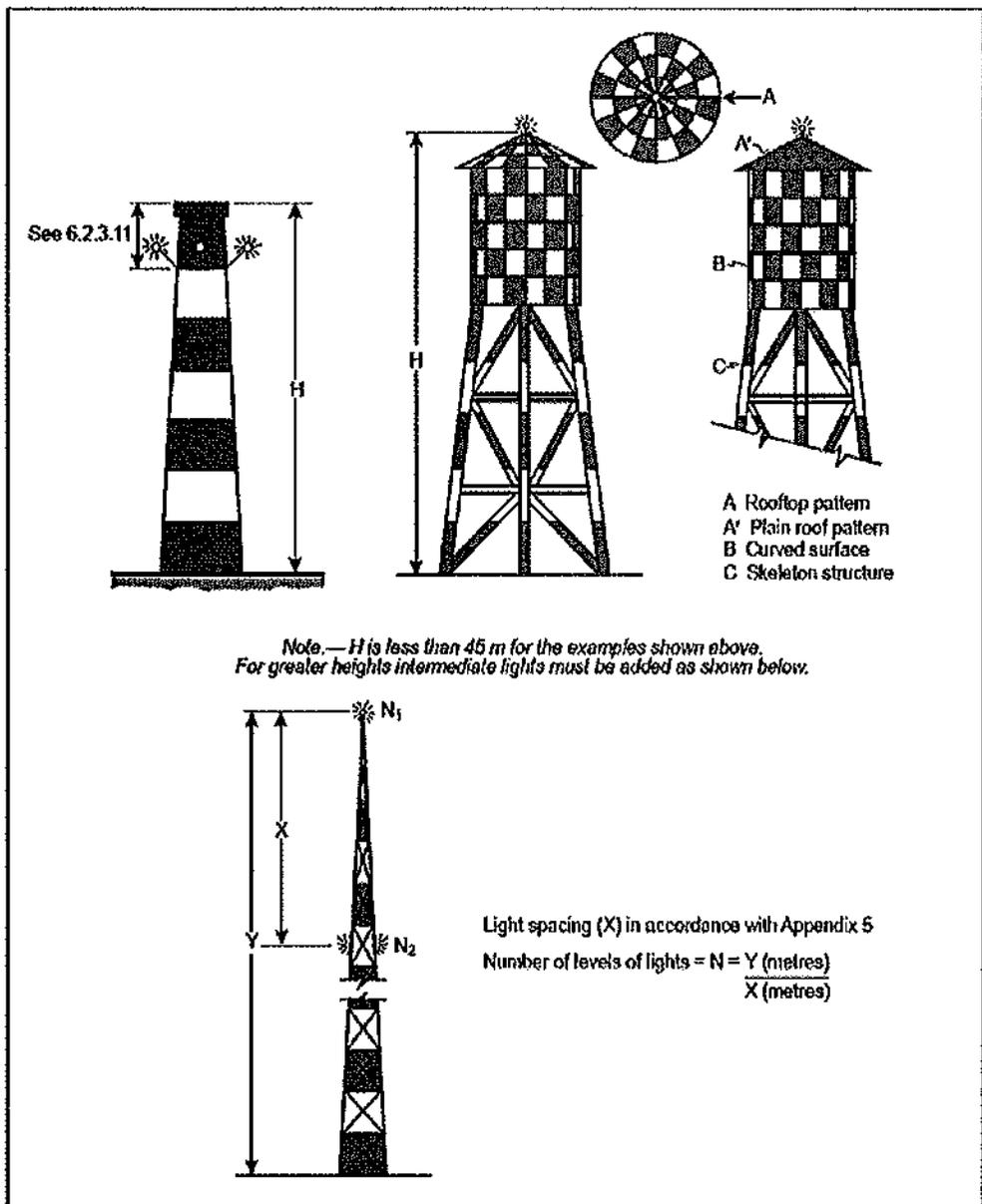


Figure S1-40. Examples of marking and lighting of tall structures

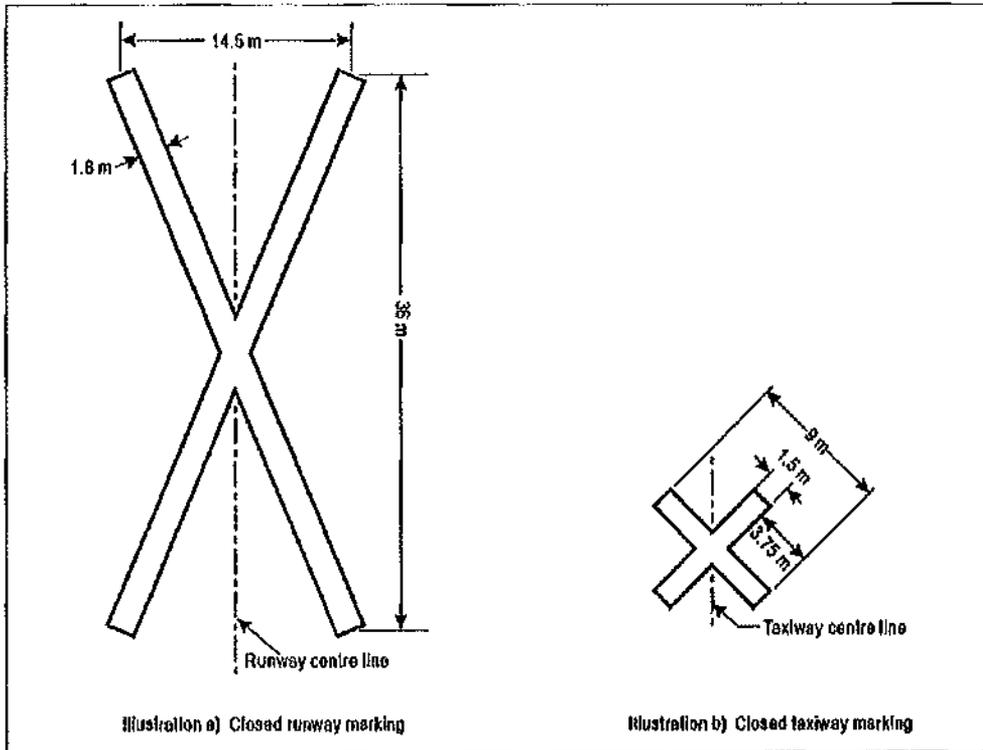


Figure S1-41. Closed runway and taxiway markings

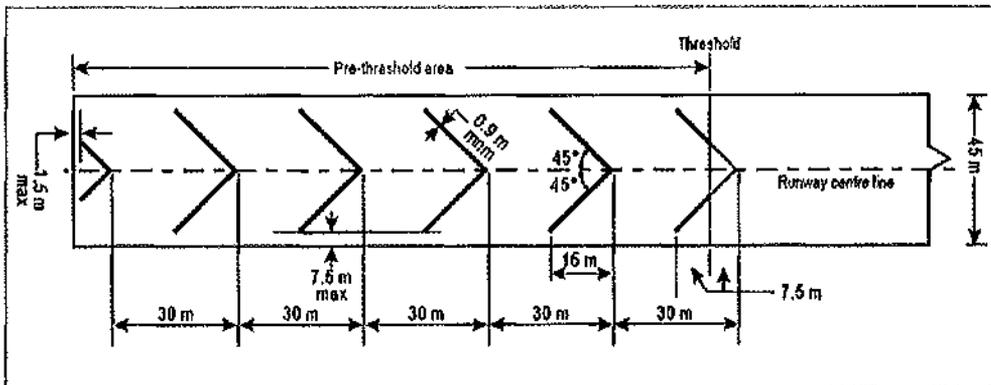


Figure S1-42. Pre-threshold marking

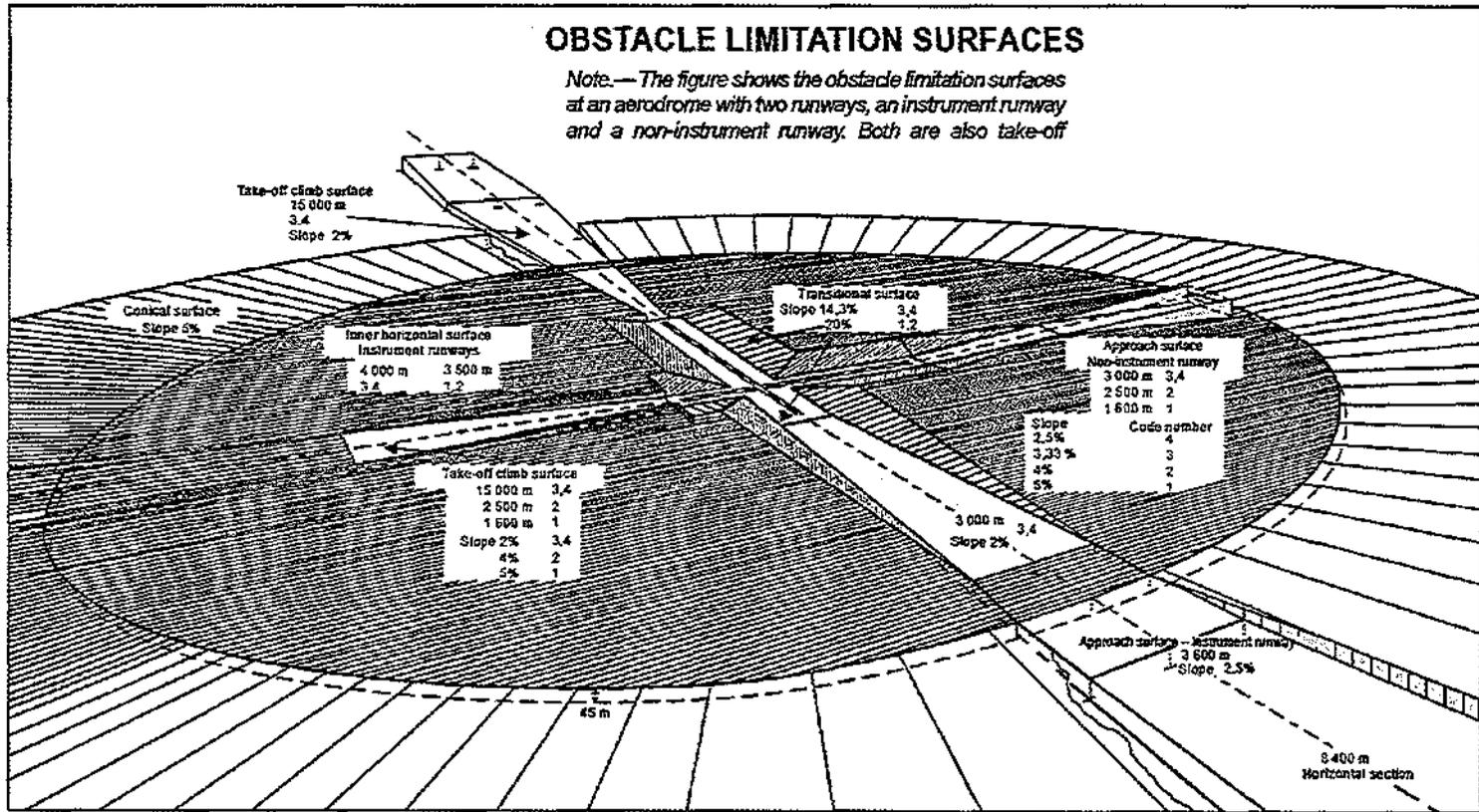


Figure S1-43. Obstacle limitation surfaces

SUPPLEMENTARY TABLES TO THE REGULATIONS

Table S1-1. Aerodrome reference code

Code element 1

<i>Code number</i>	<i>Aerodrome reference field length</i>
1	Less than 800m
2	800m up to but not including 1200m
3	1200m up to but not including 1800m
4	1800m and over

Code element 2

<i>Code letter</i>	<i>Wingspan</i>
A	Up to but not including 15m
B	15m up to but not including 24m
C	24m up to but not including 36m
D	36m up to but not including 52m
E	52m up to but not including 65m
F	65m up to but not including 80m

Table S1-2. Runway width tabulation table

<i>Code number</i>	<i>Code letter</i>					
	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<i>E</i>	<i>F</i>
1a	18m	18m	23m	-	-	-
2a	23m	23m	30m	-	-	-
3	30m	30m	30m	45m	-	-
4	-	-	45m	45m	45m	60m

a.

Outer Main Gear Wheel Span (OMGWS)

<i>Code number</i>	Up to but not including 4.5m	4.5 up to but not including 6m	6m up to but not including 9m	9m up to but not including 15m
1 ^a	18m	18m	23m	-
2 ^a	23m	23m	30m	-
3	30m	30m	30m	45m
4	-	-	45m	45m

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

Note 1. — The combinations of code numbers and letters for which widths are specified have been developed for typical aeroplane characteristics.

Note 2. — Factors affecting runway width are determined by the Authority

Code letter	Distance between taxiway centre line and runway centre line (metres)								Taxiway centre line to taxiway centre line (metres)	Taxiway, other than aircraft stand taxiway, centre line to object (metres)	Aircraft stand centre line to aircraft stand taxiway centre line (metres)	Aircraft stand centre line to object (metres)
	Instrument runways				Non-instrument runways							
	Code number				Code number							
1	2	3	4	1	2	3	4					
(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	87	--	32	20	28.5	16.5
C	88	88	158	158	48	58	93	93	44	26	40.5	22.5
D	--	--	166	166	--	--	101	101	63	37	59.5	33.5
E	--	--	172.5	172.5	--	--	107.5	107.5	76	43.5	72.5	40
F	--	--	180	180	--	--	115	115	91	51	87.5	47.5

Note 1.—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 the Aerodrome Design Manual (Doc 9157), Part 2.

Note 2.—The distances in columns (2) to (9) do not guarantee sufficient clearance behind a holding aeroplane to permit the passing of another aeroplane on a parallel taxiway. See the Aerodrome Design Manual (Doc 9157), Part 2.

Table SI-4. Minimum distance from the runway centre line to a holding bay, runway-holding position or road-holding position

Code number	1	2	3	4
Type of runway				
Non-instrument	30 m	40 m	75 m	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,c}
Precision approach categories II and III			90 m ^{a,b}	90 m ^{a,b,c}
Take-off runway	30 m	40 m	75 m	75 m

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

^bThis 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 Civil Aviation (Radio Navigation Aids) Regulations.

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 centre line, 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 centre line, being clear of the obstacle free zone.

^cWhere the code letter is F, this distance should be 107.5 m.

Note. — The distance of 107.5 m for code number 4 where the code letter is F 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 centre line, being clear of the obstacle free zone.

Table S1-5. Dimensions and slopes of obstacle limitation surfaces — Approach runways

Surface and dimensions ^a	RUNWAY CLASSIFICATION									
	Non-instrument				Non-precision approach			Precision Approach Category		
	Code number	Code number		Code number		Code number		Code number		Code number
(1)	1	2	3	4	1,2	3	4	1,2	3,4	3,4
	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
CONICAL										
Slope	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Height	35m	55m	75m	100m	60m	75m	100m	60m	100m	100m
INNER HORIZONTAL										
Height	45 m	45 m	45 m	45 m	45 m	45 m	45 m	45 m	45 m	45 m
Radius	2000m	2500m	4000m	4000m	3500m	4000m	4000m	3500m	4000m	4000m
INNER APPROACH										
Width	—	—	—	—	—	—	—	90m	120m ^c	120m ^c
Distance from threshold	—	—	—	—	—	—	—	60m	60m	60m
Length	—	—	—	—	—	—	—	900m	900m	900m
Slope	—	—	—	—	—	—	—	2.5%	2%	2%
APPROACH										
Length of inner edge	60m	80m	150m	150m	140m	280m	280m	140m	280m	280m
Distance from threshold	30m	60m	60m	60m	60m	60m	60m	60m	60m	60m
Divergence (each side)	10%	10%	10%	10%	15%	15%	15%	15%	15%	15%
First section										
Length	1600m	2500m	3000m	3000m	2500m	3000m	3000m	3000m	3000m	3000m
Slope	5%	4%	3.33%	2.5%	3.33%	2%	2%	2.5%	2%	2%
Second section										
Length	—	—	—	—	—	3600m ^b	3600m ^b	12000m	3600m ^b	3600m ^b
Slope	—	—	—	—	—	2.5%	2.5%	3%	2.5%	2.5%
Horizontal section										
Length	—	—	—	—	—	8400m ^b	8400m ^b	—	8400m ^b	8400m ^b
Total Length	—	—	—	—	—	15000m	15000m	15000m	15000m	15000m
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	—	—	—	—	—	—	90m	120m ^c	120m ^c
Distance from threshold	—	—	—	—	—	—	c	1800m ^d	1800m ^d
Divergence (each side)	—	—	—	—	—	—	10%	10%	10%
Slope	—	—	—	—	—	—	4%	3.33%	3.33%

- a. All dimensions are measured horizontally unless specified otherwise.
- b. Variable length (see Reg. 87.96, 98 and 100)
- c. Distance to the end of strip.
- d. Or end of runway whichever is less.
- e. Where the code letter is F (Table S1-1), the width is increased to 140 m except for those aerodromes that accommodate a code letter F aeroplane equipped with digital avionics that provide steering commands to maintain an established track during the go-around maneuver.

Note. — See Circulars 301 and 345, and Chapter 4 of the PANS-Aerodromes, Part I (Doc 9981) for further information.

Table S1-6. Dimensions and slopes of obstacle limitation surfaces

Surface and dimensions ^a	Code number		
	1	2	3 or 4
(1)	(2)	(3)	(4)
TAKE-OFF CLIMB	60 m	80 m	180 m
Length of inner edge			
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 distance of the clearway if the clearway length exceeds the specified.
- ^c 1 800 m when the intended track includes changes of heading greater than 15° for operations conducted in IMC.
VMC by night.
- ^d Regulation 102

Distance from the visual approach slope indicator system ^a	D ₁ +30 m	D ₁ +60 m						
Divergence (each side)	10%	10%	10%	10%	15%	15%	15%	15%
Total length	7 500 m	7 500 m ^b	15 000 m	15 000 m	7 500 m	7 500 m ^b	15 000 m	15 000 m
<i>Slope</i>								
a) T-VASIS AT-VASIS	and	- ^c	1,9°	1,9°	1,9°	-	1,9°	1,9°
b) PAPI ^d	-	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 S1-25

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 S1-24). 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.

Table S1-10. A-VDGS recommended displacement accuracy

Guidance information	Maximum deviation at stop position (stop area)	Maximum deviation at 9 m from stop position	Maximum deviation at 15 m from stop position	Maximum deviation at 25 m from stop position
Azimuth	±250 mm	±340 mm	±400 mm	±500 mm
Distance	±500 mm	±1 000 mm	±1 300 mm	Not specified

Table S1-11. Location distances for taxiing guidance signs including runway exit signs

Code number	Sign height (mm)			Perpendicular distance from defined taxiway pavement edge to near side of sign	Perpendicular distance from defined runway pavement edge to near side of sign
	Face Legend	Face (min.)	Installed (max.)		
1 or 2	200	400	700	5-11 m	3-10 m
1 or 2	300	600	900	5-11 m	3-10 m
3 or 4	300	600	900	11-21 m	8-15 m
3 or 4	400	800	1 100	11-21 m	8-15 m

1	2	3	4			7
			Peak intensity (cd) at given Back ground Luminance (b)			
			Day (Above 500 cd/m ²)	Twilight (50-500 cd/m ²)	Night (Below 50 cd/m ²)	
Light Type	Colour	Signal type/ (Flash rate)	Light Distribution Table			
Low-intensity, Type A (fixed obstacle)	Red	Fixed	N/A	N/A	10	Table 6-2
Low-intensity, Type B (fixed obstacle)	Red	Fixed	N/A	N/A	32	Table 6-2
Low-intensity, Type C (mobile obstacle)	Yellow/Blue (s)	Flashing (60-90 fpm)	N/A	40	40	Table 6-2
Low-intensity, Type D (follow-on; vehicle)	Yellow	Flashing (80-90 fpm)	N/A	200	200	Table 6-2
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	Table 6-3
Medium-intensity, Type B	Red	Flashing (20-60 fpm)	N/A	N/A	2 000	Table 6-3
Medium-intensity, Type C	Red	Fixed	N/A	N/A	2 000	Table 6-3
High-intensity, Type A	White	Flashing (40-60 fpm)	200 000	20 000	2 000	Table 6-3
High-intensity, Type B	White	Flashing (40-60 fpm)	100 000	20 000	2 000	Table 6-3

Table S1-12. Characteristics of obstacle lights

- a) See Regulation 199
b) For flashing lights, effective intensity as determined in accordance with the *guidance materials on visual aids*
c) For wind turbine application, to flash at the same rate as the lighting on the nacelle.

Table S1-13. Light distribution for low-intensity obstacle lights

	Minimum intensity (a)	Maximum intensity (a)	Vertical beam spread (b)	
			Minimum beam spread	Intensity
Type A	10 cd (b)	N/A	10°	5 cd
Type B	32 cd (b)	N/A	10°	16 cd
Type C	40 cd (b)	400 cd	12° (d)	20 cd
Type D	200 cd (c)	400 cd	N/A (e)	N/A

Note.— This table does not include recommended horizontal beam spreads. Regulation 198 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.

Runway meant for take-off in runway visual range conditions less than a value of 800 m	Runway edge	15 seconds ^c
	Runway end	1 second
	Runway centre line	1 second
	All stop bars	1 second
	Essential taxiway ^a	15 seconds
	Obstacle ^a	15 seconds

Runway	Lighting aids requiring power	Maximum switch-over time
Non-Instrument	Visual approach slope indicators ^b	See
	Runway edge ^b	8.1.4 and
	Runway threshold ^b	8.1.9
	Runway end ^b	
	Obstacle ^b	
Non-precision approach	Approach lighting system	15 seconds
	Visual approach slope indicators ^{b,d}	15 seconds
	Runway edge ^d	15 seconds
	Runway threshold ^d	15 seconds
	Runway end	15 seconds
Precision approach category I	Approach lighting system	15 seconds
	Runway edge ^d	15 seconds
	Visual approach slope indicators ^{b,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 centre 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 range conditions less than a value of 800 m	Runway edge
Runway end		1 second
Runway centre 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, 5.3.2, regarding the use of emergency lighting.

c. One second where no runway centre line lights are provided.

d. One second where approaches are over hazardous or precipitous terrain.

(See Regulation 258)

Table S1-18. Aerodrome category for rescue and fire fighting

<i>Aerodrome category</i>	<i>Aeroplane overall length</i>	<i>Maximum fuselage width</i>
(1)	(2)	(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

Table S1-19. 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 powders (kg) (8)	Discharge Rate (kg/second) (9)
1	350	350	230	230	160	160	45	2.25
2	1 000	800	670	550	460	360	90	2.25
3	1 800	1 300	1 200	900	820	630	135	2.25
4	3 600	2 600	2 400	1 800	1 700	1 100	135	2.25
5	8 300	4 500	5 400	3 000	3 900	2 200	180	2.25
6	11 800	6 000	7 900	4 000	5 800	2 900	225	2.25
7	18 200	7 900	12 100	5 300	8 800	3 800	225	2.25
8	27 300	10 800	18 200	7 200	12 800	5 100	450	4.5
9	36 400	13 500	24 300	9 000	17 100	6 300	450	4.5
10	48 200	16 600	32 300	11 200	22 800	7 900	450	4.5

Note.— The quantities of water shown in columns 2, 4 and 6 are based on the average overall length of aeroplanes in a given category.

Table S1-20. Number of Rescue and fire fighting vehicles.

<i>Aerodrome category</i>	<i>Rescue and fire fighting vehicles</i>
1	1
2	1
3	1
4	1
5	1
6	2
7	2
8	3
9	3
10	3

SCHEDULE 2
(reg. 36 (2), 38 (4), and 54 (4))

Guidance Material Supplementary to the Aerodromes Regulations

1. NUMBER, SITING AND ORIENTATION OF RUNWAYS

1.1 Siting and orientation of runways

1.1.1 Many factors shall be taken into account in the determination of the siting and orientation of runways. Without attempting to provide an exhaustive list of these factors or an analysis of their effects, it appears useful to indicate those which most frequently require study. These factors may be classified under four headings.

1.1.2 Type of operation. Attention shall be paid in particular to whether the aerodrome is to be used in all meteorological conditions or only in visual meteorological conditions, and whether it is intended for use by day and night, or only by day.

1.1.3 Climatological conditions. A study of the wind distribution shall be made to determine the usability factor. In this regard, the following comments shall be taken into account —

1.1.3.1 Wind statistics used for the calculation of the usability factor are normally available in ranges of speed and direction, and the accuracy of the results obtained depends, to a large extent, on the assumed distribution of observations within these ranges. In the absence of any sure information as to the true distribution, it is usual to assume a uniform distribution since, in relation to the most favourable runway orientations, this generally results in a slightly conservative for the usability factor.

1.1.3.2 The maximum mean cross-wind components given in regulation 62 refer to normal circumstances. There are some factors which may require that a reduction of those maximum values be taken into account at a particular aerodrome. These include:

- (a) the wide variations which may exist, in handling characteristics and maximum permissible crosswind components, among diverse types of aeroplanes (including future types) within each of the three groups given in regulation 62;
- (b) prevalence and nature of gusts;
- (c) prevalence and nature of turbulence;
- (d) the availability of a secondary runway;
- (e) the width of runways;
- (f) the runway surface conditions — water, snow and ice on the runway materially reduce the allowable crosswind component; and
- (g) the strength of the wind associated with the limiting cross-wind component.

A study shall also be made of the occurrence of poor visibility and/or low cloud base. Account shall be taken of their frequency as well as the accompanying wind direction and speed.

1.1.4 Topography of the aerodrome site, its approaches, and surroundings, particularly —

- (a) compliance with the obstacle limitation surfaces;
- (b) current and future land use. The orientation and layout shall be selected so as to protect as far as possible the particularly sensitive areas such as residential, school and hospital zones from the discomfort caused by aircraft noise. Detailed information on this topic is provided by the Authority through guidance on Airport Planning and in Guidance on the Balanced Approach to Aircraft Noise Management;

- (c) current and future runway lengths to be provided;
 - (d) construction costs; and
 - (e) possibility of installing suitable non-visual and visual aids for approach-to-land.
- 1.1.5 Air traffic in the vicinity of the aerodrome, particularly —
- (a) proximity of other aerodromes or ATS routes;
 - (b) traffic density; and
 - (c) air traffic control and missed approach procedures.
- 1.1.6 Number of Runways in each direction The number of runways to be provided in each direction depends on the number of aircraft movements to be catered to.

1. CLEARWAYS AND STOP WAYS

- 2.1 The decision to provide a stop way and/or a clearway as an alternative to an increased length of runway will depend on the physical characteristics of the area beyond the runway end, and on the operating performance requirements of the prospective aeroplanes. The runway, stop way and clearway lengths to be provided are determined by the aeroplane takeoff performance, but a check shall also be made of the landing distance required by the aeroplanes using the runway to ensure that adequate runway length is provided for landing. The length of a clearway, however, cannot exceed half the length of take-off run available.
- 2.2 The aeroplane performance operating limitations require a length which is enough to ensure that the aeroplane can, after starting a take-off, either be brought safely to a stop or complete the take-off safely. For the purpose of discussion, it is supposed that the runway, stop way and clearway lengths provided at the aerodrome are only just adequate for the aeroplane requiring the longest take-off and accelerate-stop distances, taking into account its take-off mass, runway characteristics and ambient atmospheric conditions. Under these circumstances there is, for each take-off, a speed, called the decision speed; below this speed, the take-off must be abandoned if an engine fails, while above it the take-off must be completed. A very long take-off run and take-off distance would be required to complete a take-off when an engine fails before the decision speed is reached, because of the insufficient speed and the reduced power available. There would be no difficulty in stopping in the remaining accelerate stop distance available provided action is taken immediately. In these circumstances the correct course of action would be to abandon the take-off.
- 2.3 On the other hand, if an engine fails after the decision speed is reached, the aeroplane will have sufficient speed and power available to complete the take-off safely in the remaining take-off distance available. However, because of the high speed, there would be difficulty in stopping the aeroplane in the remaining accelerate-stop distance available.
- 2.4 The decision speed is not a fixed speed for any aeroplane, but can be selected by the pilot within limits to suit the accelerate-stop and take-off distance available, aeroplane take-off mass, runway characteristics, and ambient atmospheric conditions at the aerodrome. Normally, a higher decision speed is selected as the accelerate-stop distance available increases.
- 2.5 A variety of combinations of accelerate-stop distances required and take-off distances required can be obtained to accommodate a particular aeroplane, taking into account the aeroplane take-off mass, runway characteristics, and ambient atmospheric conditions. Each combination requires its particular length of takeoff run.

