RA 3511 - Permanent Fixed Wing Aerodrome - Physical Characteristics

Rationale

The physical characteristics of an aerodrome are defined to reduce the Risk to Life (RtL) associated with an Air System transiting over, when taking-off and landing or when taxiing around the aerodrome. The characteristics are also designed to reduce RtL during an incident or accident scenario; to enable safe use by rescue and firefighting vehicles; when loading, and unloading passengers, crew and cargo; and when servicing Air Systems.

Contents

Regulation 3511(1)

Pavement - Characteristics

3511(1) Heads of Establishments (HoEs) and Aviation Duty Holder-Facing Organizations (ADH-Facing Organizations) **shall** ensure that the Pavements at their aerodrome are sufficient, in terms of Bearing strength, Overload operations, friction levels and surface evenness, to cope with the continual use of the Air System for which the aerodrome is intended to serve.

Acceptable Means of Compliance 3511(1)

Pavement – Characteristics

Bearing Strength.

1. The bearing strength of a pavement, including the runway, intended for Air Systems of All Up Mass (AUM) greater than 5700 kg **should** be made available using the Aircraft Classification Number - Pavement Classification Number (ACN-PCN) method by reporting all the following information:

   a. The Pavement Classification Number (PCN);

   b. Pavement type for ACN-PCN determination;

   c. Subgrade strength category;

   d. Maximum allowable tyre pressure category or maximum allowable tyre pressure value; and

   e. Evaluation method.

2. For the purposes of determining the Aircraft Classification Number (ACN), the behaviour of a pavement **should** be classified as equivalent to a rigid or flexible construction.

3. Information on pavement type for ACN-PCN determination, subgrade strength category, maximum allowable tyre pressure category and evaluation method **should** be reported using the codes from Table 1.

4. The bearing strength of a pavement intended for Air Systems of AUM equal to or less than 5700 kg **should** be made available by reporting the following information:

   a. Maximum allowable Air System mass; and

   b. Maximum allowable tyre pressure.

Acceptable Means of Compliance 3511(1)

Table 1. PCN Reporting

Part	Description	Remarks
1	PCN	ACN max at appropriate subgrade category
2	Pavement type	Rigid Flexible
3	Pavement subgrade category	A = High B = Medium C = Low D = Ultra Low
4	Tyre pressure max authorized	1.5 MPa (217psi) < W (high) 1.0 MPa (145psi) < X (medium) ≤ 1.5 MPa (217 psi) 0.5 MPa (73 psi) < Y (low) ≤ 1.0 MPa (145 psi) Z (very low) ≤ 0.5 MPa (73 psi)
5	Pavement design method	T = Technical design or evaluation U = By experience of Air Systems using the pavement

Overload Operations.

5. Overload operations **should** only be permitted by the Aerodrome Operator having considered the criteria contained in the Defence Infrastructure Organization (DIO) publication 'A Guide to Airfield Pavement Design and Evaluation' (3rd Edn 2011)[1].

Friction Levels.

6. The surface of a taxiway **should** be constructed or resurfaced to provide suitable surface friction characteristics in accordance with (iaw) International Civil Aviation Organization (ICAO) Annex 14 Vol I Attachment A, section 7.

Surface Evenness.

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

8. Maximum surface irregularities **should** be no more than those shown in Table 2.

Table 2. Surface Evenness

	Minimum acceptable length of irregularity (m)								
Surface irregularity	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

Guidance Material 3511(1)

Pavement – Characteristics

9. Whilst the above considerations are important for all Air System movement areas, they are most critical for runways.

10. Detailed descriptions of the ACN-PCN method are given in the ICAO DOC 9157 Aerodrome Design Manual, Part 3 (2nd Edn 1983) and in the DIO publication 'A Guide to Airfield Pavement Design and Evaluation' (3rd Edn 2011).

11. Subgrade Strength Category Decode:

[1]Refer to RA 3500 - Aerodrome Design and Safeguarding for contact details.