- 2.6 The most familiar case is where the decision speed is such that the take-off distance required is equal to the accelerate-stop distance required; this value is known as the balanced field length. Where stop way and clearway are not provided, these distances are both equal to the runway length. However, if landing distance is for the moment ignored, runway is not essential for the whole of the balanced field length, as the take-off run required is, of course, less than the balanced field length. The balanced field length can, therefore, be provided by a runway supplemented by an equal length of clearway and stop way, instead of wholly as a runway. If the runway is used for take-off in both directions, an equal length of clearway and stop way has to be provided at each runway end. The saving in runway length is, therefore, bought at the cost of a greater overall length.
- 2.7 In case economic considerations preclude the provision of stop way and, as a result, only runway and clearway are to be provided, the runway length (neglecting landing requirements) shall be equal to the accelerate-stop distance required or the take-off run required, whichever is the greater. The take-off distance available will be the length of the runway plus the length of clearway.
- 2.8 The minimum runway length and the maximum stop way or clearway length to be provided may be determined as follows, from the data in the aeroplane flight manual for the aeroplane considered to be critical from the viewpoint of runway length requirements if a stop way is —
- economically possible, the lengths to be provided are those for the balanced field length. The runway length is the take-off run required or the landing distance required, whichever is the greater. If the accelerate-stop distance required is greater than the runway length so determined, the excess may be provided as stop way, usually at each end of the runway. In addition, a clearway of the same length as the stop way must also be provided; and
 - not to be provided, the runway length is the landing distance required, or if it is greater, the accelerate-stop distance required, which corresponds to the lowest practical value of the decision speed. The excess of the take-off distance required over the runway length may be provided as clearway, usually at each end of the runway.
- 2.9 In addition to the above consideration, the concept of clearways in certain circumstances can be applied to a situation where the take-off distance required for all engines operating exceeds that required for the engine failure case.
- 2.10 The economy of a stop way can be entirely lost if, after each usage, it must be re-graded and compacted. Therefore, it shall be designed to withstand at least a certain number of loadings of the aeroplane which the stop way is intended to serve without inducing structural damage to the aeroplane.

3. CALCULATION OF DECLARED DISTANCES

- 3.1 The declared distances to be calculated for each runway direction comprise: the take-off run available (TORA), take-off distance available (TODA), accelerate-stop distance available (ASDA), and landing distance available (LDA).
- 3.2 Where a runway is not provided with a stop way or clearway and the threshold is located at the extremity of the runway, the four declared distances shall normally be equal to the length of the runway, as shown in Figure S2-1 (A).
- 3.3 Where a runway is provided with a clearway (CWY), then the TODA will include the length of clearway, as shown in Figure S2-1 (B).
- 3.4 Where a runway is provided with a stop way (SWY), then the ASDA will include the length of stop way, as shown in Figure S2-1 (C).

- 3.5 Where a runway has a displaced threshold, then the LDA will be reduced by the distance the threshold is displaced, as shown in Figure S2-1 (D). A displaced threshold affects only the LDA for approaches made to that threshold; all declared distances for operations in the reciprocal direction are unaffected.
- 3.6 Figures S2-1 (B) through S2-1 (D) illustrate a runway provided with a clearway or a stop way or having a displaced threshold. Where more than one of these features exist, then more than one of the declared distances will be modified — but the modification will follow the same principle illustrated. An example showing a situation where all these features exist is shown in Figure S2-1 (E).
- 3.7 A suggested format for providing information on declared distances is given in Figure S2-1 (F). If a runway direction cannot be used for take-off or landing, or both, because it is operationally forbidden, then this shall be declared and the words “not usable” or the abbreviation “NU” entered.

4.3 Radio altimeter operating area

In order to accommodate aeroplanes making auto-coupled approaches and automatic landings (irrespective of weather conditions) it is desirable that slope changes be avoided or kept to a minimum, on a rectangular area at least 300 m long before the threshold of a precision approach runway. The area shall be symmetrical about the extended centre line, 120 m wide. When special circumstances so warrant, the width may be reduced to no less than 60 m if an aeronautical study indicates that such reduction would not affect the safety of operations of aircraft. This is desirable because these aeroplanes are equipped with a radio altimeter for final height and flare guidance, and when the aeroplane is above the terrain immediately prior to the threshold, the radio altimeter will begin to provide information to the automatic pilot for auto flare. Where slope changes cannot be avoided, the rate of change between two consecutive slopes shall not exceed 2 percent per 30 m.

5. RUNWAY SURFACE EVENNESS

- 5.1. In adopting tolerances for runway surface irregularities, the following standard of construction is achievable for short distances of 3 m and conforms to good engineering practice –

Except across the crown of a camber or across drainage channels, the finished surface of the wearing course is to be of such regularity that, when tested with a 3 m straightedge placed anywhere in any direction on the surface, there is no deviation greater than 3 mm between the bottom of the straight-edge and the surface of the pavement anywhere along the straight edge.

- 5.2. Caution shall also be exercised when inserting runway lights or drainage grilles in runway surfaces to ensure that adequate smoothness of the surface is maintained.
- 5.3. The operation of aircraft and differential settlement of surface foundations will eventually lead to increases in surface irregularities. Small deviations in the above tolerances will not seriously hamper aircraft operations. In general, isolated irregularities of the order of 2.5 cm to 3 cm over a 45 m distance are tolerable. Although maximum acceptable variations vary with the type and speed of an aircraft, the limits of acceptable surface irregularities can be estimated to a reasonable extent. Table S10-1 describes the maximum and temporarily acceptable limits. If the maximum limits are exceeded, the corrective action shall be undertaken as soon as reasonably practicable to improve the ride quality. If the temporarily acceptable limits are exceeded, the portions of the runway that exhibit such roughness shall have corrective measures taken immediately if aircraft operations are to be continued.

Table S2-1 Runway Surface evenness

<i>Surface irregularity</i>	<i>Minimum acceptable length of irregularity (m)</i>									
	3	6	9	12	15	20	30	45	60	
Maximum surface irregularity height (or depth) (cm)	3	3.5	4	5	5.5	6	6.5	8	10	
Temporary acceptable surface irregularity height (or depth) (cm)	3.5	5.5	6.5	7.5	8	9	11	13	15	

Note that “surface irregularity” is defined herein to mean isolated surface elevation deviations that do not lie along a uniform slope through any given section of a runway. For the purposes of this concern, a “section of a runway” is defined herein to mean a segment of a runway throughout which a continuing general uphill, downhill or flat slope is prevalent. The length of this section is generally between 30 and 60 metres, and can be greater, depending on the longitudinal profile and the condition of the pavement.

- 5.4 The maximum tolerable step type bump, such as that which could exist between adjacent slabs, is simply the bump height corresponding to zero bump length at the upper end of the tolerable region of the roughness criteria of Figure S10-3. The bump height at this location is 1.75 cm.

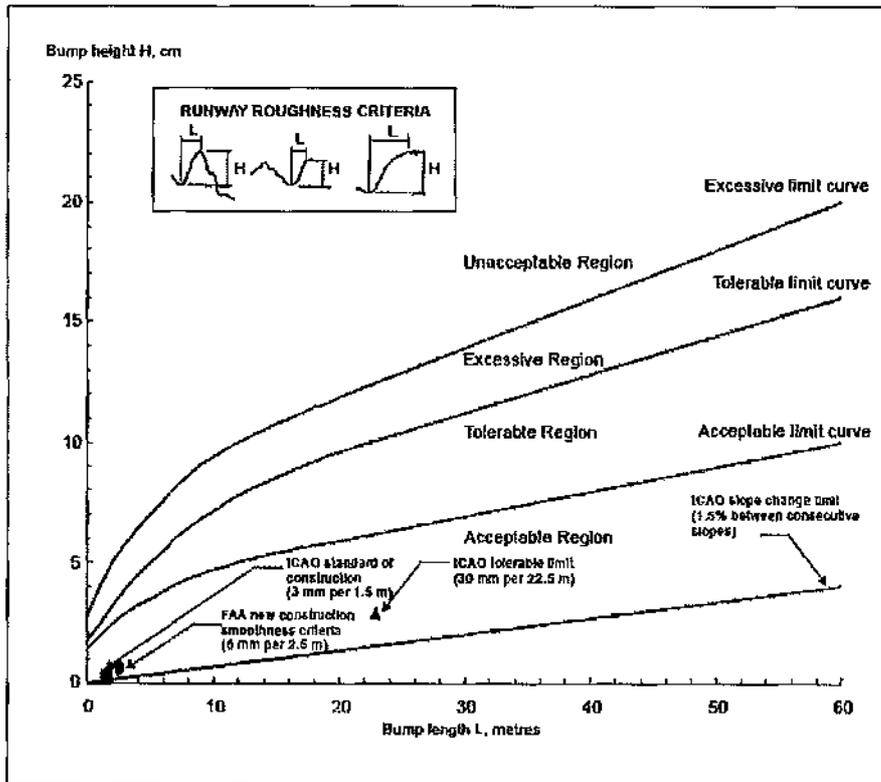


Figure S2-3. Comparison of roughness criteria

Note to figure S2-3. --- These criteria address single event roughness, not long wavelength harmonic effects nor the effect of repetitive surface undulations.

5.5 Deformation of the runway with time may also increase the possibility of the formation of water pools. Pools and shallow as approximately 3 mm in depth, particularly if they are located where they are likely to be encountered at high speed by landing aeroplanes, can induce aquaplaning, which can then be sustained on a wet runway by a smaller shallow depth of water. Improved guidance regarding the significant length and depth of pools relative to aquaplaning is the subject of further research. It is, of course especially necessary to prevent pools from forming whenever there is possibility that they might become frozen.

6. Determination of Surface Friction Characteristics for Construction and Maintenance Purposes

6.1 The guidance in this section deals with the functional measurement of friction-related aspects related to runway construction and maintenance. Excluded in this section is the operational, as opposed to functional, measurement of friction for contaminated runways.

6.2 The surface friction characteristics of a paved runway shall be —

- (a) assessed to verify the surface friction characteristics of new or resurfaced paved runways (regulation 70); and
- (b) assessed periodically in order to determine the slipperiness of paved runways (Part XIII of these regulations).

6.3 The condition of a runway pavement is generally assessed under dry conditions using a self-wetting continuous friction measuring device. Evaluation tests of runway surface friction characteristics are made on clean surfaces of the runway when first constructed or after resurfacing.

Note. - Although it is recognized that friction reduces with use, this value will represent the friction of the relatively long central portion of the runway that is uncontaminated by rubber deposits from aircraft operations and is therefore of operational value. Evaluation tests shall be made on clean surfaces. If it is not possible to clean a surface before testing, then for purposes of preparing an initial report a test could be made on a portion of clean surface in the central part of the runway.

6.4 Friction tests of existing surface conditions are taken periodically in order to avoid falling below the minimum friction level specified by the Authority. When the friction of any portion of a runway is found to be below this value, then such information is promulgated in a NOTAM specifying which portion of the runway is below the minimum friction level and its location on the runway. A corrective maintenance action must be initiated without delay. Friction measurements are taken at time intervals that will ensure the identification of runways in need of maintenance or of special surface treatment before the condition becomes serious. The time interval and mean frequency of measurement depend on factors such as: aircraft type and frequency of usage, climatic conditions, pavement type, and pavement service and maintenance requirements. (As determined by the Authority).

- 6.5 Friction measurements of existing, new or resurfaced runways are made with a continuous friction measuring device provided with a smooth tread tire. The device shall use self-wetting features to allow measurements of the surface friction characteristics to be made at a water depth of at least 1 mm.
- 6.6 When it is suspected that the friction characteristics of a runway may be reduced because of poor drainage, owing to inadequate slopes or depressions, then an additional measurement is made, but this time under natural conditions representative of a local rain. This measurement differs from the previous one in that water depths in the poorly cleared areas are normally greater in a local rain condition. The measurement results are thus more apt to identify problem areas having low friction values that could induce aquaplaning than the previous test. If circumstances do not permit measurements to be conducted during natural conditions representative of a rain, then this condition may be simulated. (See Section 7)
- 6.7 When conducting friction tests using a self-wetting continuous friction measuring device, it is important to note that a wet runway produces a drop in friction with an increase in speed. However, as the speed increases, the rate at which the friction is reduced becomes less. Among the factors affecting the friction coefficient between the tire and the runway surface, texture is particularly important. If the runway has a good macro-texture allowing the water to escape beneath the tire, then the friction value will be less affected by speed. Conversely, a low macro-texture surface will produce a larger drop in friction with increase in speed.
- 6.8 These Regulations require the Authority to specify a minimum friction level below which corrective maintenance action shall be taken. As criteria for surface friction characteristics of new or resurfaced runway surfaces and its maintenance planning, the Authority is required to establish a maintenance planning level below which appropriate corrective maintenance action shall be initiated to improve the friction. The Authority has provided guidance on establishment, maintenance, planning and minimum friction levels for runway surfaces in use which shall apply.

7. Drainage Characteristics of the Movement Area and Adjacent Areas

7.1 General

- 7.1.1 Rapid drainage of surface water is a primary safety consideration in the design, construction and maintenance of the movement area and adjacent areas. The objective is to minimize water depth on the surface by draining water off the runway in the shortest path possible and particularly out of the area of the wheel path. There are two distinct drainage processes taking place.
- 7.1.2 Natural drainage of the surface water from the top of the pavement surface until it reaches the final recipient such as rivers or other water bodies.
- 7.1.3 Dynamic drainage of the surface water trapped under a moving tire until it reaches outside the tire-to ground contact area.

7.1.4 Both processes can be controlled through —

- (a) design;
- (b) construction; and
- (c) maintenance,

of the pavements in order to prevent accumulation of water on the pavement surface.

7.2 Design of pavement

7.2.1 Surface drainage is a basic requirement and serves to minimize water depth on the surface. The objective is to drain water off the runway in the shortest path. Adequate surface drainage is provided primarily by an appropriately sloped surface (in both the longitudinal and transverse directions). The resulting combined longitudinal and transverse slope is the path for the drainage runoff. This path can be shortened by adding transverse grooves.

7.2.2 Dynamic drainage is achieved through built-in texture in the pavement surface. The rolling tire builds up water pressure and squeezes the water out the escape channels provided by the texture. The dynamic drainage of the tire-to-ground contact area may be improved by adding transverse grooves provided that they are subject to rigorous maintenance.

7.3 Construction of pavement

7.3.1 Through construction, the drainage characteristics of the surface are built into the pavement. These surface characteristics are —

- (a) slopes;
- (b) texture;
- (c) microtexture; and
- (d) macrotexture.

7.3.2 Slopes for the various parts of the movement area and adjacent parts are described in Part VI of these regulations and figures are given in percentage.

7.3.4 Texture in the literature is described as microtexture or macrotexture. These terms are understood differently in various parts of the aviation industry.

7.3.5 Microtexture is the texture of the individual stones and is hardly detectable by the eye. Microtexture is considered a primary component in skid resistance at slow speeds. On a wet surface at higher speeds a water film may prevent direct contact between the surface asperities and the tire due to insufficient drainage from the tire-to-ground contact area.

- 7.3.6 Microtexture is a built-in quality of the pavement surface. By specifying crushed material that will withstand polishing microtexture, drainage of thin waterfilms are ensured for a longer period of time. Resistance against polishing is expressed in terms of the Polished Stone Values (PSV) which is in principle a value obtained from a friction measurement in accordance with international standards. These standards define the PSV minima that will enable a material with a good microtexture to be selected.
- 7.3.7 A major problem with microtexture is that it can change within short time periods without being easily detected. A typical example of this is the accumulation of rubber deposits in the touchdown area which will largely mask microtexture without necessarily reducing macrotexture.
- 7.3.8 Macrotexture is the texture among the individual stones. This scale of texture may be judged approximately by the eye. Macrotexture is primarily created by the size of aggregate used or by surface treatment of the pavement and is the major factor influencing drainage capacity at high speeds. Materials shall be selected so as to achieve good macrotexture.
- 7.3.9 The primary purpose of grooving a runway surface is to enhance surface drainage. Natural drainage can be slowed down by surface texture, but grooving can speed up the drainage by providing a shorter drainage path and increasing the drainage rate.
- 7.3.10 For measurement of macrotexture, simple methods such as the "sand and grease patch" methods described by the Authority through guidance on pavement surface conditions. These methods were used for the early research on which current airworthiness requirements are based, which refer to a classification categorizing macrotexture from A to E. This classification was developed, using sand or grease patch measuring techniques, and issued in 1971 by the Engineering Sciences Data Unit (ESDU) as shown in table S10-2 below.

Table S2-2 Runway classification based on texture information from ESDU 71026

<i>Classification</i>	<i>Texture depths (mm)</i>
<i>A</i>	0.10 – 0.14
<i>B</i>	0.15 – 0.24
<i>C</i>	0.25 – 0.50
<i>D</i>	0.51 – 1.00
<i>E</i>	1.01 – 2.54

- 7.3.11 Using this classification, the threshold value between micro texture and macrotexture is 0.1 mm mean texture depth (MTD). Related to this scale, the normal wet runway aircraft performance is based upon texture giving drainage and friction qualities midway between classification B and C (0.25 mm). Improved drainage through better texture might qualify for a better aircraft performance class. However, such credit must be in accordance with aeroplane manufacturers' documentation and agreed by the Authority. Presently credit is given to grooved or porous friction course runways following design, construction and maintenance criteria acceptable to the Authority. The harmonized certification standards of some States refer to texture giving drainage and friction qualities midway between classification D and E (1.0mm).
- 7.3.12 For construction, design and maintenance, States use various international standards. Currently ISO 13473-1: Characterization of pavement texture by use of surface profiles — Part 1: Determination of Mean Profile Depth links the volumetric measuring technique with non-contact profile measuring techniques giving comparable texture values. These standards describe the threshold value between micro texture and macrotexture as 0.5 mm. The volumetric method has a validity range from 0.25 to 5 mm MTD. The profilometry method has a validity range from 0 to 5 mm mean profile depth (MPD). The values of MPD and MTD differ due to the finite size of the glass spheres used in the volumetric technique and because the MPD is derived from a two-dimensional profile rather than a three-dimensional surface. Therefore, a transformation equation must be established for the measuring equipment used to relate MPD to MTD.
- 7.3.13 The ESDU scale groups runway surfaces based on macrotexture from A through E, where E represents the surface with best dynamic drainage capacity. The ESDU scale thus reflects the dynamic drainage characteristics of the pavement. Grooving any of these surfaces enhances the dynamic drainage capacity. The resulting drainage capacity of the surface is thus a function of the texture (A through E) and grooving. The contribution from grooving is a function of the size of the grooves and the spacing between the grooves. Aerodromes exposed to heavy or torrential rainfall must ensure that the pavement and adjacent areas have drainage capability to withstand these rainfalls or put limitations on the use of the pavements under such extreme situations. These airports shall seek to have the maximum allowable slopes and the use of aggregates providing good drainage characteristics. They shall also consider grooved pavements in the E classification to ensure that safety is not impaired.

Maintenance of drainage characteristics of pavement

- 8.1 Macrotexture does not change within a short timespan but accumulation of rubber can fill up the texture and as such reduce the drainage capacity, which can result in impaired safety. Furthermore, the runway structure may change over time and give unevenness which results in ponding after rainfall. Guidance on rubber removal and unevenness can be found in the in the guidance on pavement surface conditions developed by the Authority.

Guidance on methods for improving surface texture can be found in the guidance material on pavements developed by the Authority.

- 8.2 When grooving's are used, the condition of the grooves shall be regularly inspected to ensure that no deterioration has occurred and that the grooves are in good condition. Guidance on pavement surface conditions, maintenance of pavements, Airport Maintenance Practices and the Aerodrome Design have been developed by the Authority.
- 8.3 The pavement may be shot blasted in order to enhance the pavement macrotexture.

9. STRIPS

9.1 Shoulders

- 9.1.1 The shoulder of a runway or stop way shall be prepared or constructed so as to minimize any hazard to an aeroplane running off the runway or stop way. Some guidance is given in the following paragraphs on certain special problems which may arise, and on the further question of measures to avoid the ingestion of loose stones or other objects by turbine engines.

9.1.2 In some cases, the bearing strength of the natural ground in the strip may be sufficient, without special preparation, to meet the requirements for shoulders. Where special preparation is necessary, the method used will depend on local soil conditions and the mass of the aeroplanes the runway is intended to serve. Soil tests will help in determining the best method of improvement (e.g. drainage, stabilization, surfacing, and light paving).

9.1.3 Attention shall also be paid when designing shoulders to prevent the ingestion of stones or other objects by turbine engines. Similar considerations apply here to those which are discussed for the margins of taxiways in the guidance on taxiways and runways developed by the Authority both as to the special measures which may be necessary and as to the distance over which such special measures, if required, shall

be

taken.

9.1.4 Where shoulders have been treated specially, either to provide the required bearing strength or to prevent the presence of stones or debris, difficulties may arise because of a lack of visual contrast between the runway surface and that of the adjacent strip. This difficulty can be overcome either by providing a good visual contrast in the surfacing of the runway or strip, or by providing a runway side stripe marking.

9.2 Objects on strips

- 9.2.1 Within the general area of the strip adjacent to the runway, measures shall be taken to prevent an aeroplane's wheel, when sinking into the ground, from striking a hard vertical face. Special problems may arise for runway light fittings or other objects mounted in the strip or at the intersection with a

taxiway or another runway. In the case of construction, such as runways or taxiways, where the surface must also be flush with the strip surface, a vertical face can be eliminated by chamfering from the top of the construction to not less than 30 cm below the strip surface level. Other objects, the functions of which do not require them to be at surface level, shall be buried to a depth of not less than 30 cm.

9.3 Grading of a strip for precision approach runways

9.3.1 Regulation 73 recommends that the portion of a strip of an instrument runway within at least 75 m from the centre line shall be graded where the code number is 3 or 4. For a precision approach runway, it may be desirable to adopt a greater width where the code number is 3 or 4. Figure S10-4 shows the shape and dimensions of a wider strip that may be considered for such a runway. This strip has been designed using information on aircraft running off runways. The portion to be graded extends to a distance of 105 m from the centre line, except that the distance is gradually reduced to 75 m from the centre line at both ends of the strip, for a length of 150 m from the runway end.

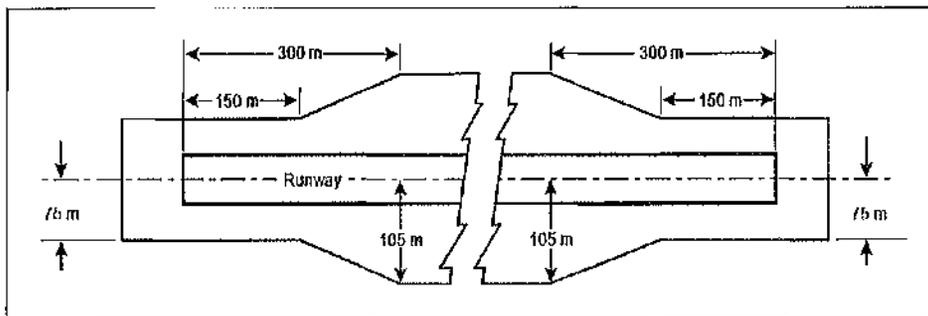


Figure S2-4. Graded portion of a strip including a precision approach runway where the code number is 3 or 4

10. Runway end safety areas

10.1 Where a runway end safety area is provided in accordance with Part IX of these regulations, consideration shall be given to providing an area long enough to contain overruns and undershoots resulting from a reasonably probable combination of adverse operational factors. On a precision approach runway, the ILS localizer is normally the first upstanding obstacle, and the runway end safety area shall extend up to this facility. In other circumstances, the first upstanding obstacle may be a road, a railroad or other constructed or natural feature. The provision of a runway end safety area shall take such obstacles into consideration.

- 10.2 Where provision of a runway end safety area would be particularly prohibitive to implement, consideration would have to be given to reducing some of the declared distances of the runway for the provision of a runway end safety area and installation of an arresting system.
- 10.3 Research programmes, as well as evaluation of actual aircraft overruns into arresting systems, have demonstrated that the performance of some arresting systems can be predictable and effective in arresting aircraft overruns.
- 10.4 Demonstrated performance of an arresting system can be achieved by a validated design method, which can predict the performance of the system. The design and performance shall be based on the type of aircraft anticipated to use the associated runway that imposes the greatest demand upon the arresting system.
- 10.5 The design of an arresting system must consider multiple aircraft parameters, including but not limited to, allowable aircraft gear loads, gear configuration, tire contact pressure, aircraft centre of gravity and aircraft speed. Accommodating undershoots must also be addressed. Additionally, the design must allow the safe operation of fully loaded rescue and fire fighting vehicles, including their ingress and egress.
- 10.6 The information relating to the provision of a runway end safety area and the presence of an arresting system shall be published in the AIP.
- 10.7 Additional information is contained in the guidance on aerodrome design on runways.

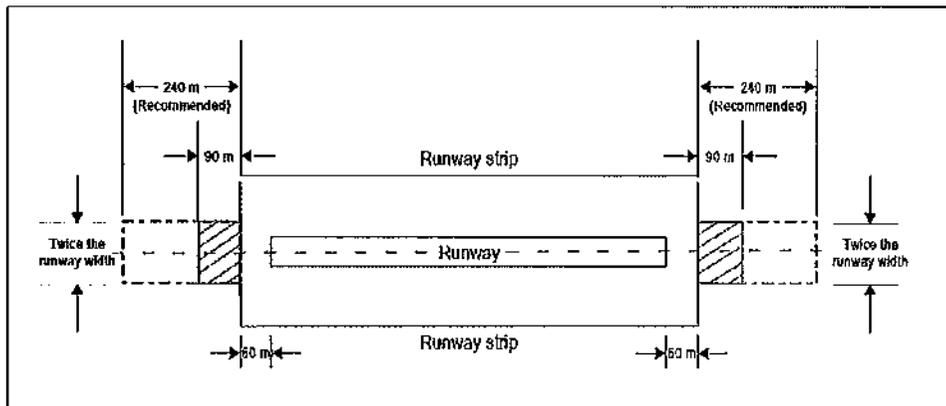


Figure S2-5. Runway end safety area for a runway where the code number is 3 or 4

11. Location of threshold

11.1 General

- 11.1.1 The threshold is normally located at the extremity of a runway, if there are no obstacles penetrating above the approach surface. In some cases, however, due to local conditions it may be desirable to displace

the threshold permanently (see below). When studying the location of a threshold, consideration shall also be given to the height of the ILS reference datum and/or MLS approach reference datum and the determination of the obstacle clearance limits. (Specifications concerning the height of the ILS reference datum and MLS approach reference datum are given in Civil Aviation Radio Navigation Aids Regulations as amended.

11.1.2 In determining that no obstacle penetrate above the approach surface, account shall be taken of mobile objects (vehicles on roads, trains, etc.) at least within that portion of the approach area within 1 200 m longitudinally from the threshold and of an overall width of not less than 150 m.

12. Displaced threshold

- 12.1 If an object extends above the approach surface and the object cannot be removed, consideration shall be given to displacing the threshold permanently.
- 12.2 To meet the obstacle limitation objectives of Part VII of these regulations, the threshold shall ideally be displaced down the runway for the distance necessary to provide that the approach surface is cleared of obstacles.
- 12.3 However, displacement of the threshold from the runway extremity will inevitably cause reduction of the landing distance available, and this may be of greater operational significance than penetration of the approach surface by marked and lighted obstacles. A decision to displace the threshold, and the extent of such displacement, shall therefore have regard to an optimum balance between the considerations of clear approach surfaces and adequate landing distance. In deciding this question, account will need to be taken of the types of aeroplanes which the runway is intended to serve, the limiting visibility and cloud base conditions under which the runway will be used, the position of the obstacles in relation to the threshold and extended centre line and, in the case of a precision approach runway, the significance of the obstacles to the determination of the obstacle clearance limit.
- 12.4 Notwithstanding the consideration of landing distance available, the selected position for the threshold shall not be such that the obstacle-free surface to the threshold is steeper than 3.3 per cent where the code number is 4 or steeper than 5 percent where the code number is 3.
- 12.5 In the event of a threshold being located according to the criteria for obstacle-free surfaces in the preceding paragraph, the obstacle marking requirements shall continue to be met in relation to the displaced threshold.

13. Approach lighting systems

13.1 Types and characteristics

- 13.1.1 The specifications in this volume provide for the basic characteristics for simple and precision approach lighting systems. For certain aspects of these systems, some latitude is permitted, for example, in the spacing between centre line lights and crossbars. The approach lighting patterns that have been generally adopted are shown in Figures S10-7 and S10-8. A diagram of the inner 300 m of the precision approach category II and III lighting system is shown on Figure S1-20 in Schedule 1.
- 13.1.2 The approach lighting configuration is to be provided irrespective of the location of the threshold, i.e. whether the threshold is at the extremity of the runway or displaced from the runway extremity. In both cases, the approach lighting system shall extend up to the threshold. However, in the case of a displaced threshold, inset lights are used from the runway extremity up to the threshold to obtain the specified configuration. These inset lights are designed to satisfy the structural requirements specified in regulation 140 and the photometric requirements specified in Schedule 7, Figure S5-1 or S7-2.
- 13.1.3 Flight path envelopes to be used in designing the lighting are shown in Figure S2-6.

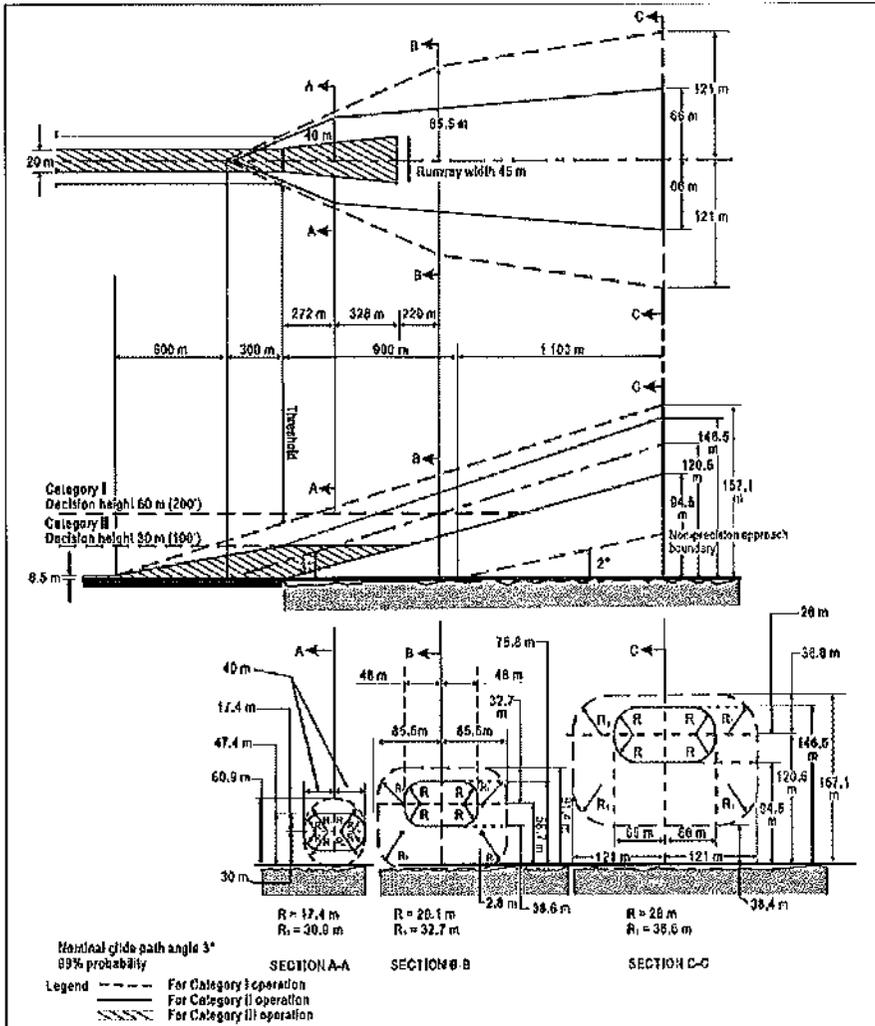


Figure S2-6. Flight path envelopes to be used for lighting design for category I, II and III operations

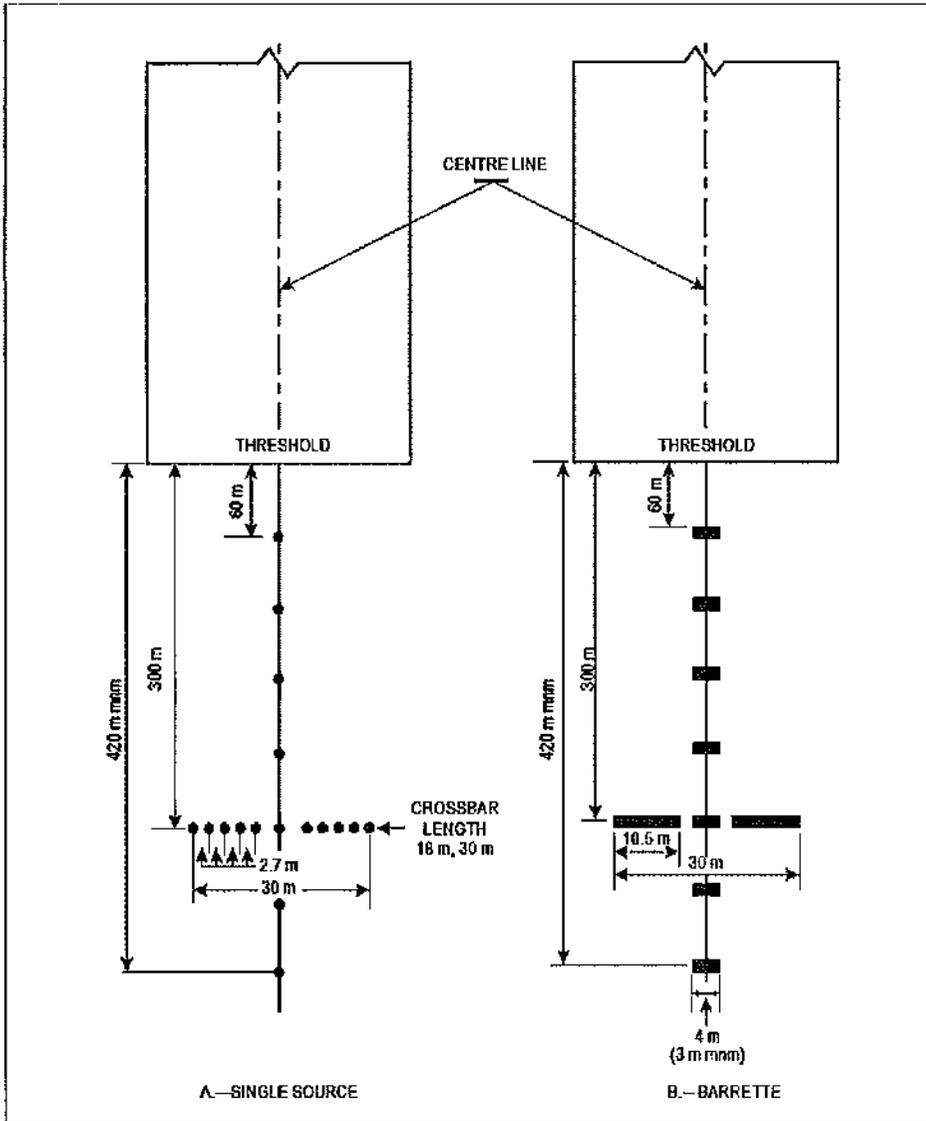


Figure S2-7. Simple approach lighting systems

14. Installation tolerances

14.1 Horizontal

- 14.1.1 The dimensional tolerances are shown in Figure S2-8.
- 14.1.2 The centre line of an approach lighting system shall be as coincident as possible with the extended centre line of the runway with a maximum tolerance of $\pm 15'$.
- 14.1.3 The longitudinal spacing of the centre line lights shall be such that one light (or group of lights) is located in the centre of each crossbar, and the intervening centre line lights are spaced as evenly as practicable between two crossbars or a crossbar and a threshold.
- 14.1.4 The crossbars and barrettes shall be at right angles to the centre line of the approach lighting system with a tolerance of $\pm 30'$, if the pattern in Figure S10-8 (A) is adopted or $\pm 2^\circ$, if Figure S10-8 (B) is adopted.
- 14.1.5 When a crossbar has to be displaced from its standard position, any adjacent crossbar shall, where possible, be displaced by appropriate amounts in order to reduce the differences in the crossbar spacing.
- 14.1.6 When a crossbar in the system shown in Figure S10-8 (A) is displaced from its standard position, its overall length shall be adjusted so that it remains one twentieth of the actual distance of the crossbar from the point of origin. It is not necessary, however, to adjust the standard 2.7 m spacing between the crossbar lights, but the crossbars shall be kept symmetrical about the centre line of the approach lighting.

15. Vertical

- 15.1 The ideal arrangement is to mount all the approach lights in the horizontal plane passing through the threshold (see Figure S10-9), and this shall be the general aim as far as local conditions permit. However, buildings, trees, etc., shall not obscure the lights from the view of a pilot who is assumed to be 1 degree below the electronic glide path in the vicinity of the outer marker.
- 15.2 Within a stop way or clearway, and within 150 m of the end of a runway, the lights shall be mounted as near to the ground as local conditions permit in order to minimize risk of damage to aeroplanes in the event of an overrun or undershoot. Beyond the stop way and clearway, it is not so necessary for the lights to be mounted close to the ground and therefore undulations in the ground contours can be compensated for by mounting the lights on poles of appropriate height.
- 15.3 It is desirable that the lights be mounted so that, as far as possible, no object within a distance of 60 m on each side of the centre line protrudes through the plane of the approach lighting system. Where a tall object exists within 60 m of the centre line and within 1 350 m from the threshold for a precision approach lighting system, or 900 m for a simple approach lighting system, it

may be advisable to install the lights so that the plane of the outer half of the pattern clears the top of the object.

15.4 In order to avoid giving a misleading impression of the plane of the ground, the lights shall not be mounted below a gradient of 1 in 66 downwards from the threshold to a point 300 m out, and below a gradient of 1 in 40 beyond the 300 m point. For a precision approach category II and III lighting system, more stringent criteria may be necessary, e.g. negative slopes not permitted within 450 m of the threshold.

15.5 Centre line - The gradients of the centre line in any section (including a stop way or clearway) shall be as small as practicable, and the changes in gradients shall be as few and small as can be arranged and shall not exceed 1 in 60. Experience has shown that as one proceeds outwards from the runway, rising gradients in any section of up to 1 in 66, and falling gradients of down to 1 in 40, are acceptable.

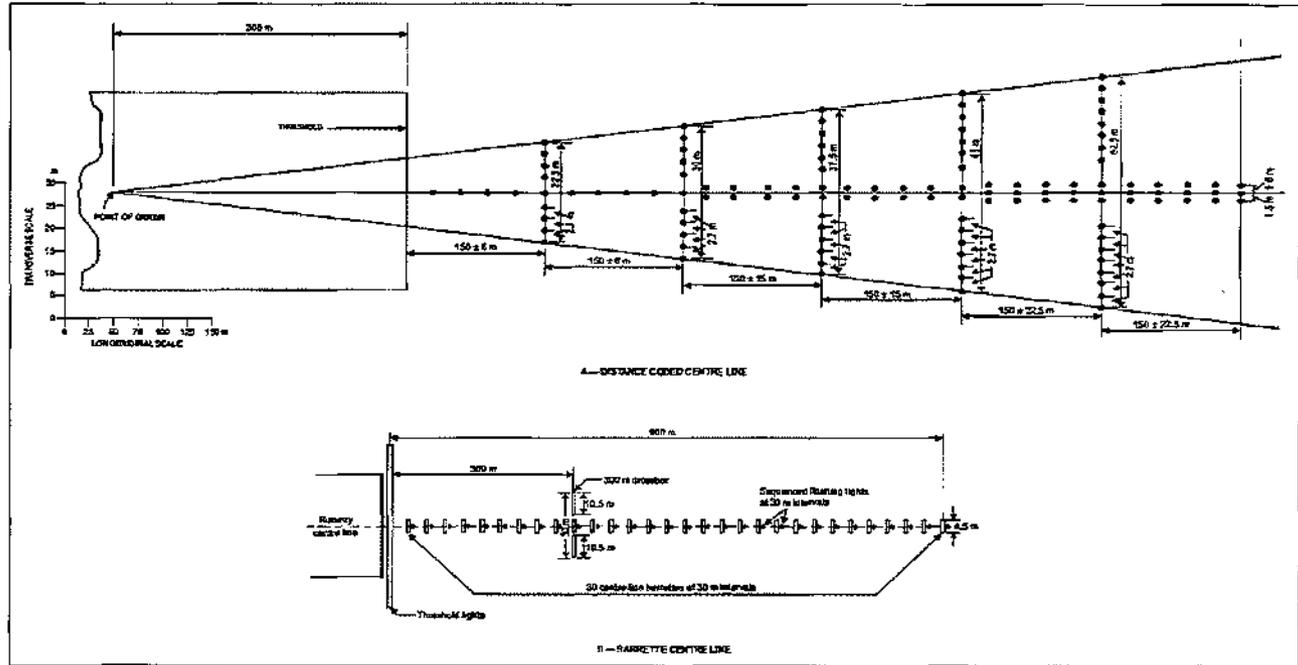


Figure S2-8. Precision approach category I lighting systems

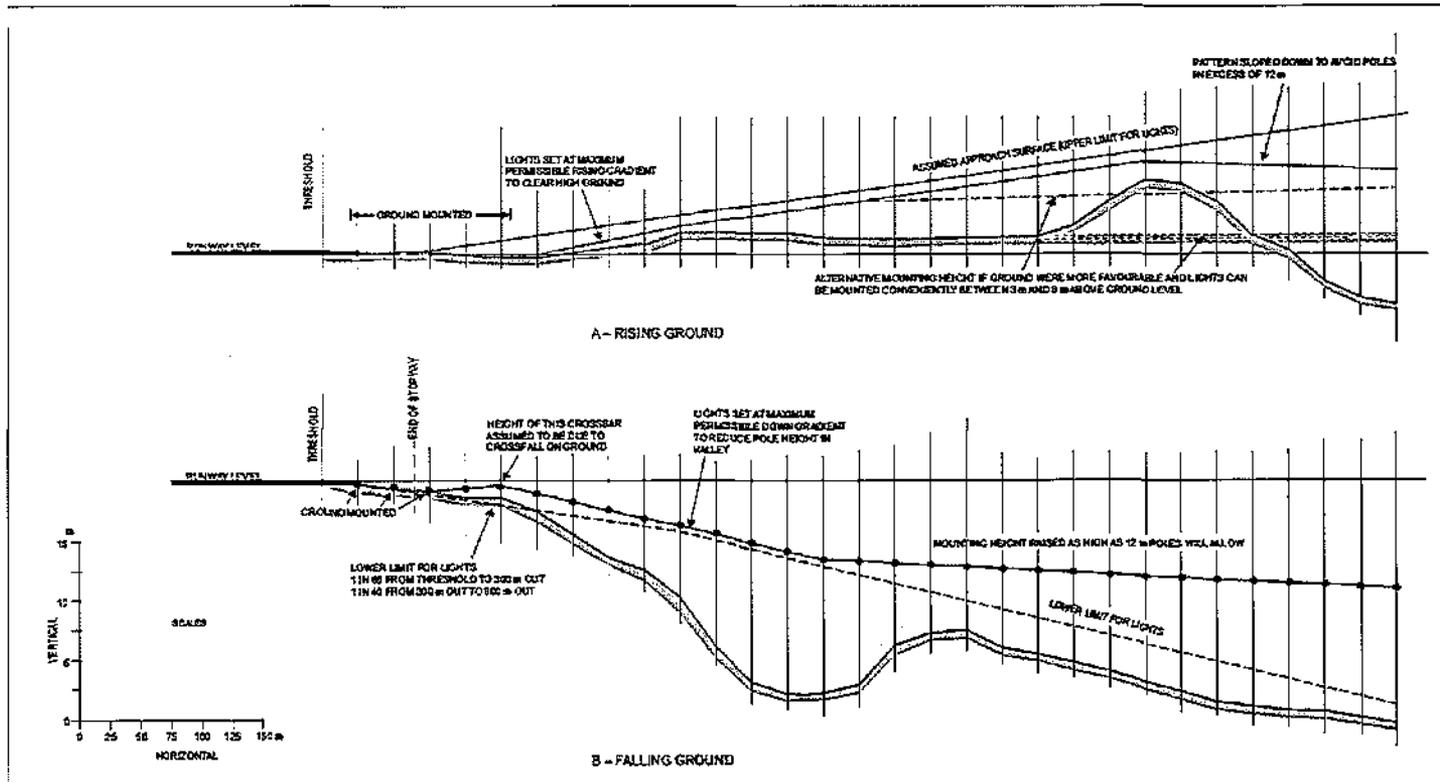


Figure 52-9. Vertical installation tolerance

- 15.6 Crossbars. The crossbar lights shall be so arranged as to lie on a straight line passing through the associated centre line lights, and wherever possible this line shall be horizontal. It is permissible, however, to mount the lights on a transverse gradient not more than 1 in 80, if this enables crossbar lights within a stop way or clearway to be mounted nearer to the ground on sites where there is a cross-fall.

16. Clearance of Obstacles

- 16.1 An area, hereinafter referred to as the light plane, has been established for obstacle clearance purposes, and all lights of the system are in this plane. This plane is rectangular in shape and symmetrically located about the approach lighting system's centre line. It starts at the threshold and extends 60 m beyond the approach end of the system, and is 120 m wide.
- 16.2 No objects are permitted to exist within the boundaries of the light plane which are higher than the light plane except as designated herein. All roads and highways are considered as obstacles extending 4.8 m above the crown of the road, except aerodrome service roads where all vehicular traffic is under control of the aerodrome authorities and coordinated with the aerodrome traffic control tower. Railroads, regardless of the amount of traffic, are considered as obstacles extending 5.4 m above the top of the rails.
- 16.3 It is recognized that some components of electronic landing aids systems, such as reflectors, antennas, monitors, etc., must be installed above the light plane. Every effort shall be made to relocate such components outside the boundaries of the light plane. In the case of reflectors and monitors, this can be done in many instances.
- 16.4 Where an ILS localizer is installed within the light plane boundaries, it is recognized that the localizer, or screen if used, must extend above the light plane. In such cases the height of these structures shall be held to a minimum and they shall be located as far from the threshold as possible. In general, the rule regarding permissible heights is 15 cm for each 30 m the structure is located from the threshold. As an example, if the localizer is located 300 m from the threshold, the screen will be permitted to extend above the plane of the approach lighting system by $10 \times 15 = 150$ cm maximum, but preferably shall be kept as low as possible consistent with proper operation of the ILS.
- 16.5 Objects existing within the boundaries of the light plane, requiring the light plane to be raised in order to meet the criteria contained herein, shall be removed, lowered or relocated where this can be accomplished more economically than raising the light plane.
- 16.6 In some instances, objects may exist which cannot be removed, lowered or relocated economically. These objects may be located so close to the threshold that they cannot be cleared by the 2 per cent slope. Where such conditions exist and no alternative is possible, the 2 per cent slope may be exceeded or a "stair step" resorted to in order to keep the approach lights above the objects. Such "step" or increased gradients shall be resorted to only when it is impracticable to follow standard slope criteria, and they shall be held to the

absolute minimum. Under this criterion no negative slope is permitted in the outermost portion of the system.

17. Consideration of the effects of reduced lengths

17.1 The need for an adequate approach lighting system to support precision approaches where the pilot is required to acquire visual references prior to landing, cannot be stressed too strongly. The safety and regularity of such operations is dependent on this visual acquisition. The height above runway threshold at which the pilot decides there are sufficient visual cues to continue the precision approach and land will vary, depending on the type of approach being conducted and other factors such as meteorological conditions, ground and airborne equipment, etc. The required length of approach lighting system which will support all the variations of such approaches is 900 m, and this shall always be provided whenever possible.

17.2 However, there are some runway locations where it is impossible to provide the 900 m length of approach lighting system to support precision approaches.

17.3 In such cases, every effort shall be made to provide as much approach lighting system as possible. The authority may impose restrictions on operations to runways equipped with reduced lengths of lighting. There are many factors which determine at what height the pilot must have decided to continue the approach to land or execute a missed approach. It must be understood that the pilot does not make an instantaneous judgment upon reaching a specified height. The actual decision to continue the approach and landing sequence is an accumulative process which is only concluded at the specified height. Unless lights are available prior to reaching the decision point, the visual assessment process is impaired and the likelihood of missed approaches will increase substantially. There are many operational considerations which must be taken into account by the appropriate authorities in deciding if any restrictions are necessary to any precision approach and these are detailed in Civil Aviation Aircraft Operations regulation as amended.

18. Priority of installation of visual approach slope indicator systems

18.1 It has been found impracticable to develop guidance material that will permit a completely objective analysis to be made of which runway on an aerodrome shall receive first priority for the installation of a visual approach slope indicator system. However, factors that must be considered when making such a decision are —

- (a) frequency of use;
- (b) seriousness of the hazard;
- (c) presence of other visual and non-visual aids;
- (d) type of aeroplanes using the runway; and

(e) frequency and type of adverse weather conditions under which the runway will be used.

18.2 With respect to the seriousness of the hazard, the order given in the application specifications for a visual approach slope indicator system, may be used as a general guide. These may be summarized as —

(a) inadequate visual guidance because —

(i) approaches over water or featureless terrain, or absence of sufficient extraneous light in the approach area by night, or

(ii) deceptive surrounding terrain;

(b) serious hazard in approach;

(c) serious hazard if aeroplanes undershoot or overrun; and

(d) unusual turbulence.

18.3 The presence of other visual or non-visual aids is a very important factor. Runways equipped with ILS or MLS would generally receive the lowest priority for a visual approach slope indicator system installation. It must be remembered, though, that visual approach slope indicator systems are visual approach aids in their own right and can supplement electronic aids. When serious hazards exist and/or a substantial number of aeroplanes not equipped for ILS or MLS use a runway, priority might be given to installing a visual approach slope indicator on this runway.

18.4 Priority shall be given to runways used by turbojet aeroplanes.

19. Lighting of unserviceable areas

19.1 Where a temporarily unserviceable area exists, it may be marked with fixed-red lights. These lights shall mark the most potentially dangerous extremities of the area. A minimum of four such lights shall be used, except where the area is triangular in shape where a minimum of three lights may be employed. The number of lights shall be increased when the area is large or of unusual configuration. At least one light shall be installed for each 7.5 m of peripheral distance of the area. If the lights are directional, they shall be orientated so that as far as possible their beams are aligned in the direction from which aircraft or vehicles will approach. Where aircraft or vehicles will normally approach from several directions, consideration shall be given to adding extra lights or using omnidirectional lights to show the area from these directions. Unserviceable area lights shall be frangible. Their height shall be sufficiently low to preserve clearance for propellers and for engine pods of jet aircraft.

20. Rapid exit taxiway indicator lights (RETILs)

- 20.1 Rapid exit taxiway indicator lights (RETILs) comprise a set of yellow unidirectional lights installed in the runway adjacent to the centre line. The lights are positioned in a 3-2-1 sequence at 100 m intervals prior to the point of tangency of the rapid exit taxiway centre line. They are intended to give an indication to pilots of the location of the next available rapid exit taxiway.
- 20.2 In low visibility conditions, RETILs provide useful situational awareness cues while allowing the pilot to concentrate on keeping the aircraft on the runway centre line.
- 20.3 Following a landing, runway occupancy time has a significant effect on achievable runway capacity. RETILs allow pilots to maintain a good roll-out speed until it is necessary to decelerate to an appropriate speed for the turn into a rapid exit turn-off. A roll-out speed of 60 knots until the first RETIL (three-light barrette) is reached is seen as the optimum.

21. Intensity control of approach and runway lights

- 21.1 The conspicuity of a light depends on the impression received of contrast between the light and its background. If a light is to be useful to a pilot by day when on approach, it must have an intensity of at least 2 000 or 3 000 cd, and in the case of approach lights and intensity of the order of 20 000 cd is desirable. In conditions of very bright daylight fog it may not be possible to provide lights of sufficient intensity to be effective. On the other hand, in clear weather on a dark night, an intensity of the order of 100 cd for approach lights and 50 cd for the runway edge lights may be found suitable. Even then, owing to the closer range at which they are viewed, pilots have sometimes complained that the runway edge lights seemed unduly bright.
- 21.2 In fog the amount of light scattered is high. At night this scattered light increases the brightness of the fog over the approach area and runway to the extent that little increase in the visual range of the lights can be obtained by increasing their intensity beyond 2 000 or 3 000 cd. In an endeavour to increase the range at which lights would first be sighted at night, their intensity must not be raised to an extent that a pilot might find excessively dazzling at diminished range.
- 21.3 From the foregoing will be evident the importance of adjusting the intensity of the lights of an aerodrome lighting system according to the prevailing conditions, so as to obtain the best results without excessive dazzle that would disconcert the pilot. The appropriate intensity setting on any particular occasion will depend both on the conditions of background brightness and the visibility. Detailed guidance material on selecting intensity setting for different conditions is given in the guidance on Aerodrome Visual Aids developed by the Authority.

22. Signal area

- 22.1 A signal area need be provided only when it is intended to use visual ground signals to communicate with aircraft in flight. Such signals may be needed when the aerodrome does not have an aerodrome control tower or an aerodrome flight information service unit, or when the aerodrome is used by aeroplanes not equipped with radio. Visual ground signals may also be useful in the case of failure of two-way radio communication with aircraft. It shall be recognized, however, that the type of information which may be conveyed by visual ground signals shall normally be available in AIPs or NOTAM. The potential need for visual ground signals shall therefore be evaluated before deciding to provide a signal area.

23. Rescue and firefighting services

23.1 Administration

- 23.1.1 The rescue and firefighting service at an aerodrome shall be under the administrative control of the aerodrome management, which shall also be responsible for ensuring that the service provided is organized, equipped, staffed, trained and operated in such a manner as to fulfill its proper functions.
- 23.1.2 In drawing up the detailed plan for the conduct of search and rescue operations (Civil Aviation Aeronautical Search and Rescue Regulations) the aerodrome management shall coordinate its plans with the relevant rescue coordination centres to ensure that the respective limits of their responsibilities for an aircraft accident within the vicinity of an aerodrome are clearly delineated.
- 23.1.3 Coordination between the rescue and firefighting service at an aerodrome and public protective agencies, such as local fire brigade, police force, coast guard and hospitals, shall be achieved by prior agreement for assistance in dealing with an aircraft accident.
- 23.1.4 A grid map of the aerodrome and its immediate vicinity shall be provided for the use of the aerodrome services concerned. Information concerning topography, access roads and location of water supplies shall be indicated. This map shall be conspicuously posted in the control tower and fire station and available on the rescue and fire fighting vehicles and such other supporting vehicles required to respond to an aircraft accident or incident. Copies shall also be distributed to public protective agencies as desirable.
- 23.1.5 Coordinated instructions shall be drawn up detailing the responsibilities of all concerned and the action to be taken in dealing with emergencies. The Airport Operator shall ensure that such instructions are promulgated and observed.

24. Training

24.1 The training curriculum shall include initial and recurrent instruction in at least the following areas —

- (a) airport familiarization;
- (b) aircraft familiarization;
- (c) rescue and firefighting personnel safety;
- (d) emergency communications systems on the aerodrome, including aircraft fire related alarms;
- (e) use of the fire hoses, nozzles, turrets and other appliances required for compliance with regulation 234
- (f) application of the types of extinguishing agents required for compliance with regulation 226.
- (g) emergency aircraft evacuation assistance;
- (h) fire fighting operations;
- (i) adaptation and use of structural rescue and firefighting equipment for aircraft rescue and fire fighting;
- (j) dangerous goods;
- (k) familiarization with fire fighters' duties under the aerodrome emergency plan; and
- (l) protective clothing and respiratory protection.

25. Level of protection to be provided

25.1 In accordance with regulation 46, aerodromes shall be categorized for rescue and firefighting purposes and the level of protection provided shall be appropriate to the aerodrome category.

25.2 However, regulation 226 permits a lower level of protection to be provided for a limited period where the number of movements of the aeroplanes in the highest category normally using the aerodrome is less than 700 in the busiest consecutive three months. It is important to note that the concession included in regulation 226 is applicable only where there is a wide range of difference between the dimensions of the aeroplanes included in reaching 700 movements.