Guidance Material 3511(1)

a. Code A - High Strength: K = 150 MN/m³ and representing all K values above 120 MN/m³ for rigid pavements, and by California Bearing Ratio (CBR) = 15 and representing all CBR values above 13 for flexible pavements.

b. Code B - Medium Strength: K = 80 MN/m³ and representing a range in K of 60 to 120 MN/m³ for rigid pavements, and by CBR = 10 and representing a range in CBR of 8 to 13 for flexible pavements.

c. Code C - Low Strength: K = 40 MN/m³ and representing a range in K of 25 to 60 MN/m³ for rigid pavements, and by CBR = 6 and representing a range in CBR of 4 to 8 for flexible pavements.

d. Code D - Ultra Low Strength: 20 MN/m³ and representing all K values below 25 MN/m³ for rigid pavements, and by CBR = 3 and representing all CBR values below 4 for flexible pavements.

12. Unless a pavement is subject to extreme overloading it is unlikely to fail suddenly or catastrophically. Regular overload operations can substantially reduce the design life of the pavement. Advice can be sought from MOD DIO Pavement specialists.

Civil Equivalence.

13. This regulation is in line with ICAO Annex 14 Vol I para 2.6.1 – 2.6.8 and Attachment A.

Regulation 3511(2)

Runway - Number, Siting and Orientation

3511(2) HoEs and ADH-Facing Organizations **shall** ensure that the number, siting and orientation of runways are such that the usability factor of the aerodrome is optimised considering that safety **shall not** be compromised.

Acceptable Means of Compliance 3511(2)

Runway - Number, Siting and Orientation

14. The number, siting and orientation of runways **should** be such that the usability factor of the aerodrome would be not less than 95% for the Air System that the aerodrome is intended to serve.

Guidance Material 3511(2)

Runway - Number, Siting and Orientation

15. Factors affecting the determination of the orientation, siting, and number of runways include:

a. The wind distribution (to minimise crosswinds liable to affect runways);

(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 on the assumed distribution of observations within these ranges.

(2) The maximum mean crosswind components for the designed Air System, refer to normal circumstances. There are some factors which may require that a reduction of those maximum values be considered 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 Air System (including future types).

(b) Prevalence and nature of gusts.

(c) Prevalence and nature of turbulence.

(d) The availability of a secondary runway.

(e) The width of runways.

Guidance Material 3511(2)

(f) The runway surface conditions - water, snow, and ice on the runway materially reduce the allowable crosswind component.

(g) The strength of the wind associated with the limiting crosswind component.

b. The need to facilitate the provision of approaches conforming to the approach surface specifications, ensuring that obstacles in these areas or other factors do not restrict the operation of the Air System for which the runway is intended. This may relate to individual obstacles or local geography (eg high ground).

c. The need to minimise interference with areas approved for residential use and other noise-sensitive areas close to the aerodrome.

d. The need to avoid the turbulence impacts of buildings on or close to the aerodrome.

e. Topography of the aerodrome site, its approaches and surroundings, particularly:

(1) Compliance with the Obstacle Limitation Surfaces (OLS).

(2) Current and future land use. The orientation and layout may be selected to protect, as far as possible, the particularly sensitive areas, such as residential, school and hospital zones, from the discomfort caused by Air System noise. Detailed information on this topic is provided in the ICAO Doc 9184, Airport Planning Manual, Part 2, Land Use and Environmental Management and in ICAO Doc 9829, Guidance on the Balanced Approach to Aircraft Noise Management;

(3) Current and future runway lengths to be provided;

(4) Construction costs; and

(5) Possibility of installing suitable non-visual and visual aids for approach-to-land.

f. Air traffic in the vicinity of the aerodrome, particularly:

(1) Proximity of other aerodromes or Air Traffic Service (ATS) routes;

(2) Traffic density; and

(3) Air Traffic Control (ATC) and missed approach procedures

Civil Equivalence.

16. This regulation is in line with ICAO Annex 14 Vol I Attachment A.

Regulation 3511(3)

Runway - Dimensions

3511(3) HoEs and ADH-Facing Organizations **shall** ensure that the length of the runway provides declared distances adequate to meet the operational requirements for the Air System(s) which the aerodrome is intended to serve, and that the width is derived according to the aerodrome reference code.

Acceptable Means of Compliance 3511(3)

Runway - Dimensions

Length.

17. The following distances **should** be calculated to the nearest metre for each runway:

a. Take-Off Run Available (TORA).

b. Take-Off Distance Available (TODA).

c. Accelerate-Stop Distance Available (ASDA).

d. Landing Distance Available (LDA).