26. Rescue equipment for difficult environments

- 26.1 Suitable rescue equipment and services shall be available at an aerodrome where the area to be covered by the service includes water, swampy areas or other difficult environment that cannot be fully served by conventional wheeled vehicles. This is particularly important where a significant portion of approach/departure operations takes place over these areas.
- 26.2 The rescue equipment shall be carried on boats or other vehicles such as helicopters and amphibious or air cushion vehicles, capable of operating in the area concerned. The vehicles shall be so located that they can be brought into action quickly to respond to the areas covered by the service.
- 26.3 At an aerodrome bordering the water, the boats or other vehicles shall preferably be located on the aerodrome, and convenient launching or docking sites provided. If these vehicles are located off the aerodrome, they shall preferably be under the control of the aerodrome rescue and firefighting service or, if this is not practicable, under the control of another competent public or private organization working in close coordination with the aerodrome rescue and fire fighting service (such as police, military services, harbour patrol or coast guard).
- 26.4 Boats or other vehicles shall have as high a speed as practicable so as to reach an accident site in minimum time. To reduce the possibility of injury during rescue operations, water jet-driven boats are preferred to water propeller driven boats unless the propellers of the latter boats are ducted. Shall the water areas to be covered by the service be frozen for a significant period of the year, the equipment shall be selected accordingly. Vehicles used in this service shall be equipped with life rafts and life preservers related to the requirements of the larger aircraft normally using the aerodrome, with two-way radio communication, and with floodlights for night operations. If aircraft operations during periods of low visibility are expected, it may be necessary to provide guidance for the responding emergency vehicles.
- 26.5 The personnel designated to operate the equipment shall be adequately trained and drilled for rescue services in the appropriate environment.

27. Facilities

- 27.1 The provision of special telephone, two-way radio communication and general alarm systems for the rescue and firefighting service is desirable to ensure the dependable transmission of essential emergency and routine information –
- (a) direct communication between the activating authority and the aerodrome fire station in order to ensure the prompt alerting and dispatch of rescue and fire fighting ;
 - (b) vehicles and personnel in the event of an aircraft accident or incident;
 - (c) emergency signals to ensure the immediate summoning of designated personnel not on standby duty;

- (d) as necessary, summoning essential related services on or off the aerodrome; and
- (e) maintaining communication by means of two-way radio with the rescue and fire fighting vehicles in attendance at an aircraft accident or incident.

27.2 The availability of ambulance and medical facilities for the removal and after-care of casualties arising from an aircraft accident shall receive the careful consideration of the aerodrome operator and shall form part of the overall emergency plan established to deal with such emergencies.

28. Operators of vehicles

28.1 The authorities responsible for the operation of vehicles on the movement area shall ensure that the operators are properly qualified. This may include, as appropriate to the driver's function, knowledge of —

- (a) the geography of the aerodrome;
- (b) aerodrome signs, markings and lights;
- (c) radiotelephone operating procedures;
- (d) terms and phrases used in aerodrome control including the ICAO spelling alphabet;
- (e) rules of air traffic services as they relate to ground operations;
- (f) airport rules and procedures; and
- (g) specialist functions as required, for example, in rescue and fire fighting.

28.2 The operator shall be able to demonstrate competency, as appropriate, in —

- (a) the operation or use of vehicle transmit/receive equipment;
- (b) understanding and complying with air traffic control and local procedures;
- (c) vehicle navigation on the aerodrome; and
- (d) special skills required for the particular function.

In addition, as required for any specialist function, the operator shall be the holder of a driver's license issued by the state, a radio operator's license issued by the Authority or other licenses approved by the Authority.

- 28.3 The above shall be applied as is appropriate to the function to be performed by the operator and it is not necessary that all operators be trained to the same level, for example, operators whose functions are restricted to the apron.
- 28.4 If special procedures apply for operations in low visibility conditions, it is desirable to verify an operator's knowledge of the procedures through periodic checks.
29. The ACN-PCN method of reporting pavement strength

29.1 Overload operations

- 29.1.1 Overload of pavements can result either from loads too large, or from a substantially increased application rate, or both. Loads larger than the defined (design or evaluation) load shorten the design life, whilst smaller loads extend it. With the exception of massive overloading, pavements in their structural behaviour are not subject to a particular limiting load above which they suddenly or catastrophically fail. Behaviour is such that a pavement can sustain a definable load for an expected number of repetitions during its design life. As a result, occasional minor over-loading is acceptable, when expedient, with only limited loss in pavement life expectancy and relatively small acceleration of pavement deterioration. For those operations in which magnitude of overload and/or the frequency of use do not justify a detailed analysis, the following criteria are suggested —
- (a) for flexible pavements, occasional movements by aircraft with ACN not exceeding 10 per cent above the reported PCN shall not adversely affect the pavement;
 - (b) for rigid or composite pavements, in which a rigid pavement layer provides a primary element of the structure, occasional movements by aircraft with ACN not exceeding 5 per cent above the reported PCN shall not adversely affect the pavement;
 - (c) if the pavement structure is unknown, the 5 per cent limitation shall apply; and
 - (d) the annual number of overload movements shall not exceed approximately 5 per cent of the total annual aircraft movements.
- 29.1.2 Such overload movements shall not normally be permitted on pavements exhibiting signs of distress or failure. Furthermore, overloading shall be avoided during any periods of thaw following frost penetration, or when the strength of the pavement or its sub-grade could be weakened by water. Where overload operations are conducted, the appropriate authority shall review the relevant pavement condition regularly and shall also review the criteria for overload operations periodically since excessive repetition of overloads can cause severe shortening of pavement life or require major rehabilitation of pavement.

29.2 ACN for several aircraft types

29.2.1 For convenience, several aircraft types currently in use have been evaluated on rigid and flexible pavements founded on the four sub-grade strength categories these regulations and the results tabulated in the guidance on Pavements developed by the Authority.

30. Autonomous runway incursion warning system (ARIWS)

30.1 General Description

30.1.1 The operation of an ARIWS is based upon a surveillance system which monitors the actual situation on a runway and automatically returns this information to warning lights at the runway (take-off) thresholds and entrances. When an aircraft is departing from a runway (rolling) or arriving at a runway (short final), red warning lights at the entrances will illuminate, indicating that it is unsafe to enter or cross the runway. When an aircraft is aligned on the runway for take-off and another aircraft or vehicle enters or crosses the runway, red warning lights will illuminate at the threshold area, indicating that it is unsafe to start the take-off roll.

30.1.2 In general, an ARIWS consists of an independent surveillance system (primary radar, multilateration, specialized cameras, dedicated radar, etc.) and a warning system in the form of extra airfield lighting systems connected through a processor which generates alerts independent from ATC directly to the flight crews and vehicle operators.

30.1.3 An ARIWS does not require circuit interleaving, secondary power supply or operational connection to other visual aid systems.

30.1.4 In practice, not every entrance or threshold needs to be equipped with warning lights. Each aerodrome will have to assess its needs individually depending on the characteristics of the aerodrome. There are several systems developed offering the same or similar functionality.

31. Flight crew actions

31.1. It is of critical importance that flight crews understand the warning being transmitted by the ARIWS system. Warnings are provided in near real-time, directly to the flight crew because there is no time for "relay" types of communications. In other words, a conflict warning generated to ATS which must then interpret the warning, evaluate the situation and communicate to the aircraft in question, would result in several seconds being taken up where each second is critical in the ability to stop the aircraft safely and prevent a potential collision. Pilots are presented with a globally consistent signal which means "STOP IMMEDIATELY" and must be taught to react accordingly. Likewise, pilots receiving an ATS clearance to take-off or cross a runway, and seeing the

red light array, must STOP and advise ATS that they aborted/stopped because of the red lights.

- 31.2 Again, the criticality of the timeline involved is so tight that there is no room for misinterpretation of the signal. It is of utmost importance that the visual signal be consistent around the world.
- 31.3 It must also be stressed that the extinguishing of the red lights does not, in itself, indicate a clearance to proceed. That clearance is still required from air traffic control. The absence of red warning lights only means that potential conflicts have not been detected.
- 31.4 In the event that a system becomes unserviceable, one of two things will occur. If the system fails in the extinguished condition, then no procedural changes need to be accomplished. The only thing that will happen is the loss of the automatic, independent warning system. Both ATS operations and flight crew procedures (in response to ATS clearances) will remain unchanged.
- 31.5 Procedures should be developed to address the circumstance where the system fails in the illuminated condition. It will be up to the ATS and/or aerodrome operator to establish those procedures depending on their own circumstances. It must be remembered that flight crews are instructed to "STOP" at all red lights. If the affected portion of the system, or the entire system, is shut off the situation is reverted to the extinguished scenario described in 20.2.3.

32. Aerodromes

- 32.1 An ARIWS does not have to be provided at all aerodromes. An aerodrome considering the installation of such a system may wish to assess its needs individually, depending on traffic levels, aerodrome geometry, ground taxi patterns, etc. Local user groups such as the Local Runway Safety Team (LRST) can be of assistance in this process. Also, not every runway or taxiway needs to be equipped with the lighting array(s), and not every installation requires a comprehensive ground surveillance system to feed information to the conflict detection computer.
- 32.2 Although there may be local specific requirements, some basic system requirements are applicable to all ARIWS —
 - (a) the control system and energy power supply of the system must be independent from any other system in use at the aerodrome, especially the other parts of the lighting system;
 - (b) the system must operate independently from ATS communications;
 - (c) the system must provide a globally accepted visual signal that is consistent and instantly understood by crews; and
 - (d) local procedures should be developed in the case of malfunction or failure of a portion of, or the entire system.

33. Air traffic Services

- 33.1 The ARIWS is designed to be complementary to normal ATS functions, providing warnings to flight crews and vehicle operators when some conflict has been unintentionally created or missed during normal aerodrome operations. The ARIWS will provide a direct warning when, for example, ground control or tower (local) control has provided a clearance to hold short of a runway but the flight crew or vehicle operator has “missed” the hold short portion of their clearance and tower has issued a take-off or landing clearance to that same runway, and the non-read back by the flight crew or vehicle operator was missed by air traffic control.
- 33.2 In the case where a clearance has been issued and a crew reports a non-compliance due to “red lights”, or aborting because of “red lights”, then it is imperative that the controller assess the situation and provide additional instructions as necessary. It may well be that the system has generated a false warning or that the potential incursion no longer exists; however, it may also be a valid warning. In any case, additional instructions and/or a new clearance need to be provided. In a case where the system has failed, then procedures will need to be put into place as described in 20.2.3.
- 33.3 In no case should the illumination of the ARIWS be dismissed without confirmation that, in fact, there is no conflict. It is worth noting that there have been numerous incidents avoided at aerodromes with such systems installed. It is also worth noting that there have been false warnings as well, usually as a result of the calibration of the warning software, but in any case, the potential conflict existence or nonexistence must be confirmed.
- 33.4 While many installations may have a visual or audio warning available to ATS personnel, it is in no way intended that ATS personnel be required to actively monitor the system. Such warnings may assist ATS personnel in quickly assessing the conflict in the event of a warning and help them to provide appropriate further instructions, but the ARIWS should not play an active part in the normal functioning of any ATS facility.
- 33.5 Each aerodrome where the system is installed will develop procedures depending upon its unique situation. Again, it must be stressed that under no circumstances should pilots or operators be instructed to “cross the red lights”. As indicated previously, the use of local runway safety teams can greatly assist in this development process.

34. Promulgation of information

- 34.1 Information on the characteristics and status of an ARIWS at an aerodrome are promulgated in the AIP section AD 2.9, and its status updated as necessary through NOTAM or ATIS in compliance with Regulation 247 of these Regulations.
- 34.2 Aircraft operators are to ensure that flight crews’ documentation include procedures regarding ARIWS and appropriate guidance information, in compliance with the Civil Aviation (Aircraft Operations) Regulations.

- 34.3 Aerodromes may provide additional sources of guidance on operations and procedures for their personnel, aircraft operators, ATS and third-party personnel who may have to deal with an ARIWS.

35. Taxiway design guidance for minimizing the potential for runway incursions

- 35.1 Good aerodrome design practices can reduce the potential for runway incursions while maintaining operating efficiency and capacity. The following taxiway design guidance may be considered to be part of a runway incursion prevention programme as a means to ensure that runway incursion aspects are addressed during the design phase for new runways and taxiways. Within this focused guidance, the prime considerations are to limit the number of aircraft or vehicles entering or crossing a runway, provide pilots with enhanced unobstructed views of the entire runway, and correct taxiways identified as hot spots as much as possible.
- 35.2 The centre line of an entrance taxiway should be perpendicular to the runway centre line, where possible. This design principle provides pilots with an unobstructed view of the entire runway, in both directions, to confirm that the runway and approach are clear of conflicting traffic before proceeding towards the runway. Where the taxiway angle is such that a clear unobstructed view, in both directions, is not possible, consideration should be given to providing a perpendicular portion of the taxiway immediately adjacent to the runway to allow for a full visual scan by the pilots prior to entering or crossing a runway.
- 35.3 For taxiways intersecting with runways, avoid designing taxiways wider than recommended in this Regulations. This design principle offers improved recognition of the location of the runway holding position and the accompanying sign, marking and lighting visual cues.
- 35.4 Existing taxiways wider than recommended in this Regulations, can be rectified by painting taxi side stripe markings to the recommended width. As far as practicable, it is preferable to redesign such locations properly rather than to repaint such locations.
- 35.6 Multi-taxiway entrances to a runway should be parallel to each other and should be distinctly separated by an unpaved area. This design principle allows each runway holding location an earthen area for the proper placement of accompanying sign, marking and lighting visual cues at each runway holding position. Moreover, the design principle eliminates the needless costs of building unusable pavement and as well as the costs for painting taxiway edge markings to indicate such unusable pavement. In general, excess paved areas at runway holding positions reduce the effectiveness of sign, marking and lighting visual cues.
- 35.7 Build taxiways that cross a runway as a single straight taxiway. Avoid dividing the taxiway into two after crossing the runway. This design principle avoids constructing “Y-shaped” taxiways known to present risk of runway incursions.

- 35.8 If possible, avoid building taxiways that enter at the mid-runway location. This design principle helps to reduce the collision risks at the most hazardous locations (high energy location) because normally departing aircraft have too much energy to stop, but not enough speed to take-off, before colliding with another errant aircraft or vehicle.
- 35.9 Provide clear separation of pavement between a rapid exit taxiway and other non-rapid taxiways entering or crossing a runway. This design principle avoids two taxiways from overlapping each other to create an excessive paved area that would confuse pilots entering a runway.
- 35.10 Avoid the placement of different pavement materials (asphalt and cement concrete) at or near the vicinity of the runway holding position, as far as practicable. This design principle avoids creating visual confusion as to the actual location of the runway holding position.
- 35.11 Many aerodromes have more than one runway, notably paired parallel runways (two runways on one side of the terminal), which creates a difficult problem in that either on arrival or departure an aircraft is required to cross a runway. Under such a configuration, the safety objective here is to avoid or at least keep to a minimum the number of runway crossings. This safety objective may be achieved by constructing a "perimeter taxiway". A perimeter taxiway is a taxi route that goes around the end of a runway, enabling arrival aircraft (when landings are on outer runway of a pair) to get to the terminal, or departure aircraft (when departures are on outer runway of a pair) to get to the runway, without either crossing a runway or conflicting with a departing or approaching aircraft.
- 35.12 A perimeter taxiway would be designed according to the following criteria —
- (a) sufficient space is required between the landing threshold and the taxiway centre line where it crosses under the approach path to enable the critical taxiing aircraft to pass under the approach without penetrating any approach surface;
 - (b) the jet blast impact of aircraft taking off should be considered in consultation with aircraft manufacturers; the extent of take-off thrust should be evaluated when determining the location of a perimeter taxiway.
 - (c) the requirement for a runway end safety area, as well as possible interference with landing systems and other navigation aids should also be taken into account. For example, in the case of an ILS, the perimeter taxiway should be located behind the localiser antenna, not between the localiser antenna and the runway, due to the potential for severe ILS disturbance, noting that this is harder to achieve as the distance between the localizer and the runway increases.

- (d) Human factors issues should also be taken into account. Appropriate measures should be put in place to assist pilots to distinguish between aircraft that are crossing the runway and those that are safely on a perimeter taxiway.

36. Introduction

- 36.1 Regulation 36, relate to the provision of aerodrome mapping data. The aerodrome mapping data features are collected and made available to the Aeronautical information services for aerodromes designated by States with consideration of the intended applications. These applications are closely tied to an identified need and operational use where the application of the data would provide a safety benefit or could be used as mitigation of a safety concern.

37. Applications

- 37.1 Aerodrome mapping data include aerodrome geographic information that supports applications which improve the user's situational awareness or supplement surface navigation, thereby increasing safety margins and operational efficiency. With appropriate data element accuracy, these data sets support collaborative decision-making, common situational awareness and aerodrome guidance applications. The data sets are intended to be used in the following air navigation applications —
 - (a) on-board positioning and route awareness including moving maps with own aircraft position, surface guidance and navigation;
 - (b) traffic awareness including surveillance and runway incursion detection and alerting (such as, respectively, in A-SMGCS levels 1 and 2);
 - (c) ground positioning and route awareness including situational displays with aircraft and vehicles position and taxi route, surface guidance and navigation (such as A-SMGCS levels 3 and 4);
 - (d) facilitation of aerodrome-related aeronautical information, including NOTAMs;
 - (e) resource and aerodrome facility management; and
 - (f) aeronautical chart production.
- 37.2 The data may also be used in other applications such as training/flight simulators and onboard or ground enhanced vision systems (EVS), synthetic vision systems (SVS) and combined vision systems (CVS).

38. Determination of Aerodromes to be considered for collection of aerodrome mapping data features

38.1 In order to determine which aerodromes may make use of applications requiring the collection of aerodrome mapping data features, the following aerodrome characteristics may be considered —

- (a) safety risks at the aerodrome;
- (b) visibility conditions; -aerodrome layout; and
- (c) traffic density.

SCHEDULE 3
(reg 76 (3), 78, 87 (5))

Shielding Of Obstacles

1. General

- 1.1. The principle of shielding as applied to obstacles to air navigation may reduce the necessity for removing obstacles or prohibiting the construction of new constructions.
- 1.2. Shielding principles are employed when some object, an existing building or natural terrain already penetrates above one of the obstacle limitation surfaces.

2. The Principles of Shielding

- 2.1. If it is considered that the nature of an object is such that its presence may be described as permanent, the additional objects within a specified area around it may be permitted to penetrate the surface without being considered as obstacles. The original obstacle is considered as dominating or shielding the surrounding area.
- 2.2. The formula for shielding shall be based on a horizontal plane projected from the top of each obstacle away from the runway and a plane with a negative slope of 10% towards the runway. Any object which is below either of the two planes would be considered shielded. The permission to allow objects to penetrate an obstacle limitation surface under the shielding principle shall however be qualified by reference to the need for an aeronautical study in all cases.
- 2.3. The shielding effect of immovable obstacles laterally in approach and take-off climb shall be more critically considered. It is important to preserve existing unobstructed cross section areas particularly when the obstacle is close to the runway. This would guard against future changes in either approach or take-off climb area specifications or the adoption of a turned take-off procedure.
- 2.4. An object shall be considered as permanent and immovable obstacle only if, when taking the longest view possible, there is no prospect of removal being practicable, possible, or justifiable, regardless of how the pattern, type or density of air operations might change. Generally, an aeronautical study will need to be carried out to determine the exact effect the construction of a new object will have on air operations.

3. Alternative Methods for Assessing Obstacles in Critical Areas

- 3.1. The Authority may assess and determine whether an obstacle is shielded. In assessing whether an existing obstacle shields other obstacles, the Authority may be guided by the following shielding practices:
 - (a) **Obstacles in the Take-off climb and Approach Surfaces**
An obstacle may be assessed as not imposing additional restrictions if —
 - (i) when located between the inner edge end and the critical obstacle, the obstacle being assessed is below a plane sloping downwards at 10 per cent from the top of the critical obstacle toward the inner edge;

- (ii) when located beyond the critical obstacle from the inner edge end, the obstacle being assessed is not higher than the height of the permanent obstacle; and
- (iii) where there is more than one critical obstacle within the approach and take-off climb area, and the obstacle being assessed is located between two critical obstacles, the height of the obstacle being assessed is not above a plane sloping downwards at 10 per cent from the top of the next critical obstacle.

(b) Obstacle in the Transitional Surfaces

An obstacle may be assessed as not imposing additional restrictions if it does not exceed the height of an existing obstacle which is closer to the runway strip and the obstacle being assessed is located perpendicularly behind the existing obstacle relative to the runway centre line.

SCHEDULE 4
(Reg. 96 (1), 102 (3), 103 (10), 169 (9))

Colours for Aeronautical Ground Lights, Markings, Signs and Panels

1. General

- 1.1 The following specifications define the chromaticity limits of colours to be used for aeronautical ground lights, markings, signs and panels. The specifications are in accord with the 1983 specifications of the International Commission on Illumination (CIE).
- 1.2 It is not possible to establish specifications for colours such that there is no possibility of confusion. For reasonably certain recognition, it is important that the eye illumination be well above the threshold of perception, that the colour not be greatly modified by elective atmospheric attenuations and that the observer's colour vision be adequate. There is also a risk of confusion of colour at an extremely high level of eye illumination such as may be obtained from a high-intensity source at very close range. Experience indicates that satisfactory recognition can be achieved if due attention is given to these factors. The chromaticities are expressed in terms of the standard observer and coordinate system adopted by the International Commission on Illumination (CIE) at its Eighth Session at Cambridge, England, in 1931.

2. Colours for aeronautical ground lights

2.1 Chromaticities

- (a) The chromaticities of aeronautical ground lights shall be within the following boundaries: CIE Equations (see Figure S4-1)

(i) 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

(ii) Yellow

Red boundary $y = 0.382$

White boundary $y = 0.790 - 0.667x$

Green boundary $y = x - 0.120$

(iii) Green

Yellow boundary $x = 0.360 - 0.080y$

White boundary $x = 0.650y$

Blue boundary $y = 0.390 - 0.171x$

(iv) Blue

Green boundary $y = 0.805x + 0.065$

White boundary $y = 0.400 - x$

Purple boundary $x = 0.600y + 0.133$

(v) 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 $y = 0.382$

(vi) 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 $y = 0.382$

(b) The Authority has provided guidance on chromaticity changes resulting from the effect of temperature on filtering elements. Where dimming is not required, or where observers with defective colour vision must be able to determine the colour of the light, green signals shall be within the following boundaries —

Yellow boundary $y = 0.726 - 0.726x$

White boundary $x = 0.650y$

Blue boundary $y = 0.390 - 0.171x$

(c) Where increased certainty of recognition 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

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

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

- 2.3 The colour variable white is intended to be used only for lights that are to be varied in intensity, e.g. to avoid dazzling —
- (i) the x coordinate of the yellow is at least 0.050 greater than the x coordinate of the white; and
 - (ii) the disposition of the lights will be such that the yellow lights are displayed simultaneously and in close proximity to the white lights.

- 2.4 The colour of aeronautical ground lights shall be verified as being within the boundaries specified in Figure S4-1 by measurement at five points within the area limited by the innermost isocandela curve (isocandela diagrams in Schedule 5 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 shall be made and recorded for review and judgment of acceptability by the appropriate authority.

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 runwayholding positions). In such instances, the appropriate authority shall assess the actual application and if necessary require a check of colour shift at angular ranges beyond the outermost curve.

- 2.5 In the case of visual approach slope indicators and other light units having a colour transition sector, the colour shall be measured at points in accordance with 2.2.4 above, except that the colour areas

shall be treated separately and no point shall be within 0.5 degrees of the transition sector.

3. Colours for Markings, Signs and Panels

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

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

Note 3.— The specifications recommended in 3.4 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 colours, colours of retro-reflective materials and colours of trans-illuminated (internally illuminated) signs and panels shall be determined under the following standard conditions —

- (a) angle of illumination: 45 degrees;
- (b) direction of view: perpendicular to surface; and
- (c) illuminant: CIE standard illuminant D₆₅.

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

CIE Equations (see Figure S4-2):

(a) Red

$$\text{Purple boundary } y = 0.345 - 0.051x$$

$$\text{White boundary } y = 0.910 - x$$

$$\text{Orange boundary } y = 0.314 + 0.047x$$

(b) Orange

$$\text{Red boundary } y = 0.285 + 0.100x$$

$$\text{White boundary } y = 0.940 - x$$

$$\text{Yellow boundary } y = 0.250 + 0.220x$$

$$\text{Luminance factor } \beta = 0.20 \text{ (mnm)}$$

(c) Yellow

Orange boundary $y = 0.108 + 0.707x$

White boundary $y = 0.910 - x$

Green boundary $y = 1.35x - 0.093$

Luminance factor $\beta = 0.45$ (mm)

(d) White

Purple boundary $y = 0.010 + x$

Blue boundary $y = 0.610 - x$

Green boundary $y = 0.030 + x$

Yellow boundary $y = 0.710 - x$

Luminance factor $\beta = 0.75$ (mm)

(e) Black

Purple boundary $y = x - 0.030$

Blue boundary $y = 0.570 - x$

Green boundary $y = 0.050 + x$

Yellow boundary $y = 0.740 - x$

Luminance factor $\beta = 0.03$ (max)

(f) Yellowish green

Green boundary $y = 1.317x + 0.4$

White boundary $y = 0.910 - x$

Yellow boundary $y = 0.867x + 0.4$

(g) Green

Yellow boundary $x = 0.313$

White boundary $y = 0.243 + 0.067x$

Blue boundary $y = 0.493 - 0.524x$

Luminance factor $\beta = 0.10$ (mm)

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

3.3 The chromaticity and luminance factors of colours of retro-reflective materials for markings, signs and panels shall be within the following boundaries when determined under standard conditions. CIE Equations (see Figure S4-3) —

(a) Red

Purple boundary $y = 0.345 - 0.051x$

White boundary $y = 0.910 - x$

Orange boundary $y = 0.314 + 0.047x$

Luminance factor $\beta = 0.03$ (mm)

(b) Orange

Red boundary $y = 0.265 + 0.205x$

White boundary $y = 0.910 - x$

Yellow boundary $y = 0.207 + 0.390x$

Luminance factor $\beta = 0.14$ (mm)

(c) Yellow

Orange boundary $y = 0.160 + 0.540x$

White boundary $y = 0.910 - x$

Green boundary $y = 1.35x - 0.093$

Luminance factor $\beta = 0.16$ (mm)

(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 $\beta = 0.27$ (mm)

(e) Blue

Green boundary $y = 0.118 + 0.675x$

White boundary $y = 0.370 - x$

Purple boundary $y = 1.65x - 0.187$

Luminance factor $\beta = 0.01$ (mm)

(f) Green

$$\text{Yellow boundary } y = 0.711 - 1.22x$$

$$\text{White boundary } y = 0.243 + 0.670x$$

$$\text{Blue boundary } y = 0.405 - 0.243x$$

$$\text{Luminance factor } \beta = 0.03 \text{ (mm)}$$

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

CIE Equations (see Figure S4-4) –

(a) Red

$$\text{Purple boundary } y = 0.345 - 0.051x$$

$$\text{White boundary } y = 0.910 - x$$

$$\text{Orange boundary } y = 0.314 + 0.047x$$

$$\text{Luminance factor (day condition) } \beta = 0.07 \text{ (mm)}$$

Relative luminance to white (night condition) 5 percent (mm), 20 percent (max)

(b) Yellow

$$\text{Orange boundary } y = 0.108 + 0.707x$$

$$\text{White boundary } y = 0.910 - x$$

$$\text{Green boundary } y = 1.35x - 0.093$$

$$\text{Luminance factor (day condition) } \beta = 0.45 \text{ (mm)}$$

Relative luminance 30 percent (mm), to white (night condition) 80 percent (max)

(c) White

$$\text{Purple boundary } y = 0.010 + x$$

$$\text{Blue boundary } y = 0.610 - x$$

$$\text{Green boundary } y = 0.030 + x$$

$$\text{Yellow boundary } y = 0.710 - x$$

$$\text{Luminance factor (day condition) } \beta = 0.75 \text{ (mm)}$$

Relative luminance 100 percent to white (night condition)

(d) 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 (day condition) $\beta = 0.03$ (max)

Relative luminance to white (night condition) 0 per cent (min), 2 per cent (max)

(e) Green

Yellow boundary $x = 0.313$

White boundary $y = 0.243 + 0.670x$

Blue boundary $y = 0.493 - 0.524x$

Luminance factor $\beta = 0.10$ minimum (day conditions)

Relative luminance to white (night Conditions) 5 per cent (min.), 30 per cent (max)

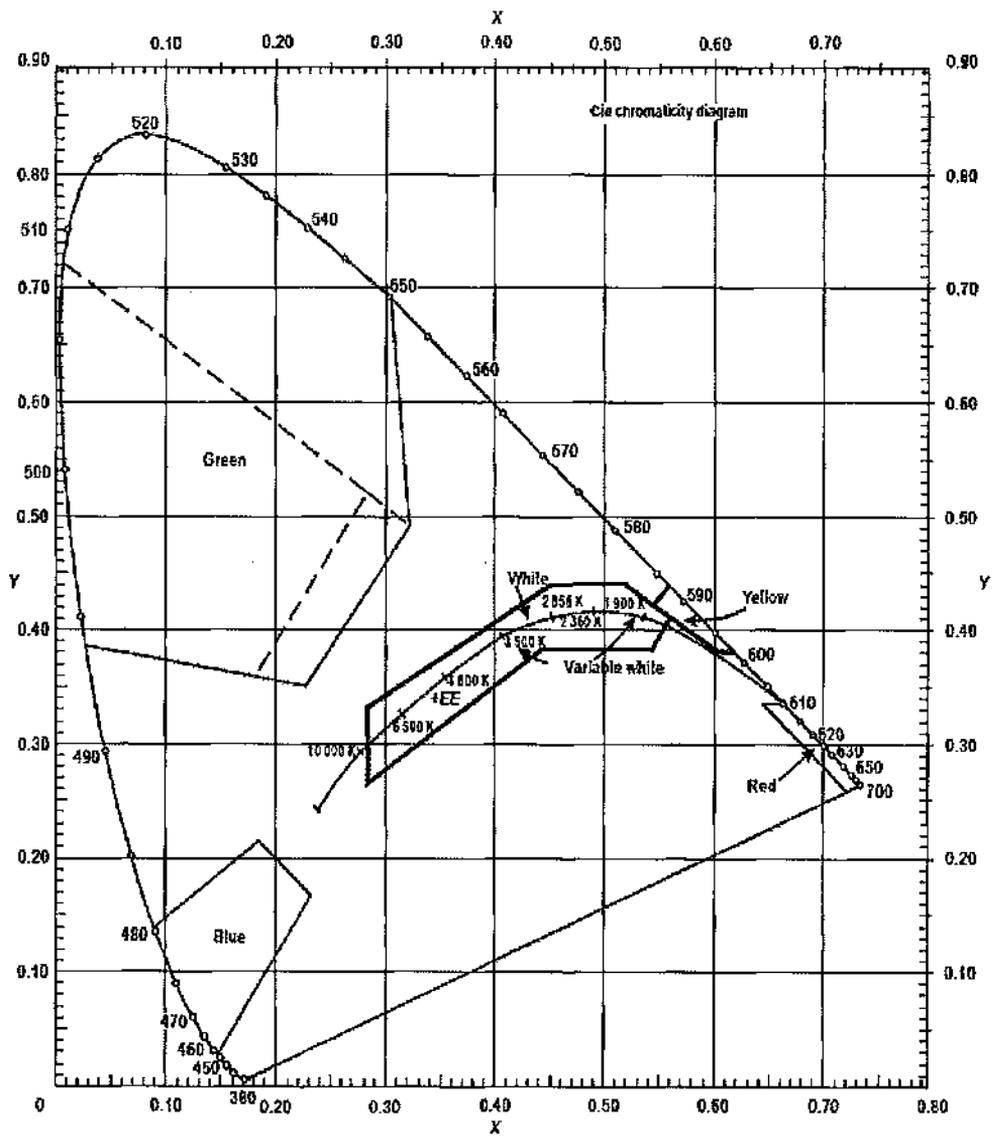


Figure S4-1. Colours for aeronautical ground lights

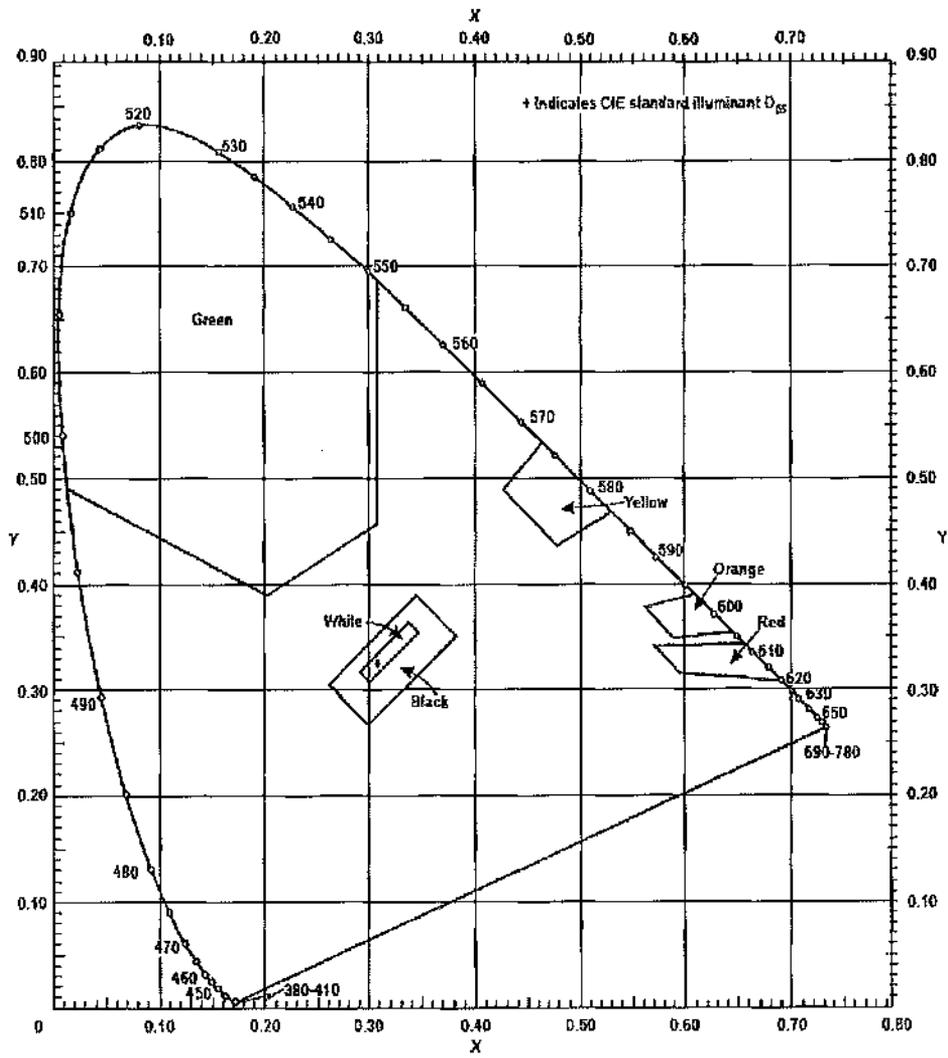


Figure S4-2. Ordinary colours for markings and externally illuminated signs and panels

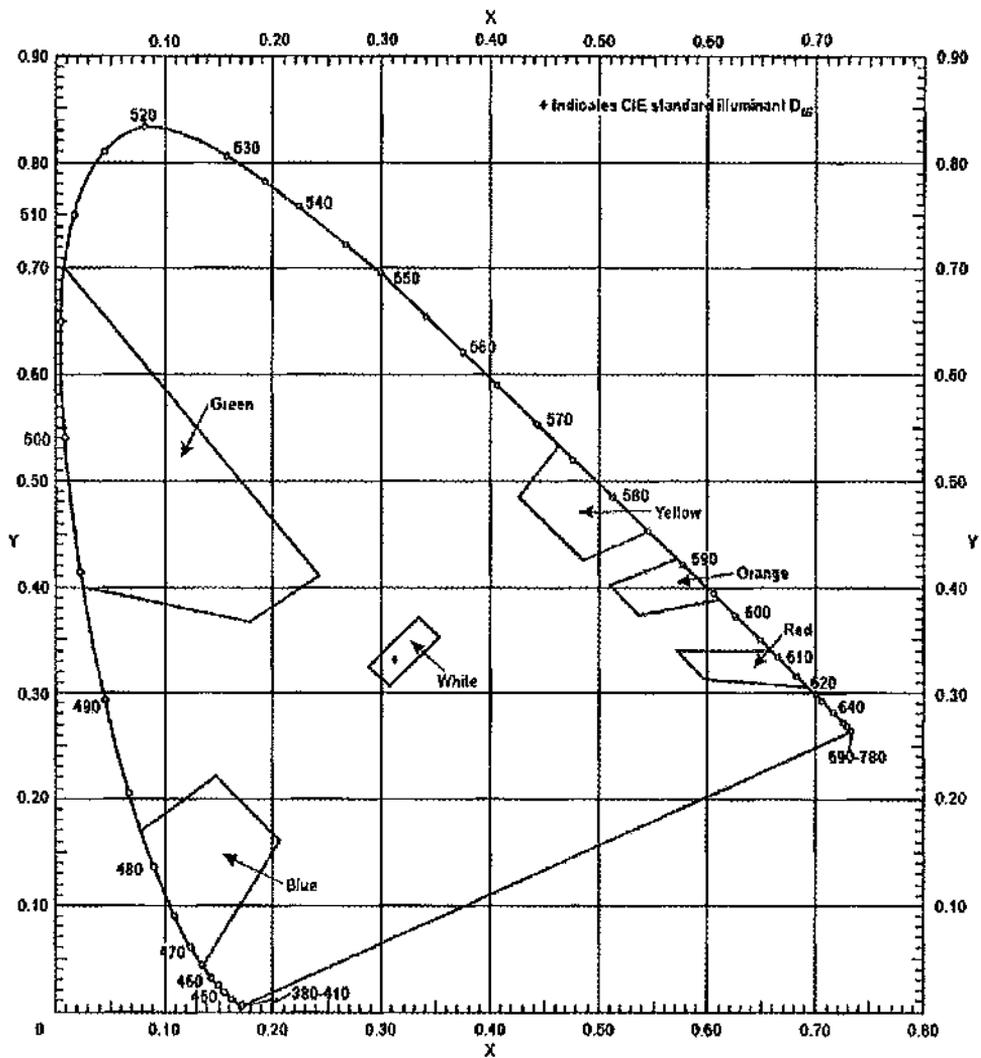


Figure S4-3. Colors of retroreflective materials for markings, signs and panels

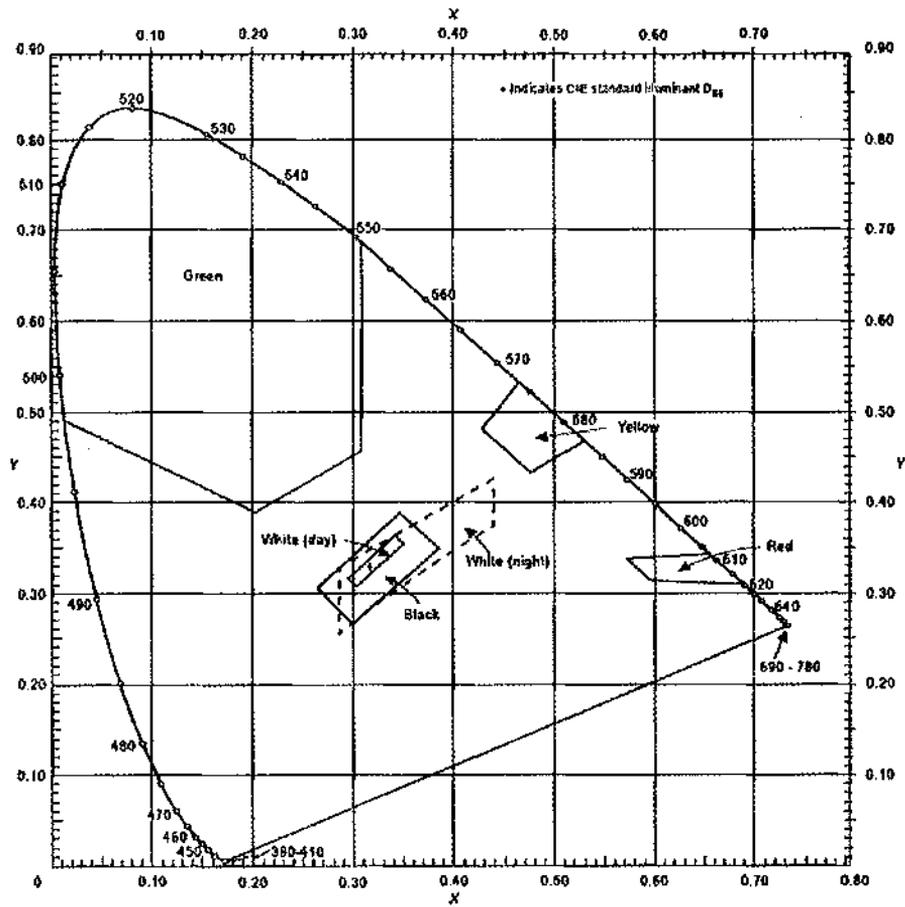


Figure S4-4. Colours of luminescent or trans-illuminated (internally illuminated) signs and panels

SCHEDULE 5
(regs. 96 (2), 147 (6), 168 (10), 239 (3), (4), (6))

Aeronautical Ground Light Characteristics

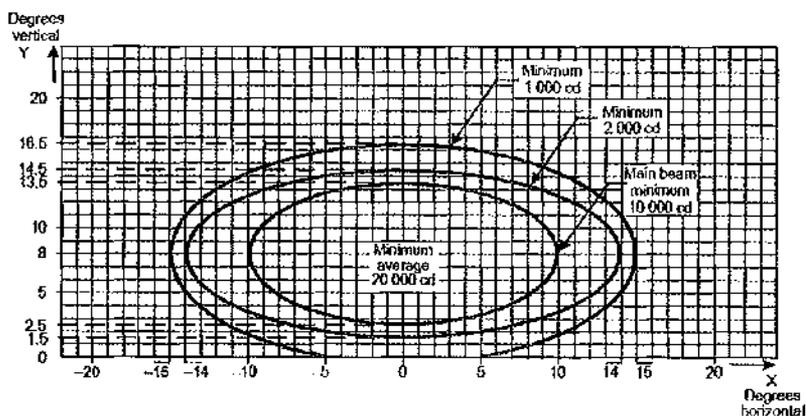


Figure S5-1 Isocandela diagram for approach centre line light and crossbars (white light)

Notes to figure S5-1

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

a	10	14	5
b	5.5	6.5	8.5

(2) Vertical 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 - 475 m	0.5° - 11.5°
476 m - 640 m	1.5° - 12.5°
641 m and beyond	2.5° - 13.5° (as illustrated above)

(3) Lights in crossbars beyond 22.5m 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 S5-1 to S5-11

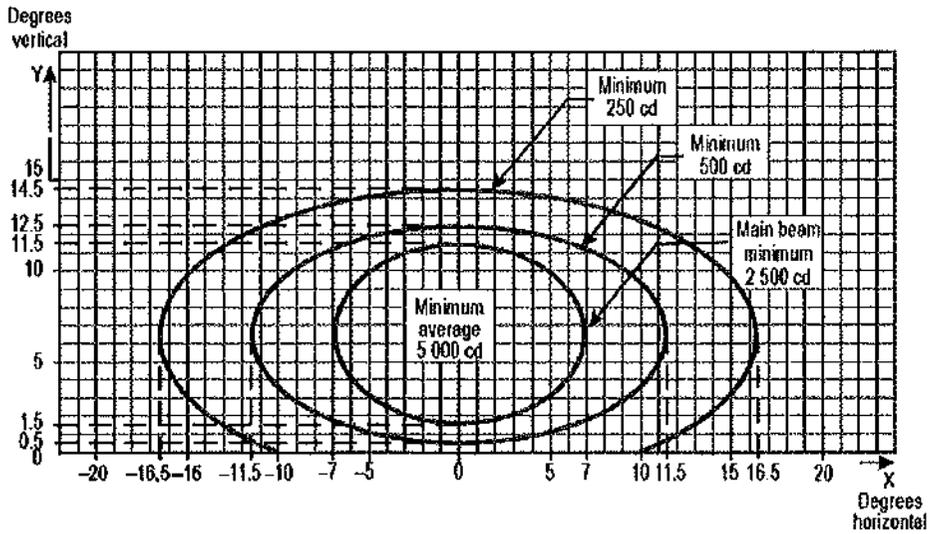


Figure S5-2. Isocandela diagram for approach side row light (red light)

Notes to figure S5-2

(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 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 115m	0.5° - 10.5°
116m - 215m	1° - 11°
216m and beyond	1.5° - 11.5° (as illustrated above)

(2) See collective notes for Figures S5-1 to S5-11

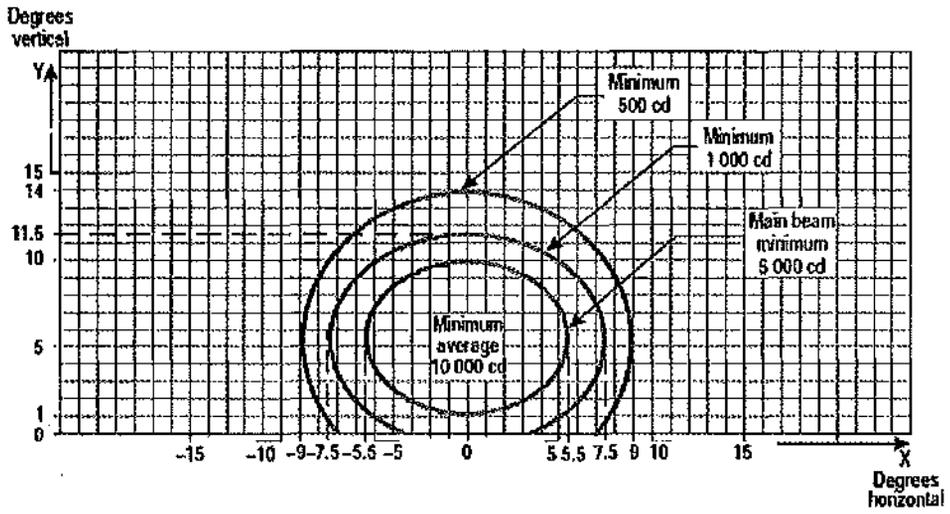


Figure S5-3. Isocandela diagram for threshold light (green light)

Notes to figure S5-3

- (1) Curves calculated on formula $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$
- (2) Toe-in 3.5 degrees
- (3) See collective notes for Figures A2-1 to A2-11

a	5.5	7.5	9.0
b	4.5	6.0	8.5

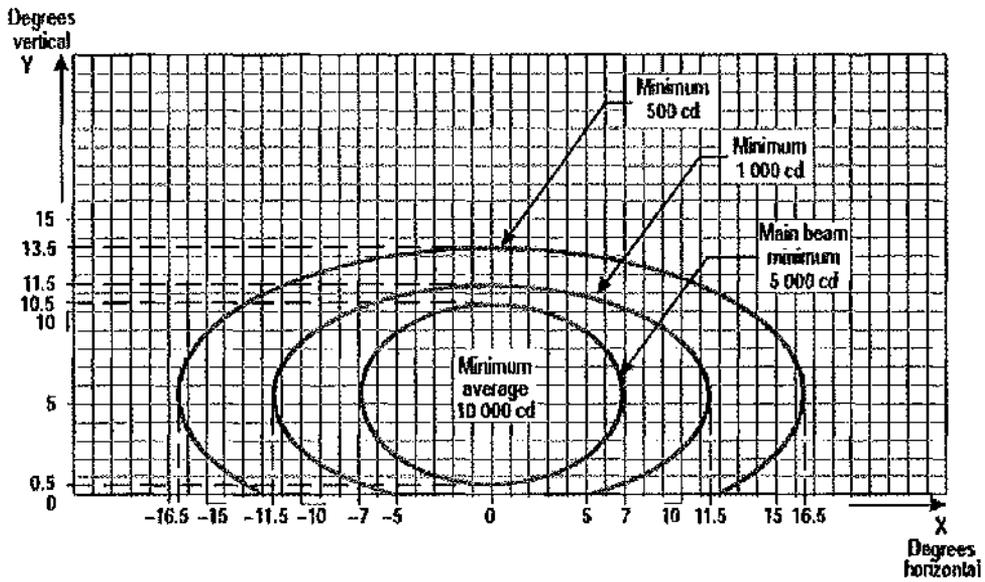


Figure S5-4. Iso candela diagram for threshold wing bar light (green light)

Notes to figure S5-4

(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

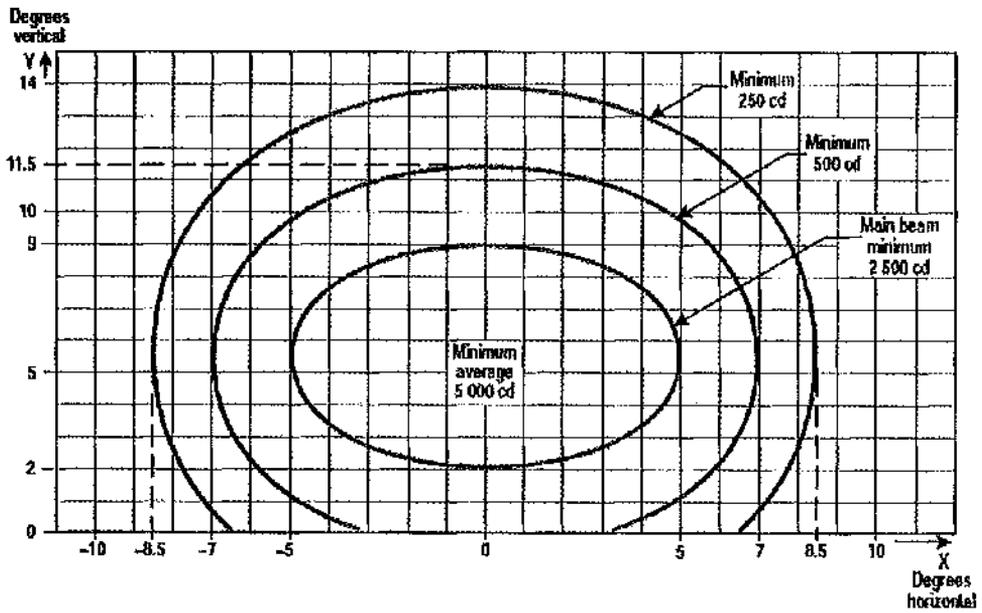


Figure S5-5. Isocandela diagram for threshold wing bar light (white light)

Notes to figure S5-5

(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 S5-1 to S5-11

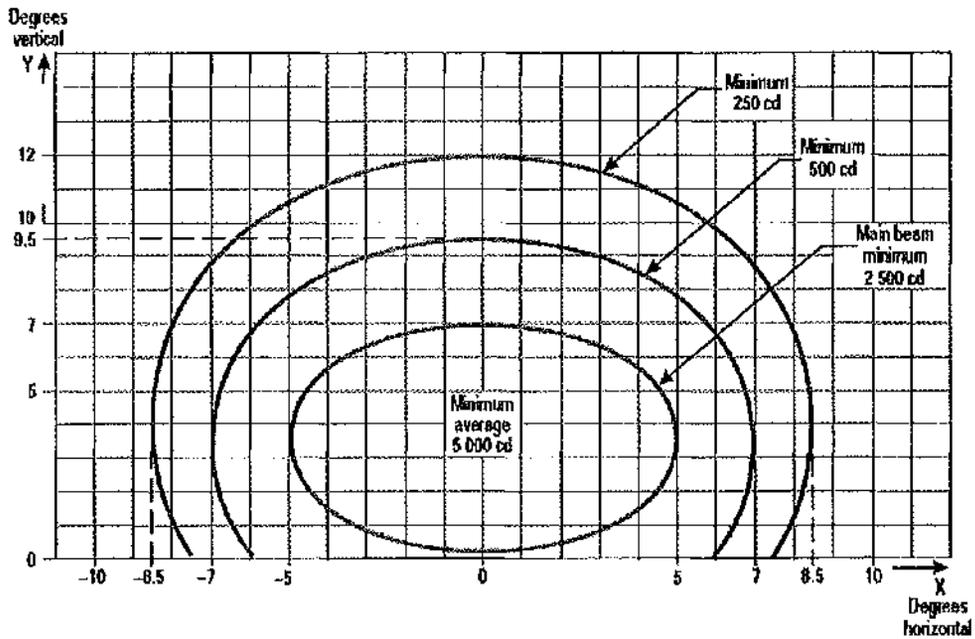


Figure S5-6. Isocandela diagram for runway centre line light with 30 m longitudinal spacing (white light) and rapid exit taxiway indicator light (yellow light)

Notes to figure S5-6

(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 S5-1 to S5-11.

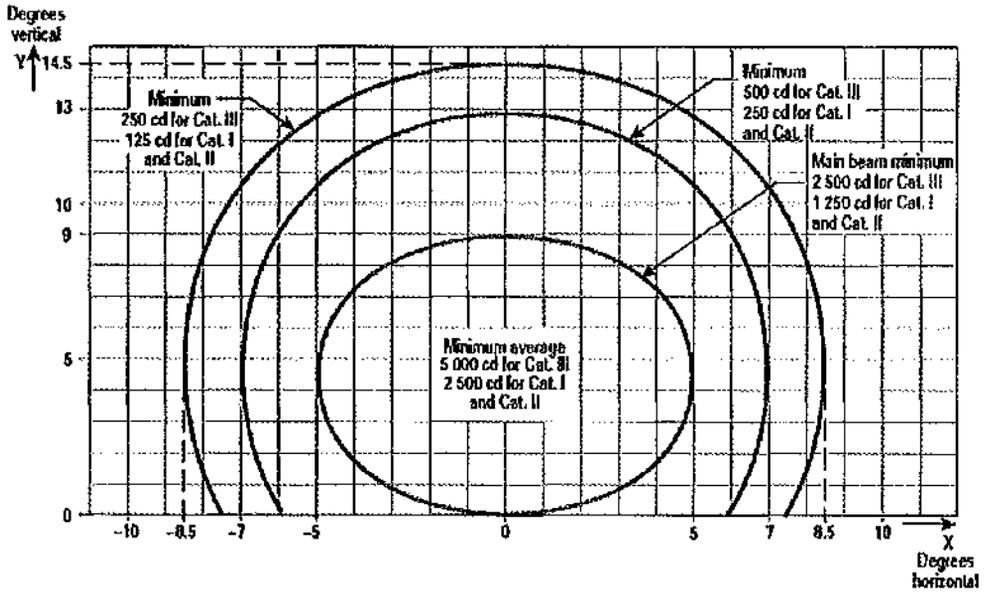


Figure S5-7. Isocandela diagram for runway centre line light with 15 m longitudinal spacing (white light) and rapid exit taxiway indicator light (yellow light)

Notes to figure S5-7

(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 S5-1 to S5-11.

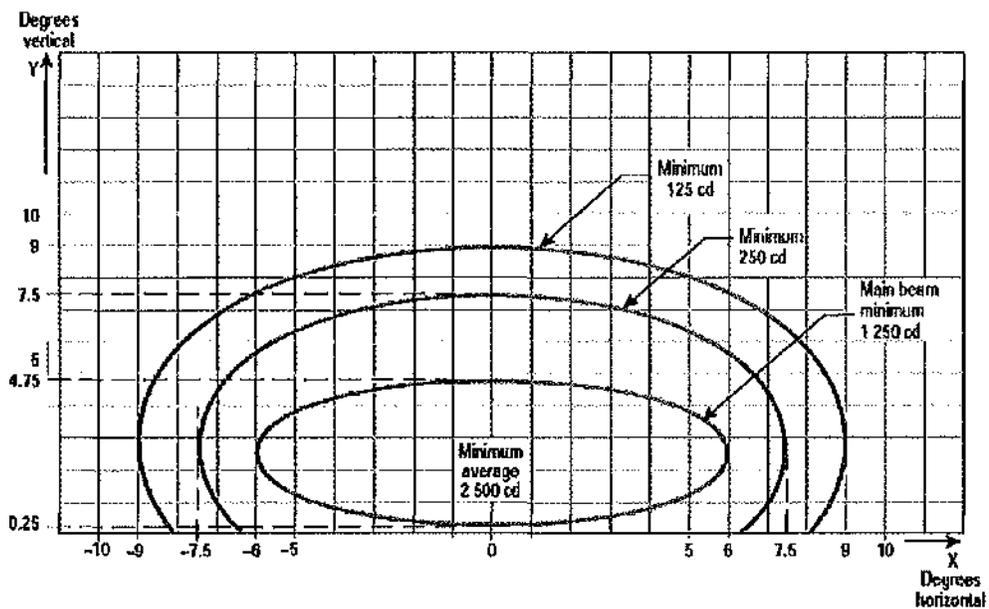


Figure S5-8. Isocandela diagram for runway end light (red light)

Notes to figure S5-8

(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 S5-1 to S5-11.