Acceptable Means of Compliance 3511(3)

18. The length of the runway **should** be measured from the start of the runway pavement or where a transverse stripe marking is provided to indicate threshold displacement, at the outer edge of the transverse stripe across the runway

19. 150 m at each end of each runway **should** be of rigid construction to combat the effects of jet engine efflux.

Width.

20. The width of a runway **should** be not less than the appropriate dimension specified in the Table 3.

21. The width of the runway **should** be measured at the outside edge of the runway side stripe marking where provided, or the edge of the runway.

Table 3. Runway Width

	Code Letter					
Code number	A	B	C	D	E	F
1[a]	18 m	18 m	23 m	-	-	-
2[a]	23 m	23 m	30 m	-	-	-
3	30 m	30 m	30 m	45 m	-	-
4	-	-	45 m	45 m	45 m	60 m

*a. The width of a precision approach runway **should not** be less than 30 m 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 Air System characteristics.

Note 2 – Factors affecting runway width are given in the Aerodrome Design Manual (ICAO Doc 9157), Part 1

Guidance Material 3511(3)

Runway - Dimensions

Civil Equivalence.

22. This regulation is in line with ICAO Annex 14 Vol I para 3.1.7 – 3.1.10.

Regulation 3511(4)

Runway - Characteristics

3511(4) HoEs and ADH-Facing Organizations **shall** ensure that the Runway physical characteristics are designed to enable the stabilised and safe use of the runway by the Air System for which the aerodrome is intended.

Acceptable Means of Compliance 3511(4)

Runway - Characteristics

Longitudinal Slope.

23. The longitudinal slope is computed by dividing the difference between the maximum and minimum elevation along the runway centre-line by the runway length and **should not** exceed:

a. 1% where the code number is 3 or greater.

b. 2% where the code number is 1 or 2.

24. Along no portion of a runway **should** the longitudinal slope exceed:

a. 1.25% where the code number is 4 or greater, except that for the first and last quarter of the length of the runway where the longitudinal slope **should not** exceed 0.8%;

Acceptable Means of Compliance 3511(4)

b. 1.5% where the code number is 3, except that for the first and last quarter of the length of a precision approach runway category II or III where the longitudinal slope **should not** exceed 0.8%; and

c. 2% where the code number is 1 or 2.

25. Where slope changes cannot be avoided, a slope change between two consecutive slopes **should not** exceed:

a. 1.5% where the code number is 3 or greater; and

b. 2% where the code number is 1 or 2.

26. The transition from one slope to another **should** be accomplished by a curved surface with a rate of change not exceeding:

a. 0.1% per 30 m (minimum radius of curvature of 30000 m) where the code number is 4 or greater;

b. 0.2% per 30 m (minimum radius of curvature of 15000 m) where the code number is 3; and

c. 0.4% per 30 m (minimum radius of curvature of 7500 m) where the code number is 1 or 2.

27. Where slope changes on runways cannot be avoided, they **should** be such that there **should** be an unobstructed line of sight from:

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

b. Any point 2 m above a runway to all other points 2 m above the runway within a distance of at least half the length of the runway where the code letter is B.

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

28. The distance between the points of intersection of two successive curves **should** be the greater of either:

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

(1) 30000 m where the code number is 4 or greater;

(2) 15000 m where the code number is 3; and

(3) 5000 m where the code number is 1 or 2; or

(4) 45 m.

Transverse Slope.

29. To promote the most rapid drainage of water, the runway surface **should** be cambered, except where a single cross fall from high to low in the direction of the wind most frequently associated with rain would ensure rapid drainage. Except at runway or taxiway intersections where flatter slopes may be necessary, the transverse slope **should** be:

a. Not less than 1% and not more than 1.5% where the code letter is C, D, E or F.

b. Not less than 1% and not more than 2% where the code letter is A or B.

30. For a cambered surface, the transverse slope on each side of the centre-line **should** be symmetrical. The transverse slope **should** be substantially the same throughout the length of a runway except at an intersection with another runway or a taxiway where an even transition **should** be provided taking account of the need for adequate drainage.

Acceptable Means of Compliance 3511(4)

Surface.

31. The surface of a paved runway **should** be constructed to provide good friction characteristics when the runway is wet.

32. The average surface texture depth of a new surface **should** be not less than 1 mm.

33. If the surface is grooved or scored, the grooves or scorings **should** be either perpendicular to the runway centre-line or parallel to non-perpendicular transverse joints where applicable.