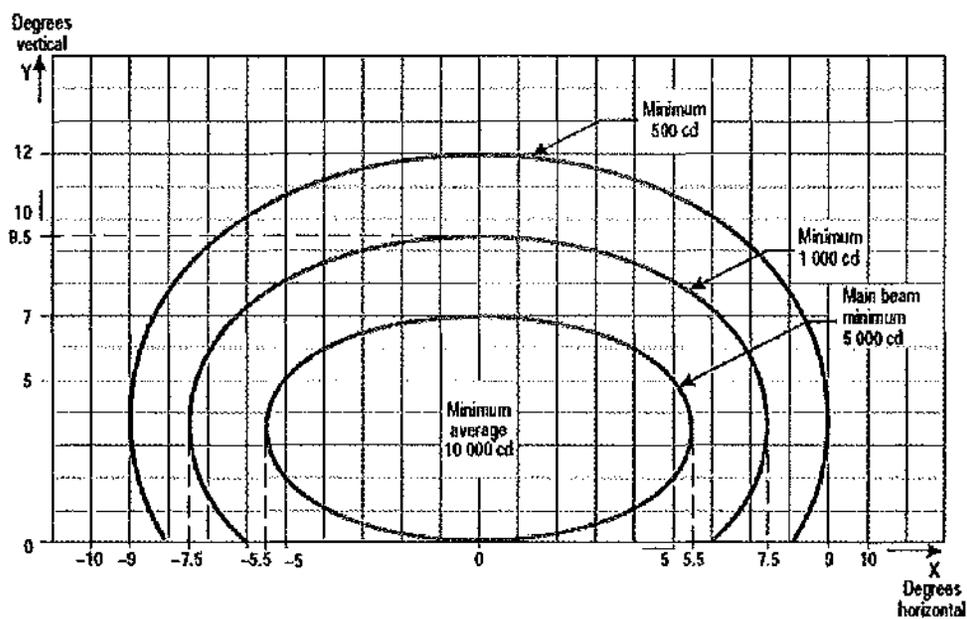


Figure S5-9. Isocandela diagram for runway edge light where width of runway is 45 m (white light)

Notes to figure S5-9

(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 S5-1 to S5-11.

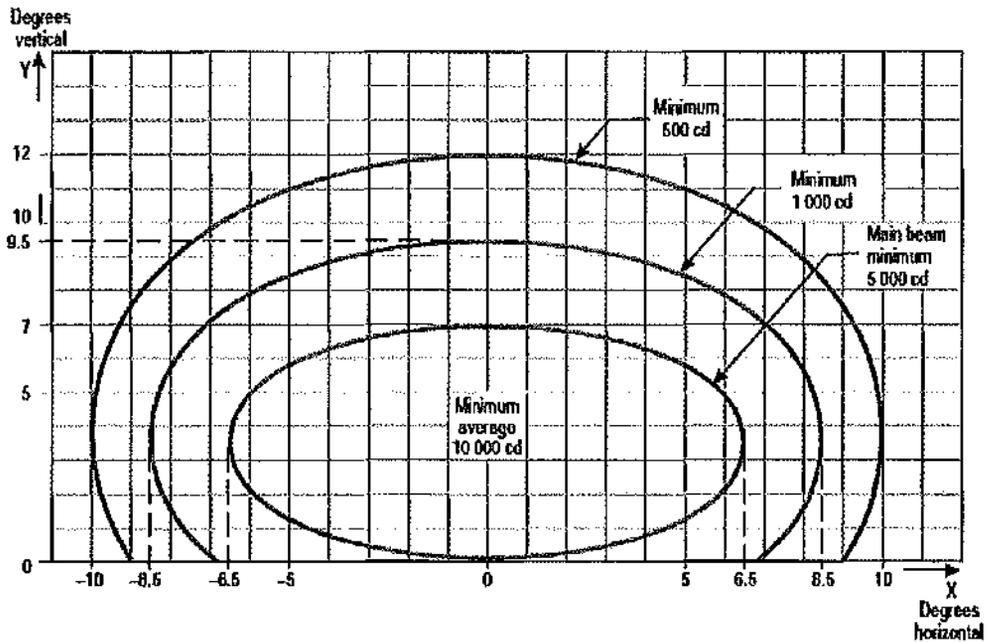


Figure S5-10. Isocandela diagram for runway edge light where width of runway is 60 m (white light)

Notes to figure S5-10

(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 S5-1 to S5-11.

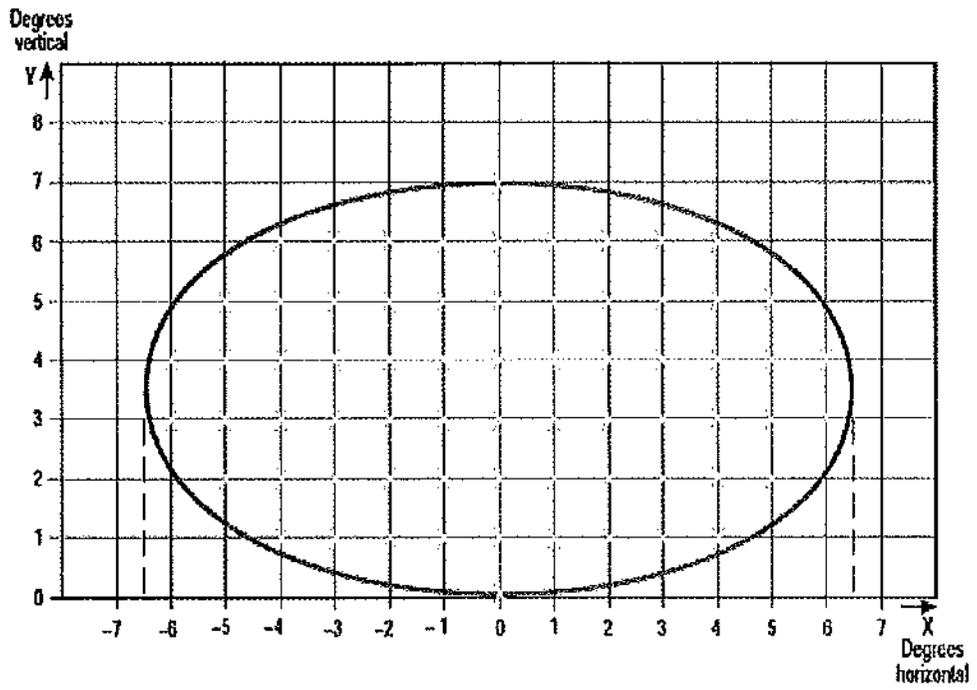


Figure 85-11. Grid points to be used for the calculation of average intensity of approach and runway lights

Collective notes to Figures S5-1 to S5-11 and S5-26

- (1) The ellipses in each figure are symmetrical about the common vertical and horizontal axes.
- (2) Figures S5-1 to S5-10, as well as Figure S5-26, show the minimum allowable light intensities. The average intensity of the main beam is calculated by establishing grid points as shown in Figure S5-11 and using the intensity value measures at all grid points located within and on the perimeter of the ellipse representing the main beam. The average value is the arithmetic average of light intensities measured at all considered grid points.
- (3) No deviations are acceptable in the main beam pattern when the lighting fixture is properly aimed.
- (4) Average intensity ratio. The ratio between the average intensity within the ellipse defining the main beam of a typical new light and the average light intensity of the main beam of a new runway edge light shall be as follows —

Figure S5-1 Approach centre line and crossbars	1.5 to 2.0 (white light)
Figure S5-2 Approach side row	0.5 to 1.0 (red light)
Figure S5-3 Threshold	1.0 to 1.5 (green light)
Figure S5-4 Threshold wing bar	1.0 to 1.5 (green light)
Figure S5-5 Touchdown zone	0.5 to 1.0 (white light)
Figure S5-6 Runway centre line (longitudinal spacing 30 m)	0.5 to 1.0 (white light)
Figure S5-7 Runway centre line (longitudinal spacing 15 m)	0.5 to 1.0 for CAT III (white light)
	0.25 to 0.5 for CAT I, II (white light)
Figure S5-8 Runway end	0.25 to 0.5 (red light)
Figure S5-9 Runway edge (45 m runway width)	1.0 (white light)
Figure S5-10 Runway edge (60 m runway width)	1.0 (white light)

- (5) The beam coverages in the figures provide the necessary guidance for approaches down to an RVR of the order of 150 m and take-offs down to an RVR of the order of 100 m.
- (6) Horizontal angles are measured with respect to the vertical plane through the runway centre line. For lights other than centre line lights, the direction towards the runway centre line is considered positive. Vertical angles are measured with respect to the horizontal plane.

- (7) Where, for approach centre line lights and crossbars and for approach side row lights, inset lights are used in lieu of elevated lights, e.g. on a runway with a displaced threshold, the intensity requirements can be met by installing two or three fittings (lower intensity) at each position.
- (8) The importance of adequate maintenance cannot be overemphasized. The average intensity should never fall to a value less than 50 per cent of the value shown in the figures, and it should be the aim of airport authorities to maintain a level of light output close to the specified minimum average intensity.

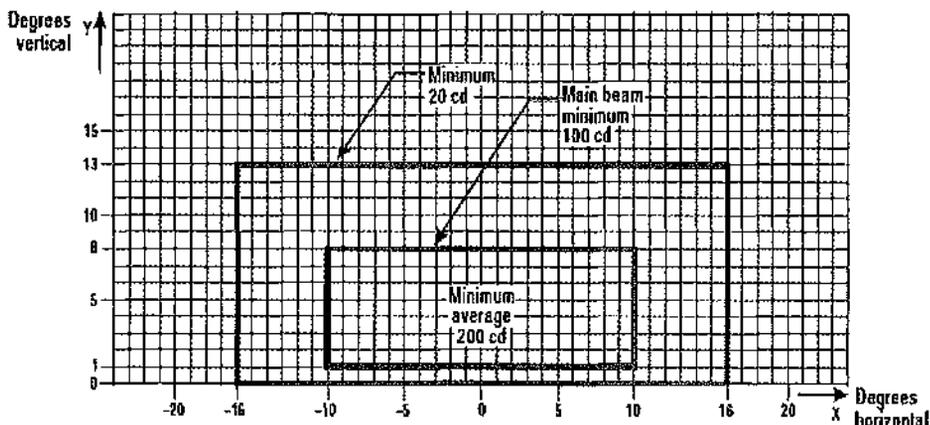


Figure S5-12. Isocandela diagram for taxiway centre line (15 m spacing), RBLs, no-entry bar and stop bar lights in straight sections intended for use in runway visual range conditions of less than a value of 350 m where large offsets can occur and for low-intensity runway guard lights, Configuration B

Notes to figure S5-12:

- (a) These beam coverages allow for displacement of the cockpit from the centre line up to distances of the order of 12 m and are intended for use before and after curves.
- (b) See collective notes for Figures S5-12 to S5-21.
- (c) Increased intensities for enhanced rapid exit taxiway centre line lights as required in regulation 178 are four times the respective intensities in the figure (i.e. 800 cd for minimum average main beam).

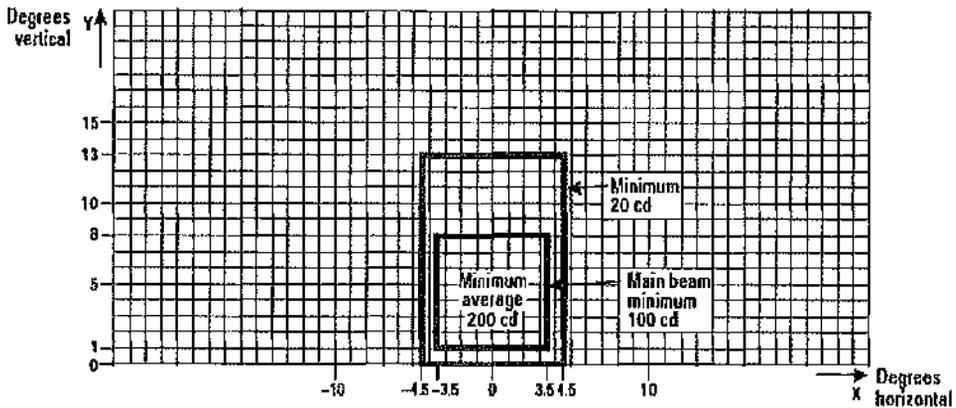


Figure S5-13, Isocandela diagram for taxiway centre line (15 m spacing), no-entry bar and stop bar lights in straight sections intended for use in runway visual range conditions of less than a value of 350 m

Notes to figure S5-13:

- (a) These beam coverages are generally satisfactory and cater for a normal displacement of the cockpit from the centre line of approximately 3 m.
- (b) See collective notes for Figures S5-12 to S5-21.

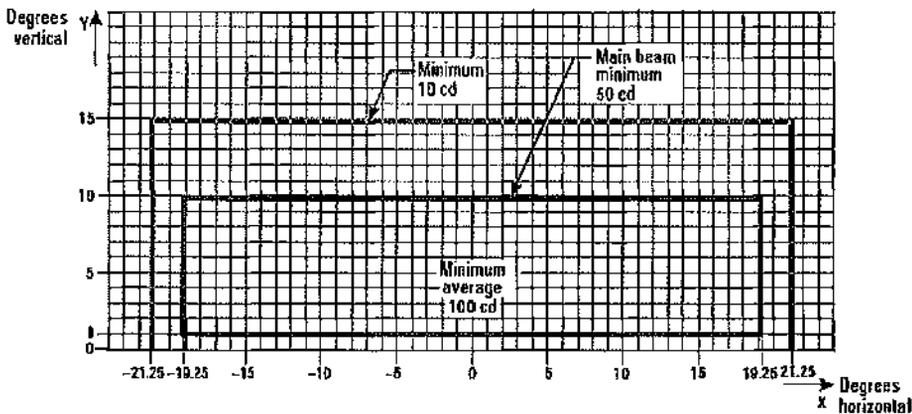


Figure S5-14, Isocandela diagram for taxiway centre line (7.5 m spacing), RELs, no-entry bar and stop bar lights in curved sections intended for use in runway visual range conditions of less than a value of 350 m

Notes to figure S5-14:

- (a) 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)

- (b) 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.
- (c) See collective notes for Figures S5-12 to S5-21.

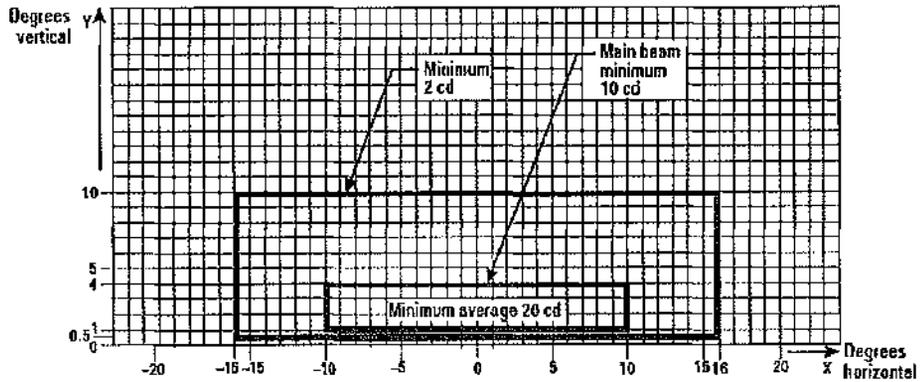


Figure S5-15. Isocandela diagram for taxiway centre line (30 m, 60 m spacing), no-entry bar and stop bar lights in straight sections intended for use in runway visual range conditions of 350 m or greater

Notes to figure S5-15:

- (a) At locations where high background luminance is usual and where deterioration of light output resulting from dust, snow and local contamination is a significant factor, the cd- values should be multiplied by 2.5.
- (b) Where omnidirectional lights are used they shall comply with the vertical beam requirements in this figure.
- (c) See collective notes for Figures S5-12 to S5-21.

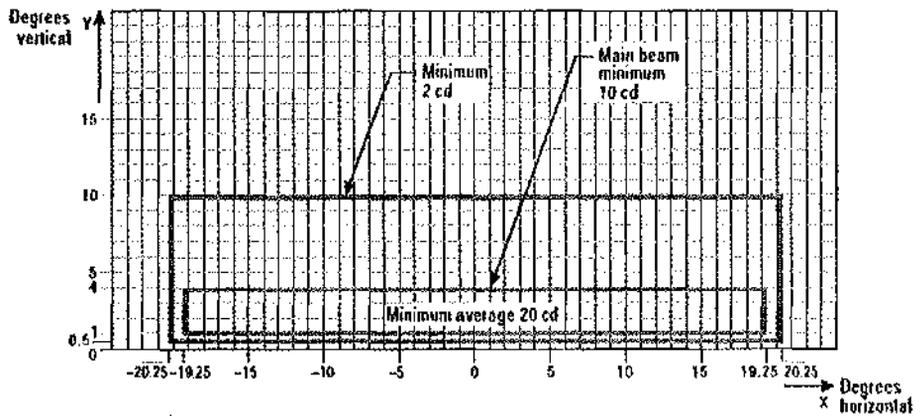
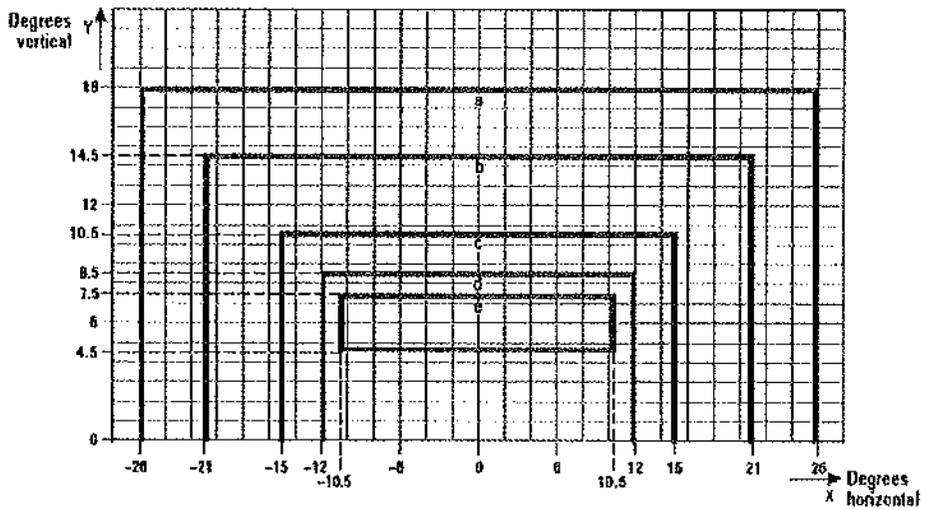


Figure S5-16. Isocandela diagram for taxiway centre line (7.5 m, 15 m, 30 m spacing), no-entry bar and stop bar lights in curved sections intended for use in runway visual range conditions of 350 m or greater

Notes to figure S5-16:

- (a) Lights on curves to be toed-in 15.75 degrees with respect to the tangent of the curve.
- (b) At locations where high background luminance is usual and where deterioration of light output resulting from dust, snow and local contamination is a significant factor, the cd- values should be multiplied by 2.5.
- (c) These beam coverages allow for displacement of the cockpit from the centre line up to distances of the order of 12 m as could occur at the end of curves.
- (d) See collective notes for Figures S5-12 to S5-21.

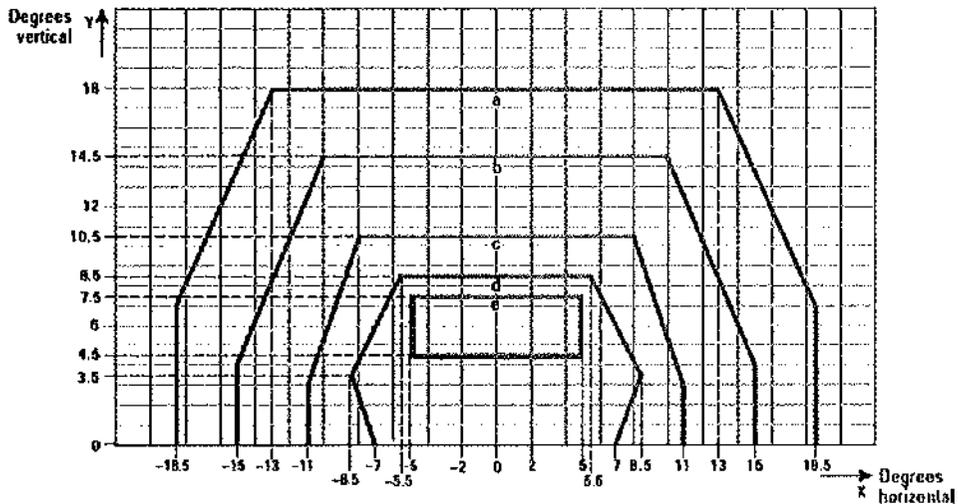


Curve	a	b	c	d	e
Intensity (cd)	8	20	100	450	1800

Figure S5-17. Isocandela diagram for high-intensity taxiway centre line (15 m spacing) 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

Notes to figure S5-17:

- (a) These beam coverages allow for displacement of the cockpit from the centre line up to distances of the order of 12 m and are intended for use before and after curves.
- (b) See collective notes for Figures S5-12 to S5-21.
- (c) Figure S5-17. Isocandela diagram for high-intensity taxiway centre line (15 m spacing), no-entry bar and stop bar lights in straight sections intended for use in an advanced surface movement guidance and control system where higher light intensities are required and where large offsets can occur.

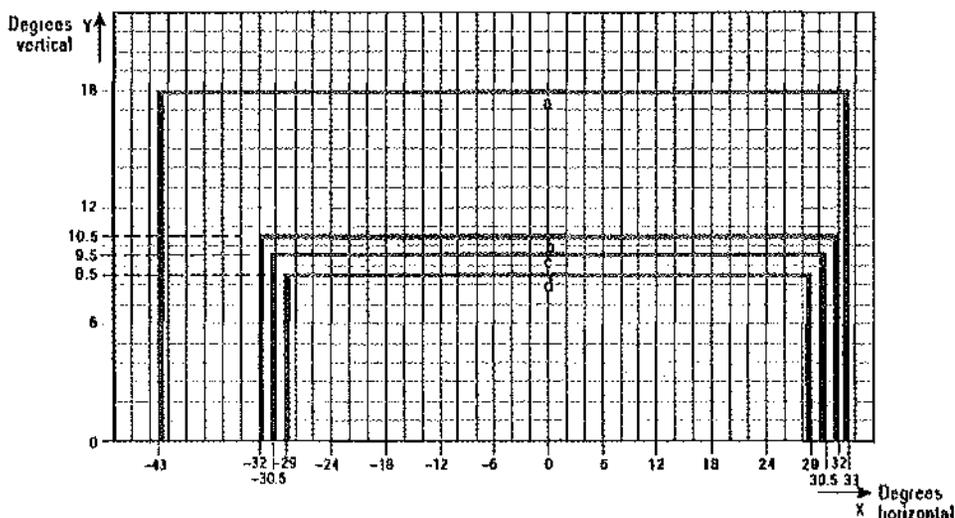


Curve	a	b	c	d	e
Intensity (cd)	8	20	100	450	1800

Figure S5-18. Isocandela diagram for high-intensity taxiway centre line (15 m spacing) 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

Notes to figure S5-18:

- (a) 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.
- (b) See collective notes for Figures S5-12 to S5-21
- (c) Figure S5-18. Isocandela diagram for high-intensity taxiway centre line (15 m spacing), no-entry bar and stop bar lights in straight sections intended for use in an advanced surface movement guidance and control system where higher light intensities are required.



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

Figure S5-19. Isocandela diagram for high-intensity taxiway centre line (7.5 m spacing) 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 to S5-19:

- (a) Lights on curves to be toed-in 17 degrees with respect to the tangent of the curve.
- (b) See collective notes for Figures S5-12 to S5-21.
- (c) Figure S5-19. Isocandela diagram for high-intensity taxiway centre line (7.5 m spacing), no-entry bar and stop bar lights in curved sections intended for use in an advanced surface movement guidance and control system where higher light intensities are required

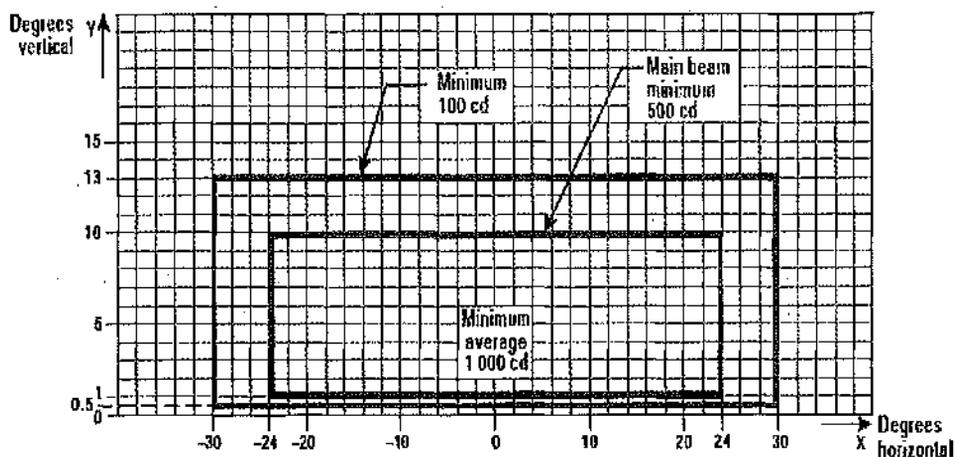


Figure S5-20. Isocandela diagram for high-intensity runway guard lights, Configuration B

Notes to figure S5-20:

- (a) Although the lights flash in normal operation, the light intensity is specified as if the lights were fixed for incandescent lamps.
- (b) See collective notes for Figures S5-12 to S5-21.

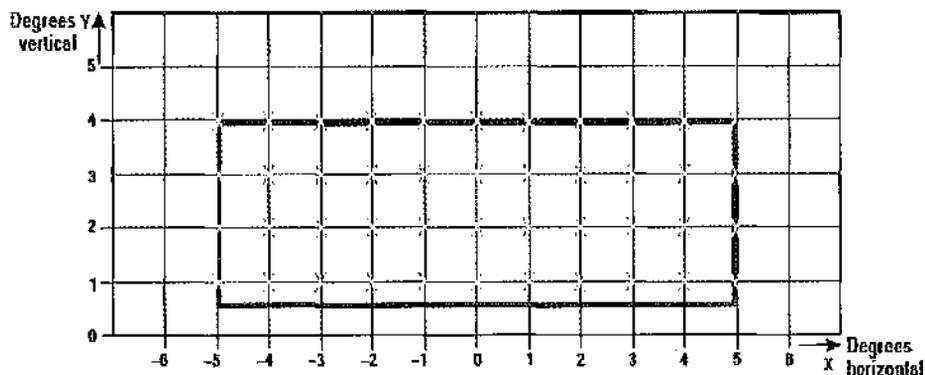


Figure S5-21. Grid points to be used for calculation of average intensity of taxiway centre line and stop bar lights

Collective notes to Figures S5-12 to S5-21

- (a) The intensities specified in Figures S5-12 to S5-20 are in green and yellow light for taxiway centre line lights, yellow light for runway guard lights and red light for stop bar lights.

- (b) Figures S5-12 to S5-20 show the minimum allowable light intensities. The average intensity of the main beam is calculated by establishing grid points as shown in Figure S5-21 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.
- (c) No deviations are acceptable in the main beam or in the innermost beam, as applicable, when the lighting fixture is properly aimed.
- (d) Horizontal angles are measured with respect to the vertical plane through the taxiway centre line except on curves where they are measured with respect to the tangent to the curve.
- (e) Vertical angles are measured from the longitudinal slope of the taxiway surface.
- (f) The importance of adequate maintenance cannot be overemphasized. The intensity, either average where applicable or as specified on the corresponding isocandela curves, should never fall to a value less than 50 per cent of the value shown in the figures, and it should be the aim of airport authorities to maintain a level of light output close to the specified minimum average intensity.
- (g) 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.