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

Runway Strips.

35. Location - a Runway Strip **should** extend before the threshold and beyond the end of the runway or stopway for a distance of at least:

a. 60 m where the code number is 2 or greater;

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

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

36. Precision Approach Runway - a strip including a precision approach runway **should** extend on each side of the centre-line of the runway and its extended centre-line throughout the length of the strip laterally to a distance of at least:

a. 140 m where the code number is 3 or greater; and

b. 70 m where the code number is 1 or 2.

37. Non-Precision Approach Runway - a strip including a non-precision approach runway **should** extend on each side of the centre-line of the runway and its extended centre-line throughout the length of the strip laterally to a distance of at least:

a. 140 m where the code number is 3 or greater; and

b. 70 m where the code number is 1 or 2.

38. A strip including a non-instrument runway **should** extend on each side of the centre-line of the runway and its extended centre-line throughout the length of the strip, to a distance of at least:

a. 75 m where the code number is 3 or greater;

b. 40 m where the code number is 2; and

c. 30 m where the code number is 1.

39. A longitudinal slope along a runway strip **should** be less than:

a. 1.5% where the code number is 4 or greater;

b. 1.75% where the code number is 3; and

c. 2% where the code number is 1 or 2.

40. Longitudinal slope changes on a strip **should** be as gradual as practicable, and abrupt changes or sudden reversals of slopes **should** be avoided.

41. Transverse slopes on that portion of a strip to be graded **should** be adequate to prevent accumulation of water on the surface. They **should** be less than 2.5% (where the code number is 3 or greater), or 3% (where the code number is 1 or 2), except that to facilitate drainage from the slope for the first 3 m outward from the direction of the runway, shoulder or stopway edge may be as great as -5% as measured in the direction away from the runway.

Acceptable Means of Compliance 3511(4)

42. The transverse slopes of any portion of a strip beyond that to be graded **should** be less than an upward slope of 5% as measured in the direction away from the runway.

43. The strip **should** be of sufficient strength such that it does not hinder the movement of rescue and fire fighting vehicles.

44. That portion of a strip of a runway within a stated minimum distance from the centre-line and extended centre-line of the runway **should** provide a graded area and be prepared or constructed to minimise hazards arising from differences in load-bearing capacity to Air Systems which the runway is intended to serve in the event of an Air System running off the runway. The minimum distance **should** be:

a. 75 m where the code number is 3 or greater.

b. 40 m where the code number is 2.

c. 40 m where the code number is 1 for an instrument runway.

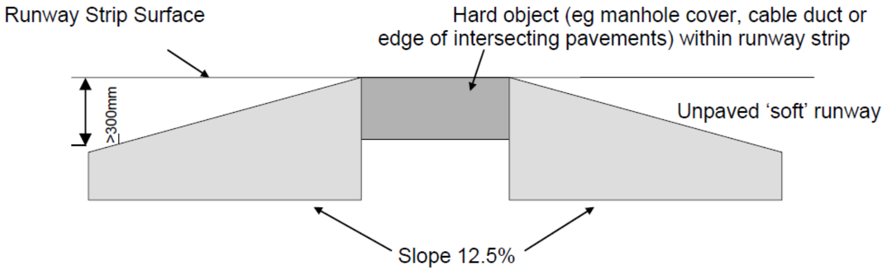
d. 30 m where the code number is 1 for a non-instrument runway.

45. The surface of that portion of a strip that abuts a runway, shoulder, or stopway **should** be flush with the surface of the runway, shoulder, or stopway.

46. That portion of a strip to at least 30 m before a threshold **should** be prepared against blast erosion to protect a landing Air System from the danger of an exposed edge.

47. The graded portion of runway strips **should** be delethalized as indicated in Figure 1; the sub-surface ramp **should** be inclined to the horizontal at a maximum slope of 12.5%.

Figure 1. Delethalization



Shoulders.

48. Runway shoulders **should** be provided for a runway where:

a. The code letter is D or E, and the runway width is less than 60 m; and

b. The code letter is F.

49. The runway shoulders **should** extend symmetrically on each side of the runway so that the overall width of the runway and its shoulders is not less than:

a. 60 m where the code letter is D or E; or

b. 75 m where the code letter is F.

50. The surface of the paved shoulder that abuts the runway **should** be flush with the surface of the runway and its transverse slope **should** be less than 2.5%.

51. A runway shoulder **should** be prepared or constructed to be capable, in the event of an Air System running off the runway, of supporting the Air System without inducing structural damage to the Air System and of supporting ground vehicles which may operate on the shoulder.

52. The surface of a runway shoulder **should** be prepared to resist erosion and prevent the ingestion of the surface material by Air System engines.

53. Longitudinal slopes of shoulders **should** be as for the associated runway.

Acceptable Means of Compliance 3511(4)

Clearways.

54. A clearway, where provided, **should** be of adequate distance to meet the operational requirements for the Air System which the runway is intended to serve.

55. The origin of a clearway **should** be at the end of the TORA.

56. The length of a clearway **should not** exceed half the length of the TORA.

57. A clearway **should** extend laterally to a distance of at least 75 m on each side of the extended centre-line of the runway.

58. The ground in a clearway **should not** project above a plane having an upward slope of 1.25%, the lower limit of this plane being a horizontal line which:

a. Is perpendicular to the vertical plane containing the runway centre-line; and

b. Passes through a point located on the runway centre-line at the end of the TORA.

59. A clearway **should** remain within an aerodrome boundary unless obstacle control can be exercised over the additional land/water outside of the boundary fence.

Stopway.

60. A stopway **should** have a length equal to the ASDA required, less the runway length, and be provided at both ends.

61. A stopway **should** have the same width as the runway with which it is associated including the runway shoulders if present.

62. Slopes and changes in slope on a stopway, and the transition from a runway to a stopway, **should** comply with the specifications of this RA for the runway with which the stopway is associated except that:

a. The limitation in this RA of a 0.8% slope for the first and last quarter of the length of a runway need not be applied to the stopway; and

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

63. A stopway **should** be prepared or constructed to be capable, in the event of an abandoned take-off, of supporting the Air System which the stopway is intended to serve without inducing structural damage to the Air System.

64. The surface of a paved stopway **should** be constructed to provide a good coefficient of friction to be compatible with that of the associated runway when the stopway is wet.

65. Concrete blast pads, where provided, **should** be of sufficient size to prevent surface erosion and migration of foreign material onto the runway. The ends **should** comply with the provisions RA 3511(6). Blast pads **should** form part of stopways, in which case they **should** be designed as paved stopways.

Arrestor Net Barrier Overruns.

66. The length of the Arrestor Net Barrier Overrun **should** allow for the full extension of the barrier type used.

67. The pavement construction for Arrestor Net Barrier Overruns **should** be designed as for a stopway, except that a paved surface **should** be provided from the end of the runway up to a point at least 2 m beyond the barrier and, in the case of flexible pavements, a minimum bituminous surfacing thickness of 100 mm **should** be provided. The run-out area beyond this point can either be paved or unpaved designed as for a stopway.

Turn Pads.

68. A runway turn pad **should**:

a. Be designed such that when the cockpit of the Air System for which the aerodrome is intended remains over the turn pad marking, the clearance

Acceptable Means of Compliance 3511(4)

distance between any wheel of the Air System landing gear and the edge of the turn pad is not less than that given by Table 4;

b. Have an intersection with the runway no greater than 30 degrees; and

c. Be designed such that the nose wheel steering angle used does not exceed 45 degrees.

69. The longitudinal and transverse slopes on a runway turn pad **should** be the same as those on the adjacent runway pavement surface.

70. The strength of a runway turn pad **should** be compatible with the adjoining runway which it serves.

71. The surface of a runway turn pad **should**:

a. Be constructed to eliminate surface irregularities that may cause damage to an Air System using the turn pad; and

b. Be constructed to provide friction characteristics compatible with the runway friction characteristics.

72. The runway turn pad shoulders **should**:

a. Be of such width as is necessary to prevent surface erosion by the jet blast of the most demanding Air System for which the turn pad is intended and any possible foreign object damage to the Air System engines; and

b. Have a strength capable of withstanding the occasional passage of the most demanding Air System it is designed to serve without inducing structural damage to the Air System and to the supporting ground vehicles that may operate on the shoulder.

Table 4. Turn Pad Clearance

Code letter	*Clearance*
A	1.5 m
B	2.25 m
C	3 m if the turn pad is intended to be used by Air System with a wheel base less than 18 m; 4.5 m if the turn pad is intended to be used by Air System with a wheel base equal to or greater than 18 m.
D	4.5 m
E	4.5 m
F	4.5 m

Note. – Wheel base means the distance from the nose gear to the geometric centre of the main gear.