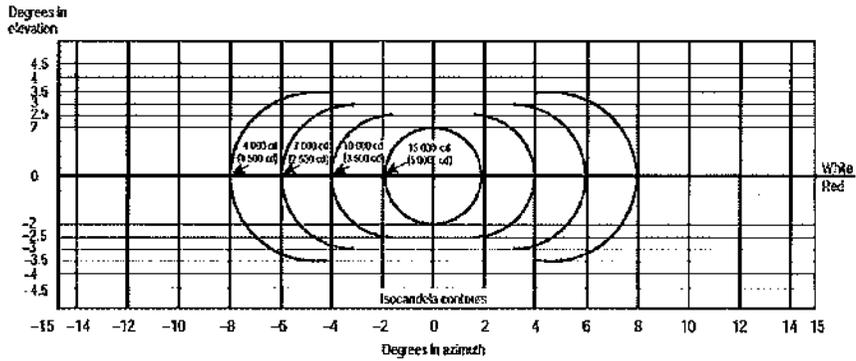


Figure S5-23. Light intensity distribution of PAPI and APAPI

Notes to figure S5-23:

- (a) These curves are for minimum intensities in red light.
- (b) 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.
- (c) The intensity values shown in brackets are for APAPI.

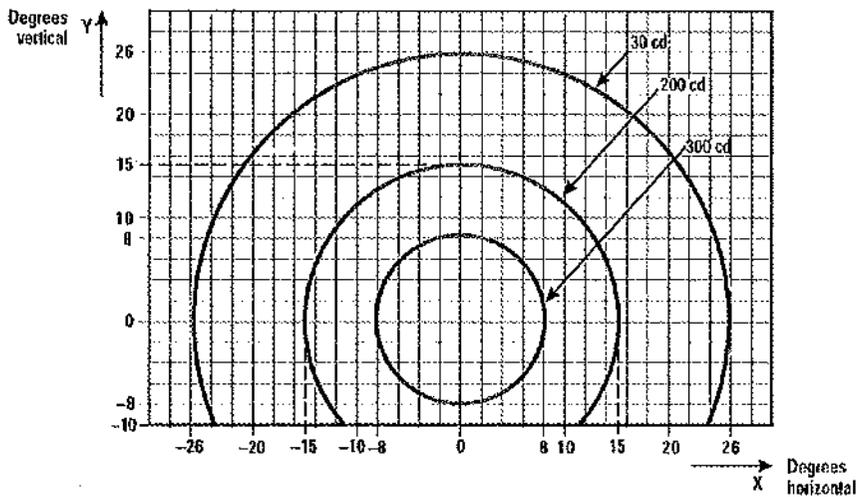


Figure S5-24. Isocandela diagram for each light in low-intensity runway guard lights, Configuration A

Notes to figure S5-24:

- (a) Although the lights flash in normal operation, the light intensity is specified as if the lights were fixed for incandescent lamps.
- (b) The intensities specified are in yellow light.

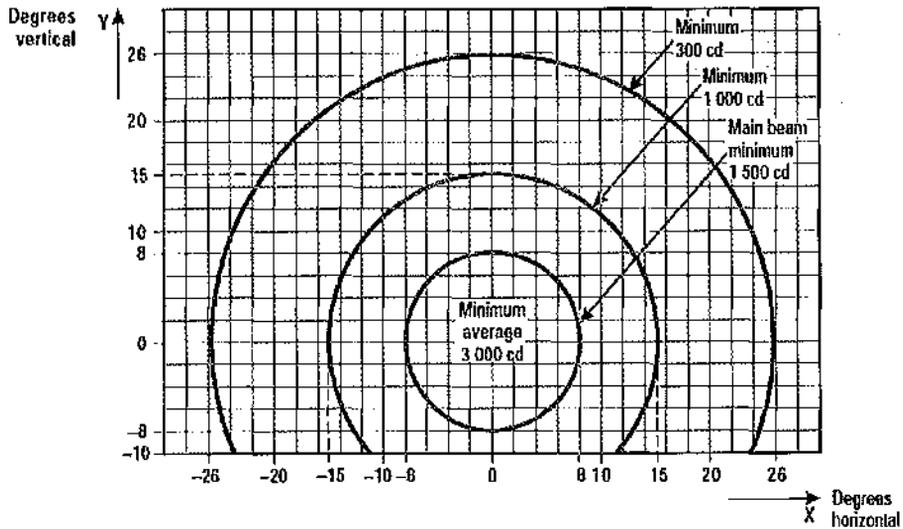


Figure S5-25. Isocandela diagram for each light in high-intensity runway guard lights, Configuration A

Notes to figure S5-24:

- (a) Although the lights flash in normal operation, the light intensity is specified as if the lights were fixed for incandescent lamps.
- (b) The intensities specified are in yellow light.

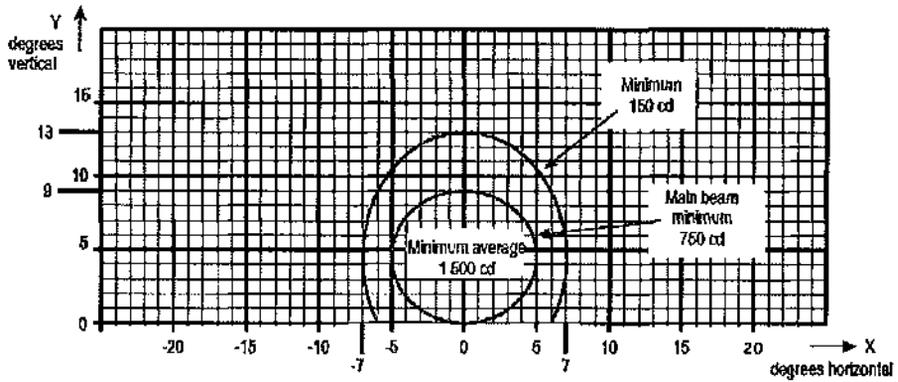


Figure S5-26. Isocandela diagram for take-off and hold lights (THL) (red light)

Notes to figure S5-9

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

a	5.0	7.0
b	4.5	8.5

- (2) See collective notes for Figures S7-1 to S7-11 and S7-26.

SCHEDULE 6

(reg. 119)

MANDATORY INSTRUCTION MARKINGS AND INFORMATION MARKINGS

Note 1. — See regulations 119 and 120 for specifications on the application, location and characteristics of mandatory instruction markings and information markings.

Note 2. — This schedule details the form and proportions of the letters, numbers and symbols of mandatory instruction markings and information markings on a 20 cm grid.

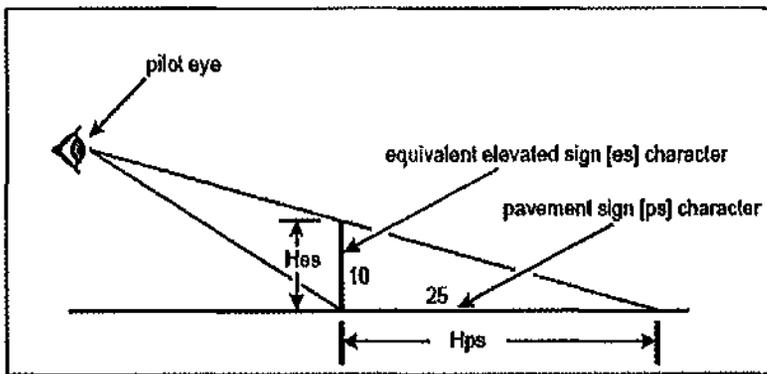
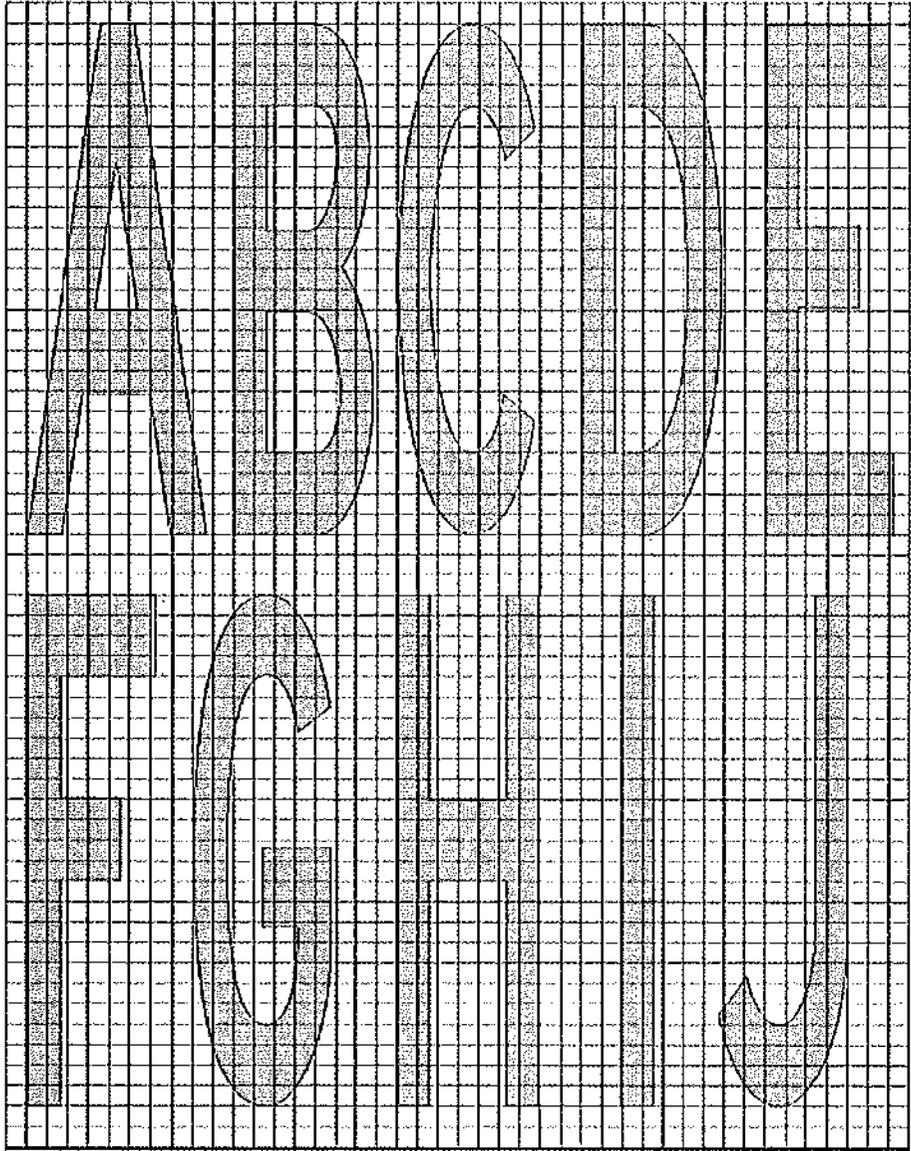
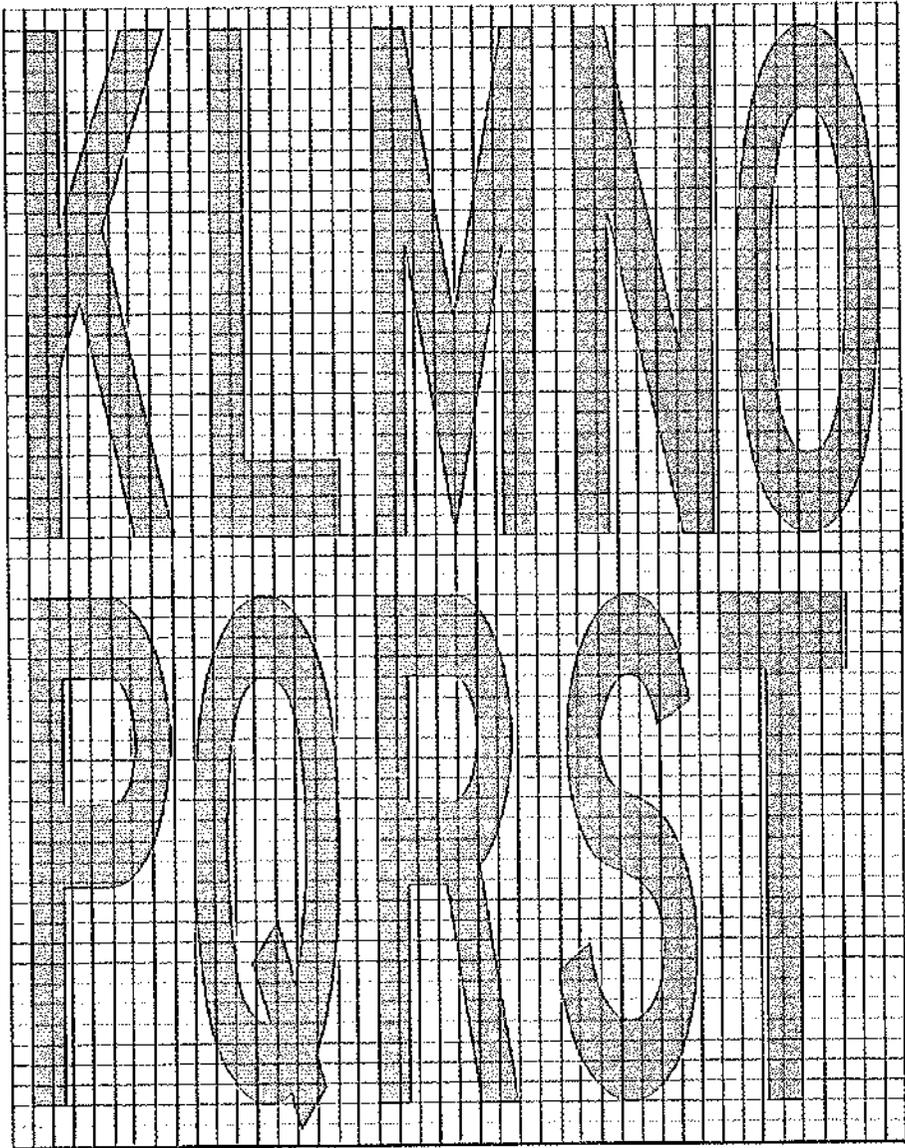
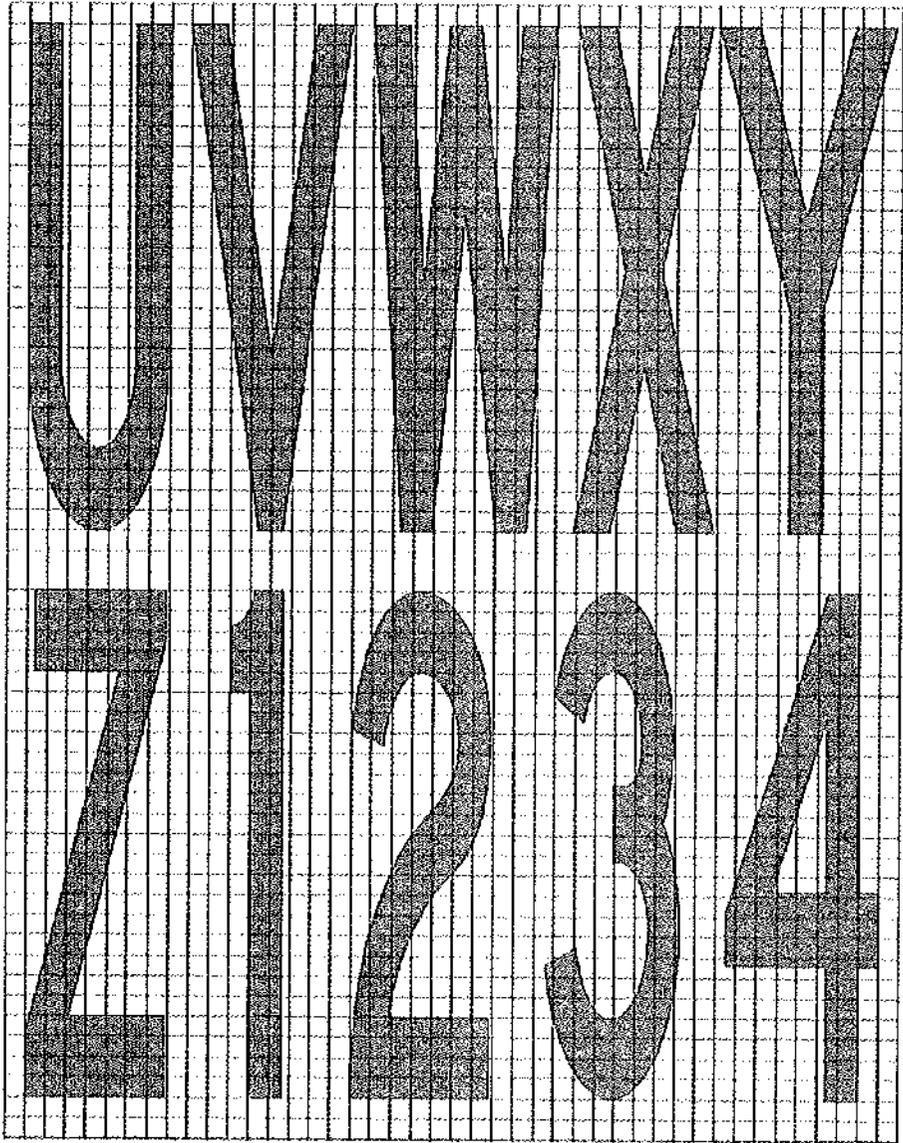


Figure S6-1









SCHEDULE 7

(reg. 169 (4), (6), (7))

Requirements Concerning Design of Taxiing Guidance Signs

- Inscription heights shall conform to the table S7-1 below.

Table S7-1. Inscription heights for marking

Runway code number	Minimum character height		
	Mandatory instruction sign	Information sign Runway and exit and runway vacated signs	Other signs
1 or 2	300 mm	300mm	200mm
3 or 4	400 mm	400mm	300mm

Note. — Where a taxiway location sign is installed in conjunction with a runway designation sign (see Regulation 182) the character size shall be that specified for mandatory instruction signs.

- Arrow dimensions shall be as follows:

Legend height	Stroke
200 mm	32 mm
300 mm	48 mm
400 mm	64 mm

- Stroke width for single letter shall be as follows:

Legend height	Stroke
200 mm	32 mm
300 mm	48 mm
400 mm	64 mm

- Sign luminance shall be as follows:

- Where operations are conducted in runway visual range conditions less than a value of 800m, average sign luminance shall be at least:

Red	30 cd/m ²
Yellow	150 cd/m ²
White	300 cd/m ²

- Where operations are conducted in accordance with regulation 197 average sign luminance shall be at least:

Red	10 cd/m ²
Yellow	50 cd/m ²
White	100 cd/m ²

Note. — in runway visual range conditions less than a value of 400 m, there will be some degradation in the performance of signs.

1. The luminance ratio between red and white elements of a mandatory sign shall be between 1:5 and 1:10.
2. The average luminance of the sign is calculated by establishing grid points as shown in Figure S5-1 and using the luminance values measured at all grid points located within the rectangle representing the sign.
3. The average value is the arithmetic average of the luminance values measured at all considered grid points.

The Authority has provided guidance on measuring the average luminance of a sign.

1. 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.
2. The forms of characters, i.e. letters, numbers, arrows and symbols, shall conform to those shown in Figure S5-2. The width of characters and the space between individual characters shall be determined as indicated in Table S5-2 in the Schedule 5 to these regulations.
3. The face height of signs shall be as follows:

<i>Legend height</i>	<i>Face height (min)</i>
200 mm	300 mm
300 mm	450 mm
400 mm	600 mm

4. The face width of signs shall be determined using Figure S7-3 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.

The Authority has provided additional guidance on determining the face width of a sign.

1. Borders

- 1.1 The black vertical delineator between adjacent direction signs shall have a width of approximately 0.7 of the stroke width.
- 1.2 The yellow border on a stand-alone location sign shall be approximately 0.5 stroke width.
- 1.3 The colours of signs shall be in accordance with the appropriate specifications in Schedule 4 to these regulations.

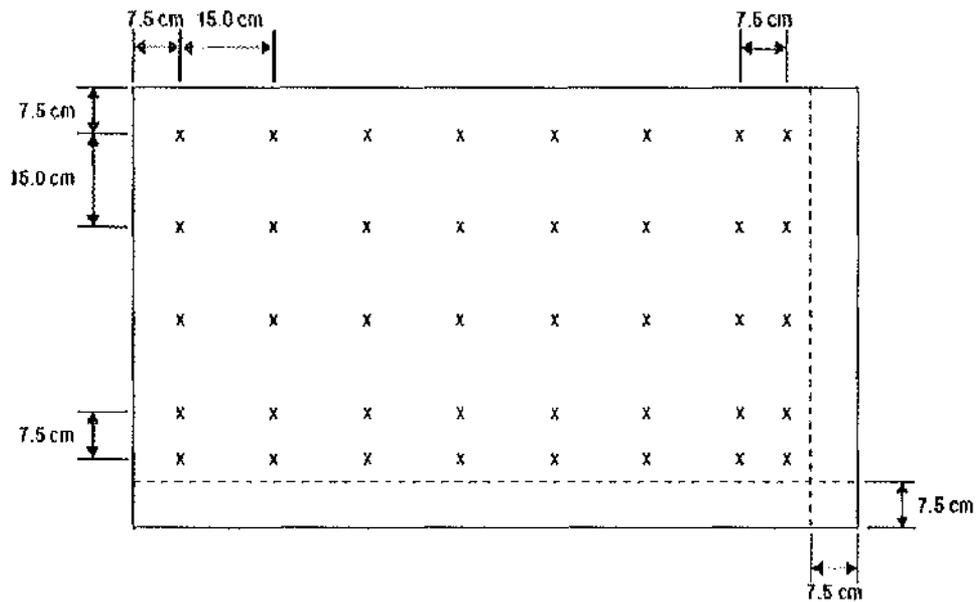


Figure S7-1. Grid points for calculating average luminance of a sign

Notes to figure S7-1]

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 colour (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; and
- (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.

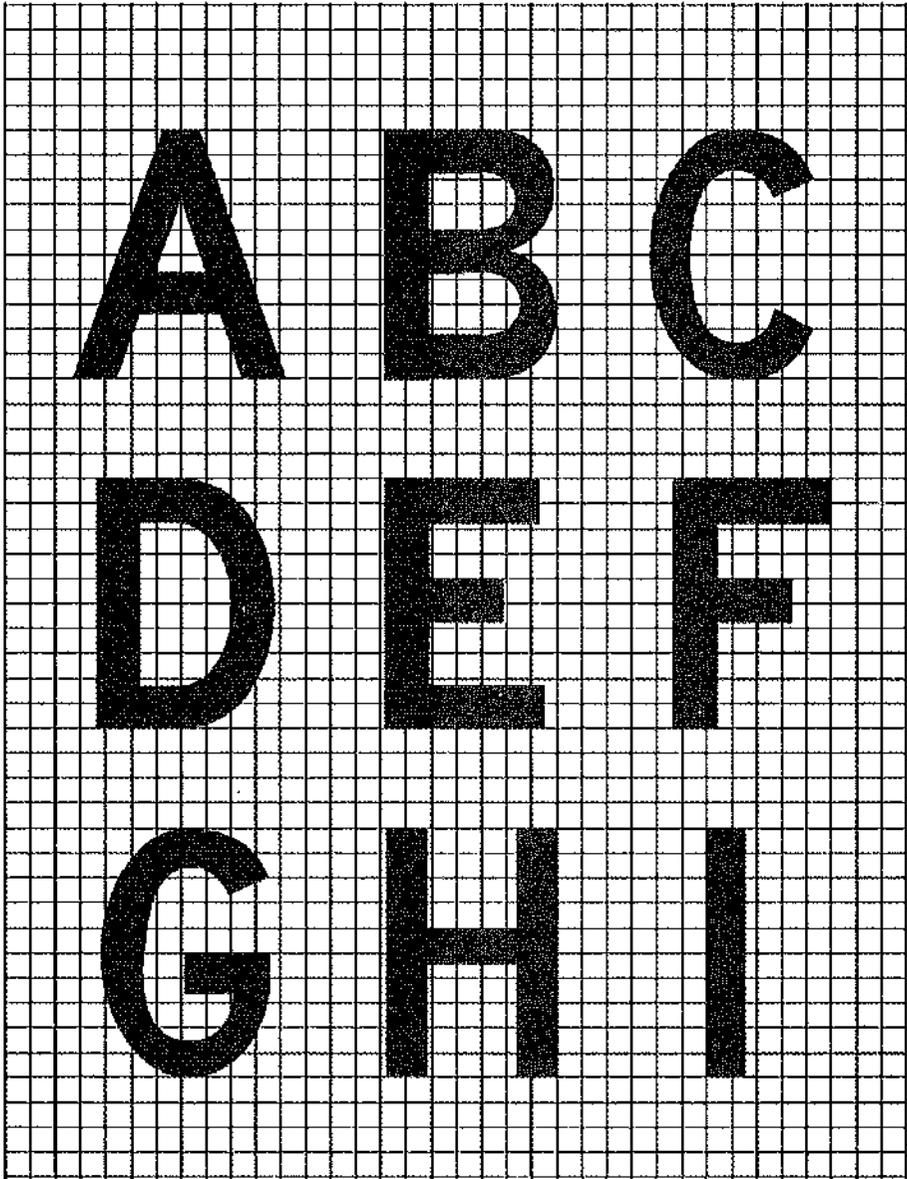


Figure S7-2. Forms of characters

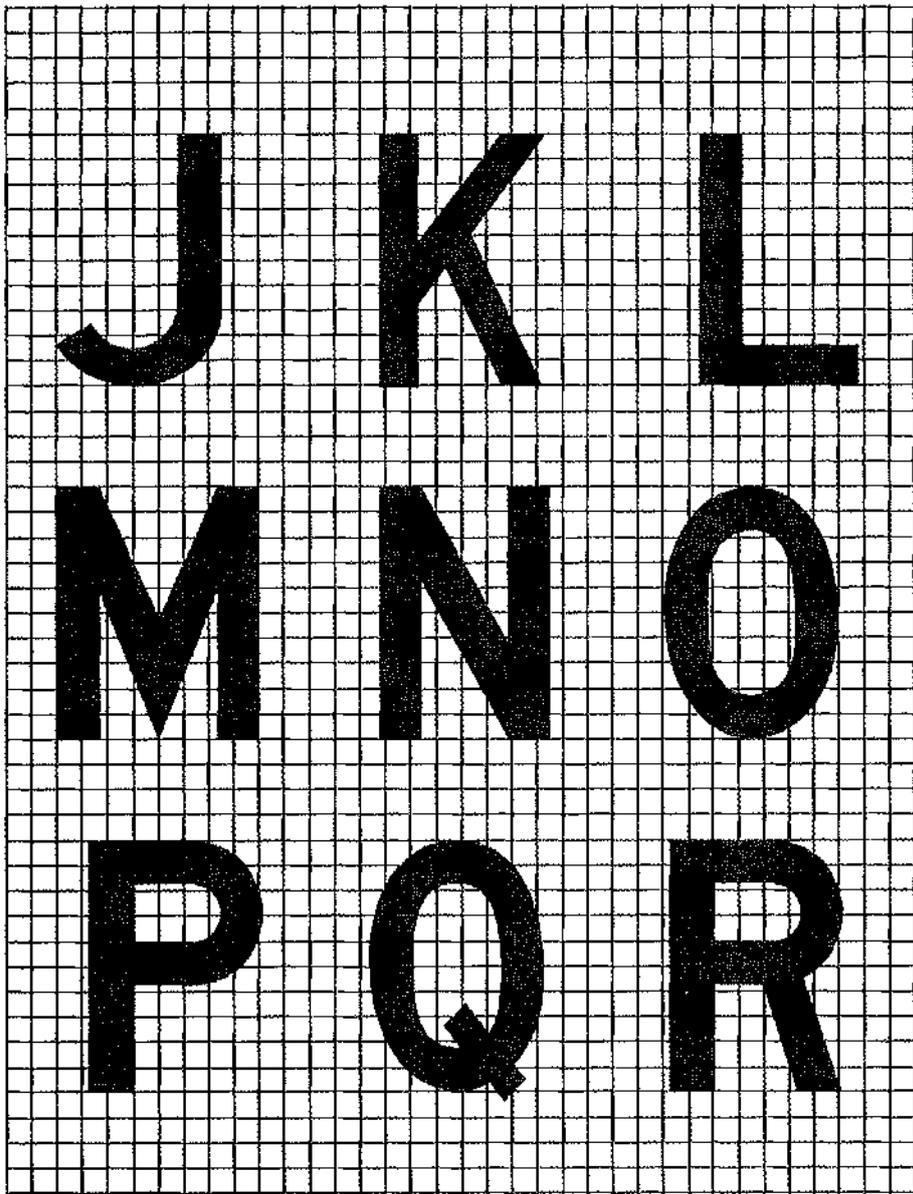


Figure S7-2. (cont.)

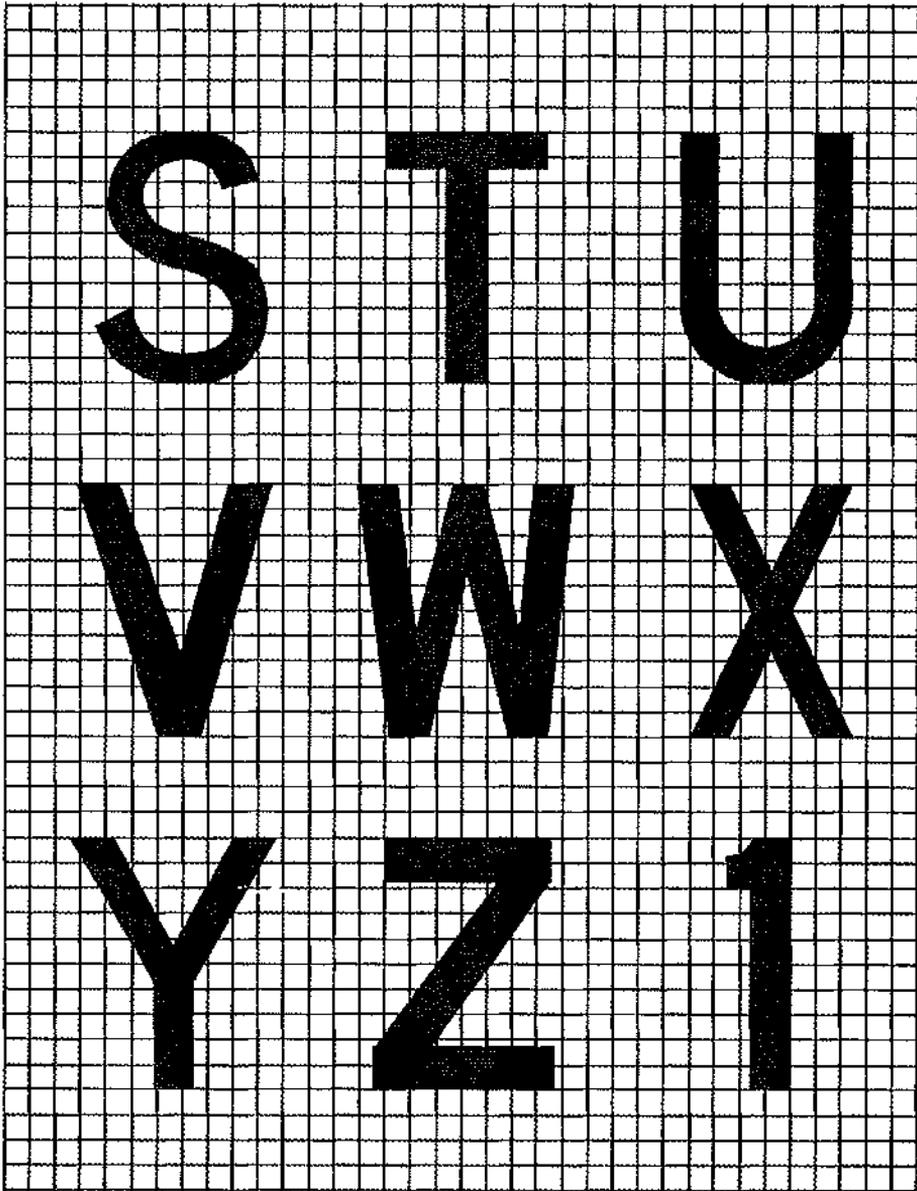


Figure S7-2. (cont.)

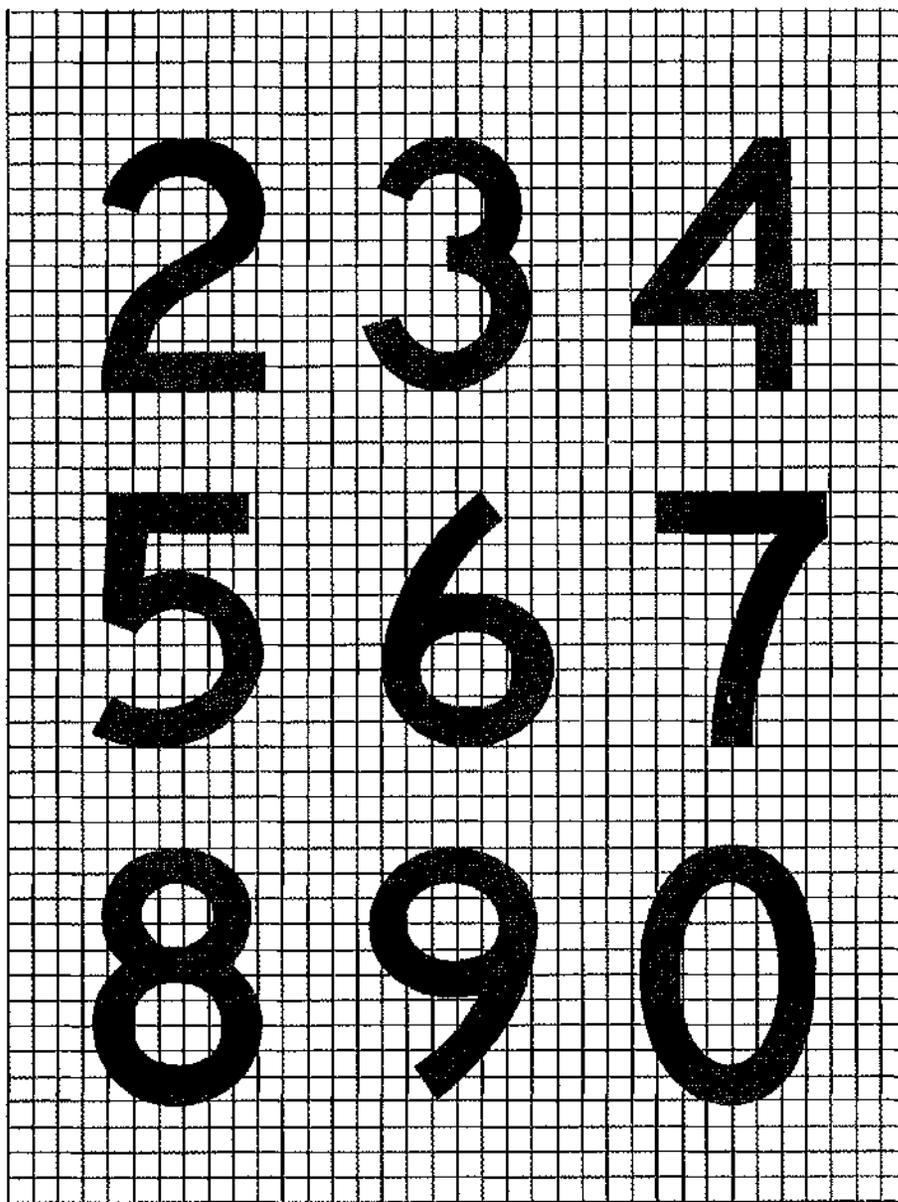


Figure S7-2. (cont.)

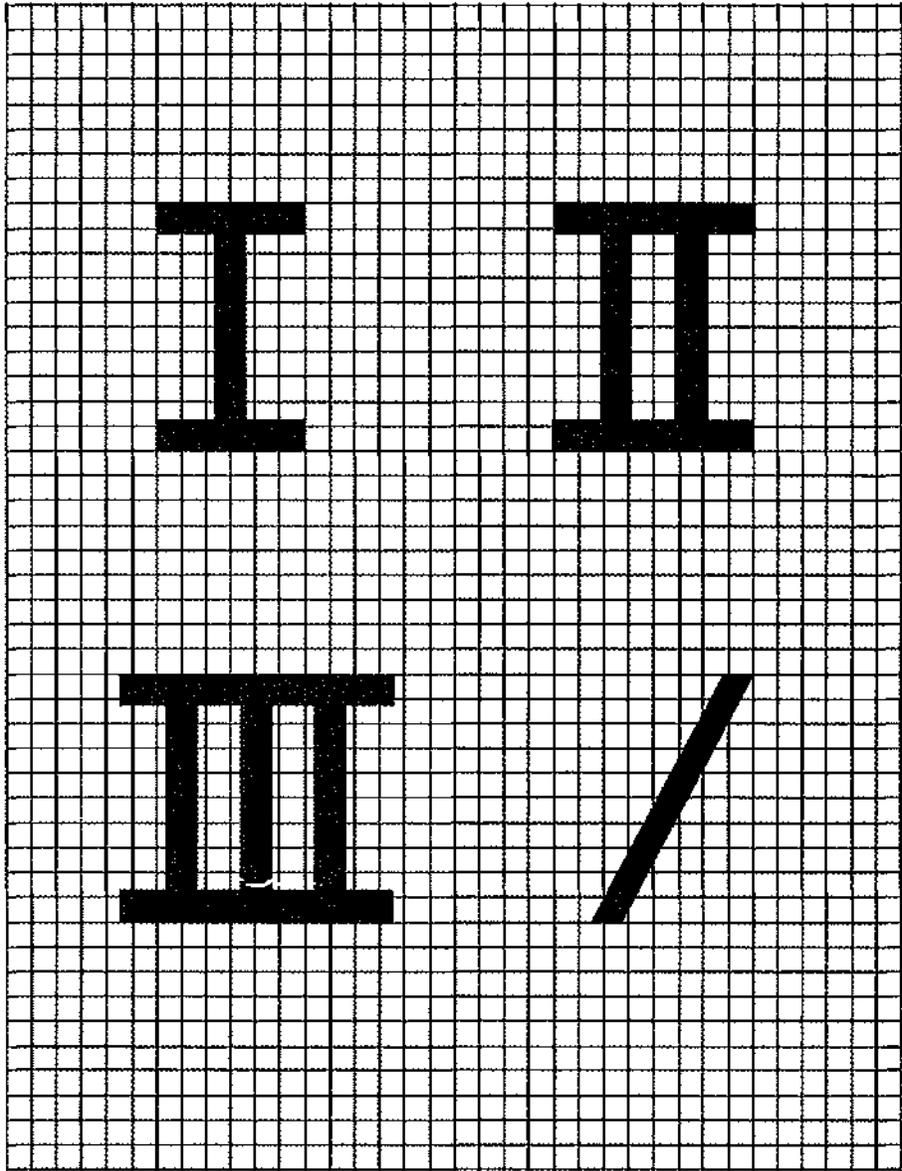
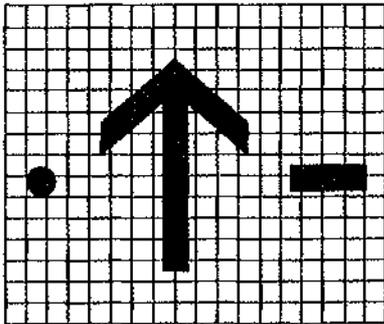


Figure S7-2. (cont.)

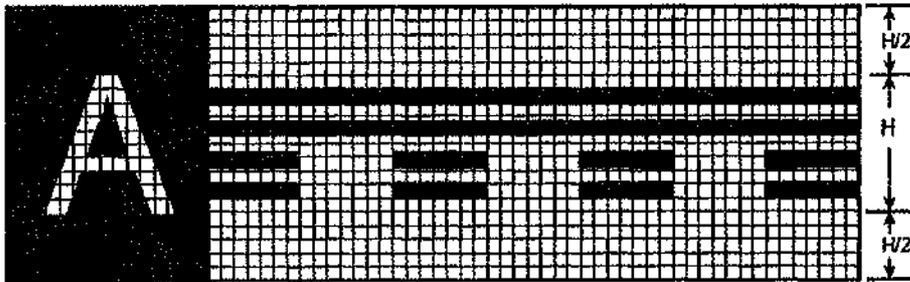


Note 1.—The arrow stroke width, diameter of the dot, and both width and length of the dash shall be proportioned to the character stroke widths.

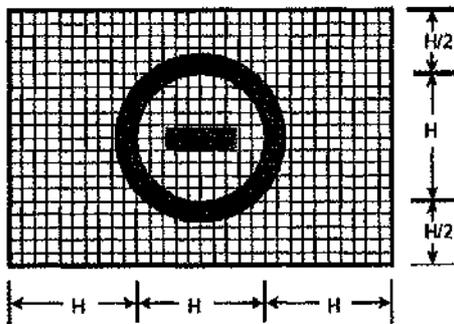
Note 2.—The dimensions of the arrow shall remain constant for a particular sign size, regardless of orientation.

Arrow, dot and dash

Figure S7-2. (cont.)



Runway vacated sign (with typical location sign)



NO ENTRY sign

Figure S7-3. Runway vacated and NO ENTRY signs

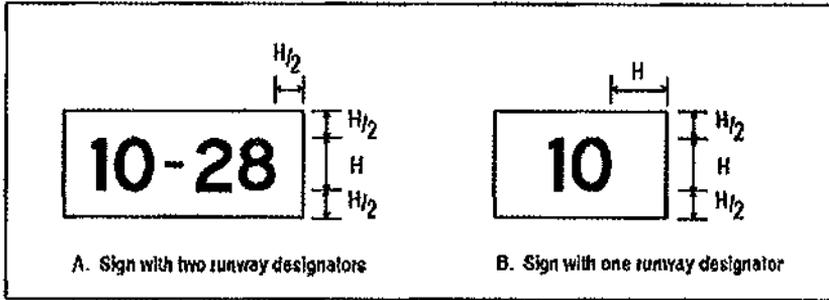


Figure S7-4. Sign dimensions

Table S7-2. Letter and numeral widths and space between letters or numerals

a) Letter to letter code number			
Preceding Letter	Following Letter		
	B, D, F, F, H, J, K, L, M, N, P, R, U	C, G, O, Q, S, X, Z	A, I, T, V, W, Y
Code number			
A	2	2	4
B	1	2	2
C	2	2	1
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

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
3	1	2	2
4	2	2	4
5	1	2	2
6	1	2	2
7	2	2	4
8	1	2	2
9	1	2	2
0	1	2	2

c) Space between characters			
Code No.	Character height (mm)		
	200	300	400
Space (mm)			
1	48	71	98
2	38	57	78
3	25	38	50
4	13	19	26

d) Width of letter			
Letter	Letter height (mm)		
	200	300	400
Width (mm)			
A	170	265	340
B	137	205	274
C	137	205	274
D	137	205	274
E	124	188	248
F	124	188	248
G	137	205	274
H	137	205	274
I	32	49	64
J	127	193	254
K	140	210	280
L	124	188	248
M	157	238	314
N	137	205	274
O	143	214	285
P	137	205	274
Q	143	214	286
R	137	205	274
S	137	205	274
T	124	188	248
U	137	205	274
V	162	229	304
W	178	267	358
X	137	205	274
Y	171	257	342
Z	137	205	274

e) Width of numeral			
Numeral	Numeral height (mm)		
	200	300	400
Width (mm)			
1	60	74	98
2	137	205	274
3	137	205	274
4	140	224	298
5	137	205	274
6	137	205	274
7	137	205	274
8	137	205	274
9	137	205	274
0	143	214	286

INSTRUCTIONS

- 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.
- The space between words or groups of characters forming an abbreviation or symbol should 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.
- Where the numeral follows a letter or vice versa use Code 1.
- Where a hyphen, dot, or diagonal stroke follows a character or vice versa use Code 1.
- For the intersection take-off sign, the height of the lower case 'm' is 0.75 of the height of the preceding 'U' (zero) and spaced from the preceding 'U' at code 1 for the character height of the numerals.

SCHEDULE 8
(reg. 186 (7), 190 (5), 191 (8), 192 (9))

LOCATION OF LIGHTS ON OBSTACLES

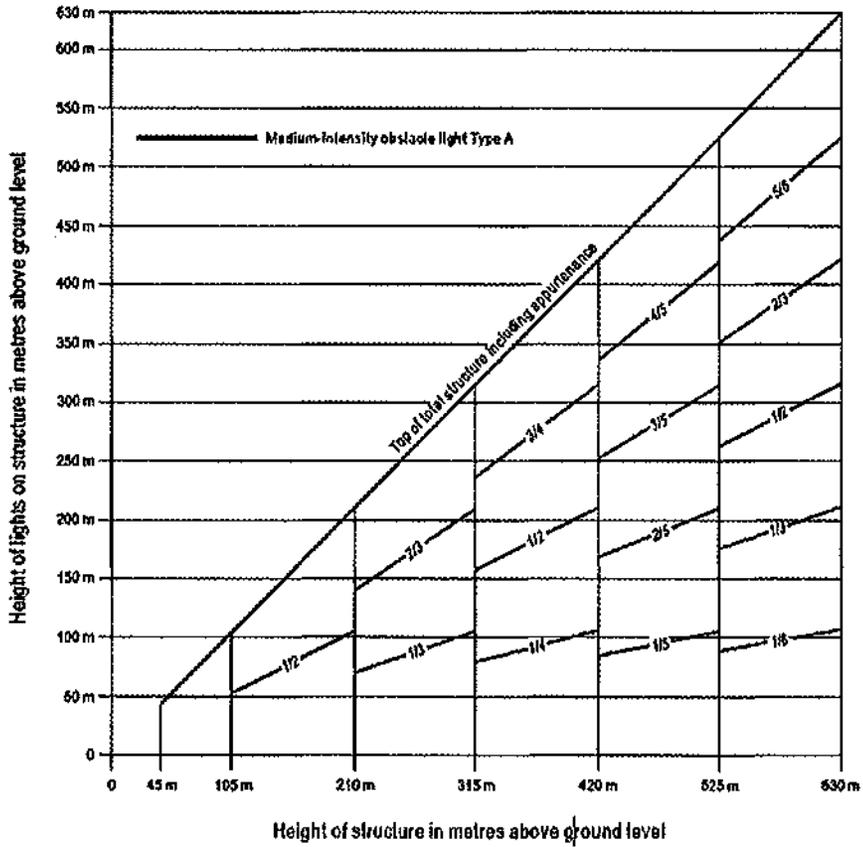


Figure S8-1. Medium-intensity flashing-white obstacle lighting system, Type A.

Note to figure S8-1. — 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.

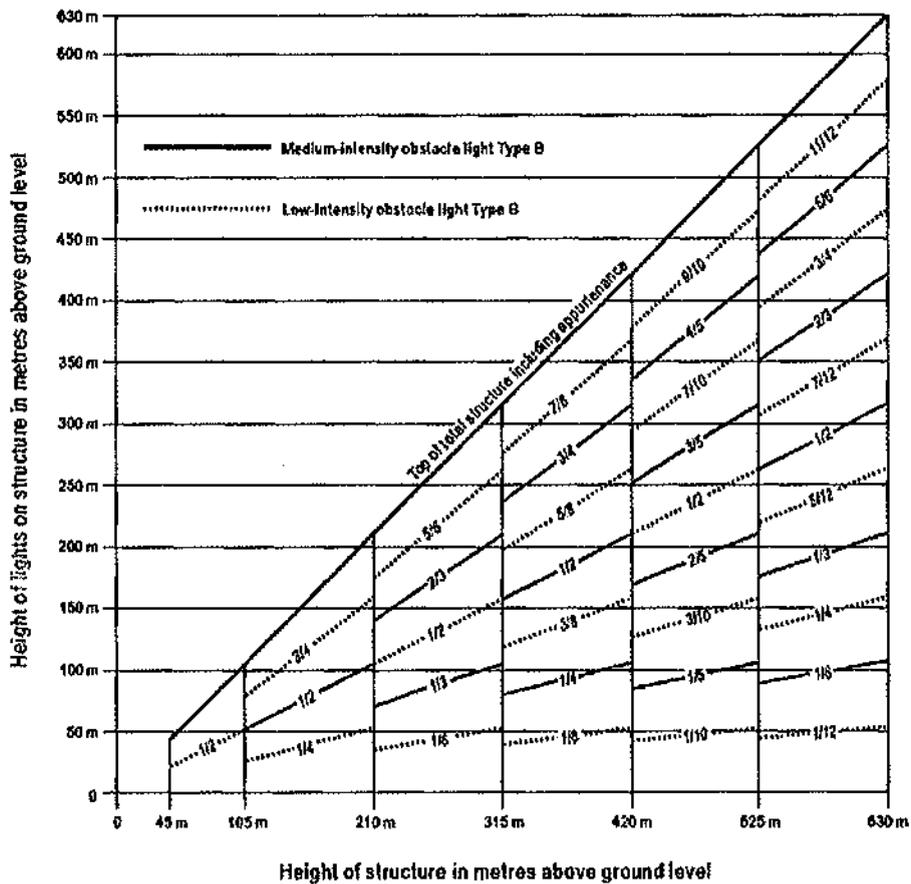


Figure S8-2. Medium-intensity flashing-red obstacle lighting system, Type B

Note to figure S8-2. — For night-time use only.

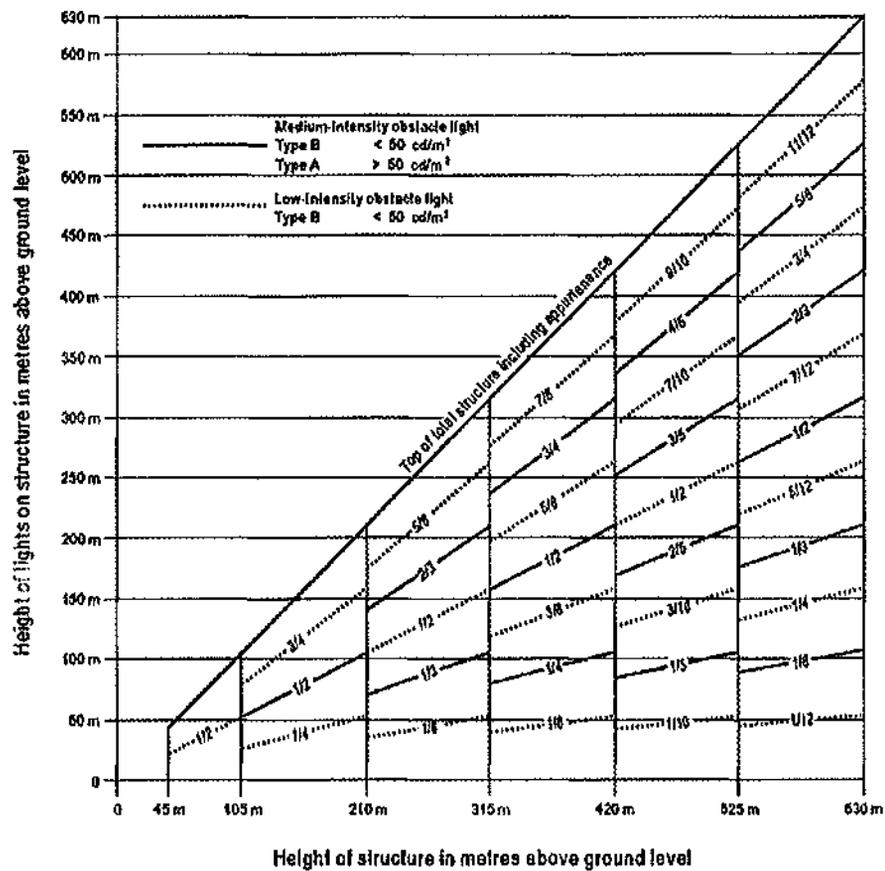


Figure S8-4. Medium-intensity dual obstacle lighting system, Type A/Type B

Note to figure S8-4 — 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.

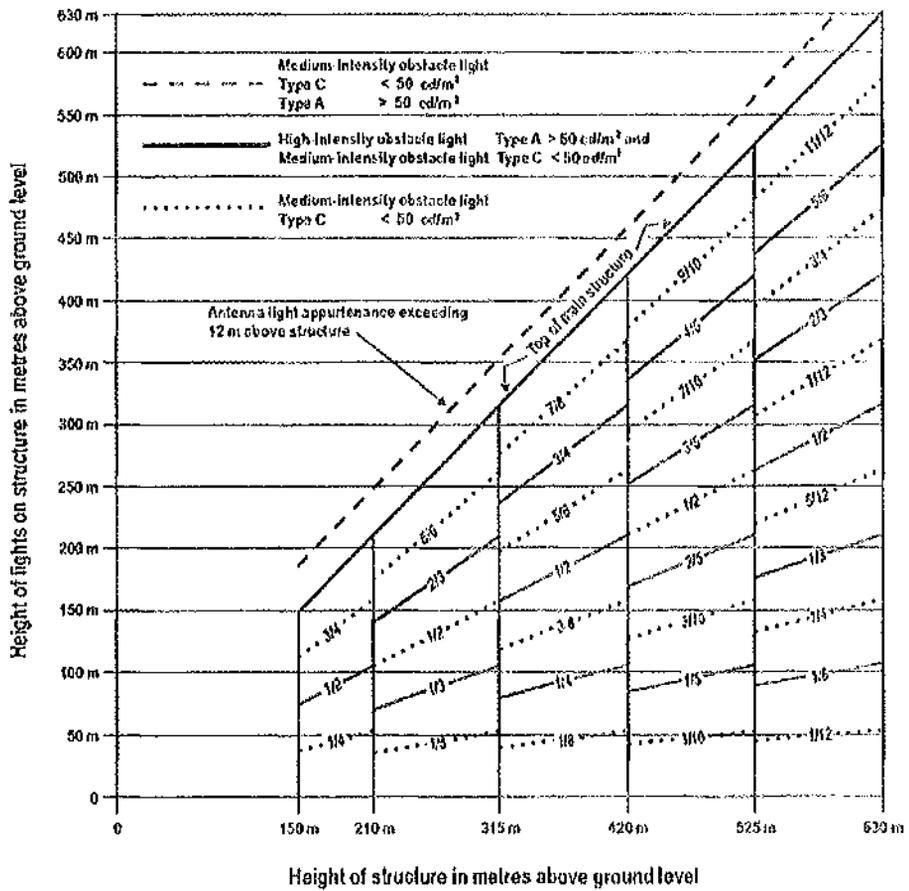


Figure S8-3. High-/medium-intensity dual obstacle lighting system, Type A/Type C

SCHEDULE 9
(reg. 257 (6), and (7))

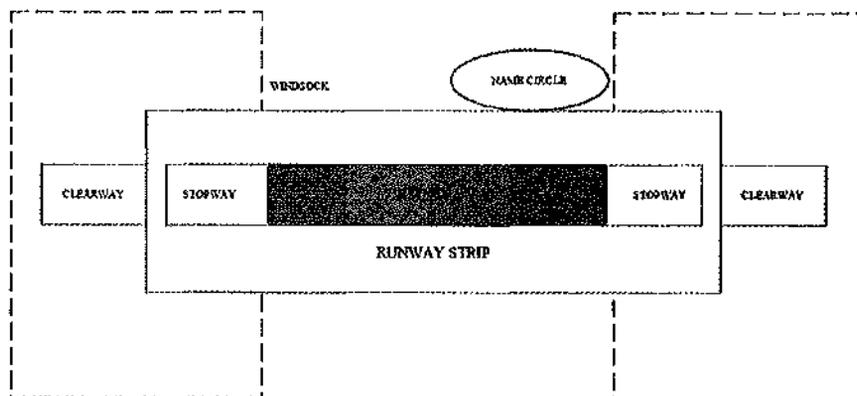


Figure S9-1. Aerodrome layout plan

NOTES to figure S9-1:

- Clearway:** A defined rectangular area at the end of the runway selected or prepared as a suitable area over which an aircraft may take a portion of its initial climb after take-off to a specified height.
- Stopway:** A defined rectangular area on the ground at the end of a runway prepared as a suitable area in which an aircraft can be stopped without danger to aircraft in the event of an aborted take-off.
- Strip:** A defined area including the runway and stopway, if provided.
- Obstruction:** Any object or feature, whether natural or man-made, which by reason of its height or position may endanger the safety of aircraft

MADE this 13th day of June, 2022.

ERIC MOTHIBI MOLALE,
Minister of Transport and Public Works.