Parallel Runway Operations.

73. Where parallel non-instrument runways are intended for simultaneous use, the minimum distance between their centre-lines **should** be:

a. 210 m where the aerodrome code number is 3 or greater.

b. 150 m where the aerodrome code number is 2.

c. 120 m where the aerodrome code number is 1.

74. Where parallel instrument runways are intended for simultaneous use, the minimum distance between their centre-lines **should** be:

a. 1035 m for independent parallel approaches; and

Acceptable Means of Compliance 3511(4)

b. 915 m for dependent parallel approaches; and

c. 760 m for independent parallel departures; and

d. 760 m for segregated parallel operations.

75. For segregated parallel operations, the specified minimum distance **should** be:

a. Decreased by 30 m for each 150 m that the arrival runway is staggered toward the arriving Air System, to a minimum of 300 m; and

b. Increased by 30 m for each 150 m that the arrival runway is staggered away from the arriving Air System.

Short Take Off and Landing (STOL)/Vertical and/or STOL (VSTOL) Operations.

76. Runway dimensions (length and width) for STOL/VSTOL operations are laid down in respective Air System manuals and will vary from Air System to Air System. The requirements will be dependent on payload and crosswind components and the manuals for the aerodrome/runway design Air System **should** be consulted before any design or construction work is undertaken. In all other respects the runway **should** be treated as a standard runway with the criteria being dictated by the Aerodrome Code Number and Letter.

Guidance Material 3511(4)

Runway - Characteristics

77. The slopes on a runway are intended to prevent the accumulation of water (or possible fluid contaminant) on the surface and to facilitate rapid drainage of surface water (or possible fluid contaminant). The water (or possible fluid contaminant) evacuation is facilitated by an adequate combination between longitudinal and transverse slopes and may also be assisted by grooving the runway surface. Slopes may be so designed as to minimise impact on Air Systems and so not to hamper their operations.

78. Slope changes are designed to reduce dynamic loads on the undercarriage system of the Air System. Minimising slope changes is especially important on runways where Air Systems move at high speeds.

79. For precision approach runways, slopes in a specified area from the runway end, including the touchdown area, may be designed so that they will correspond to the characteristics needed for such type of approach.

80. Caution may be needed when inserting runway lights or drainage grilles in runway surfaces to ensure that adequate smoothness of the surface is maintained.

81. Runway shoulders need to be capable of supporting the Air System using the runway without causing structural damage to those Air Systems. They also need to be capable of supporting vehicles such as firefighting appliances. In some cases, whilst the bearing strength of the natural ground may be sufficient, special preparation may be necessary to avoid erosion and the possible ingestion of debris by engines.

82. Runway shoulders are required because strong crosswinds may result in significant deviation from the runway centre-line. Thus, with some large Air Systems the wing-mounted engines may overhang the runway edge and there is then a risk of jet blast eroding the surface adjacent to the runway. This can cause dust and the possible ingestion of debris by the engines.

83. Paved shoulders may be authorized in special cases (eg for Air Systems with outrigger wheels on the wing-tips or where jet blast from large Air Systems with wing-mounted engines overhanging the pavement edge causing possible Foreign Object Debris (FOD) problems or where the topsoil/climate will not support grassed shoulders).

84. For runways where the code letter is D, there may be circumstances where the shoulder need not be paved. Where the runway is not used by 4-engined Air Systems, it may be possible to contain the risk from erosion or the ingestion of debris in the absence of paved shoulders. In such cases:

Guidance Material 3511(4)

a. The ground could be prepared so that there is full grass coverage with no loose gravel or other material. This may include additional materials if the bearing strength and surface of the ground are not sufficient.

b. A programme of inspections of the shoulders and runway may be implemented to confirm its continuing serviceability and ensure that there is no deterioration that could create a risk of FOD, or otherwise hazard Air System operations.

c. A programme of sweeping may be required before and after movements, if debris is drawn onto the runway surface.

85. If movements of 4-engined Air Systems with a code letter D or larger take place, the need for full paved width shoulders could be assessed by local hazard analysis.

86. Because of transverse or longitudinal slopes on a runway, shoulder, or strip, in certain cases, the lower limit of the clearway plane specified above may be below the corresponding elevation of the runway, shoulder, or strip. It is not intended that these surfaces be graded to conform with the lower limit of the clearway plane

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

88. A stopway needs to be designed to withstand at least a certain number of loadings of the Air System which the stopway is intended to serve without inducing structural damage to the Air System. Notwithstanding that a stopway may have a paved surface, it is not intended that PCN figures need to be developed for a stopway.

89. When an Arrestor Net Barrier is provided, the length of the overrun beyond the barrier need not normally be included in ASDA as not all Air Systems can trample a lowered Barrier.

90. Except that for independent parallel approaches, combinations of minimum distances and associated conditions other than those specified in the ICAO Document 4444[2] may be applied when it is determined that such combinations would not adversely affect the safety of Air System operations.

91. Procedures and facilities requirements for simultaneous operations on parallel or near-parallel instrument runways are contained in the Doc 4444, Chapter 6 and the ICAO Document 8168[3], Volume I, Part III, Section 2, and Volume II, Part I, Section 3; Part II, Section 1; and Part III, Section 3, and relevant guidance is contained in ICAO Document 9643[4].

92. Guidance on operating surface and strength characteristics may be obtained from global best practice where required, provided the MAA is kept informed of all design decisions and rationale.

Civil Equivalence.

93. This regulation is in line with ICAO Annex 14 Vol I para 3.1.13 – 3.1.23 and para 3.4.

Regulation 3511(5)

Runway – Runway-End Safety Areas

3511(5) HoEs and ADH-Facing Organizations **shall** ensure that Runway-End Safety Areas (RESA) are provided for all runways to reduce the risk of damage to an Air System undershooting or over running the runway and to facilitate the movement of rescue and fire fighting vehicles.

[2] ICAO Document 4444 – Procedures for Air Navigation Services – Air traffic Management (PANS-ATM).
[3] ICAO Document 8168 – Procedures for Air Navigation Services – Aircraft Operations (PANS-OPS).
[4] ICAO Document 9643 – Manual on Simultaneous Operations on Parallel or Near-Parallel Instrument Runways (SOIR).

Acceptable Means of Compliance 3511(5)

Runway – Runway-End Safety Areas

94. A RESA **should** extend from the end of a runway strip to a distance of at least 90 m and, as far as practicable, extend to a recommended distance of:

a. 240 m where the code number is 3 or greater;

b. 120 m where the code number is 1 or 2 and the runway is an instrument one.

95. Where the code number is 1 or 2 and the runway is a non-instrument one the RESA **should** be at least 30 m.

96. A Safety Audit which takes account of adverse operational factors **should** be provided where the recommended distances are not practicable, notwithstanding compliance with the minimum requirement.

97. The width of a RESA **should** be at least twice that of the associated runway and, wherever practicable, equal to that of the graded portion of the associated runway strip.

98. The longitudinal slopes of a RESA **should** be such that:

a. No part of the RESA penetrates the approach or take-off climb surface; and

b. They do not exceed a downward slope of 5%; and

c. Slope changes are as gradual as practicable. Abrupt changes or sudden reversals of slopes are to be avoided.

99. The transverse slopes of a RESA **should** be such that:

a. They do not exceed an upward or downward slope of 5%; and

b. Transitions between differing slopes are as gradual as practicable.

100. Engineered Materials Arrestor System (EMAS) or other arresting system designs **should** be supported by a validated design method that can predict the performance of the system. The design method **should** be derived from field or laboratory tests. Testing may be based either on the passage of an actual Air System or an equivalent single wheel load through a test bed. The design **should** consider multiple Air System parameters, including but not limited to allowable Air System gear loads, gear configuration, tyre contact pressure, Air System centre of gravity and Air System speed. The model **should** calculate imposed Air System gear loads, g-forces on Air System occupants, deceleration rates and stopping distances within the arresting system. Any rebound of the crushed material that may lessen its effectiveness, **should** also be considered.

Guidance Material 3511(5)

Runway – Runway-End Safety Areas

101. It is recognized that achieving the recommended distance could present challenges. Therefore, the aim of this guidance is to identify the types of aerodrome activities that can be undertaken to reduce the likelihood and consequences of an overrun occurring, and to decide on appropriate actions and it is suggested that aerodrome operators assess their RESA provisions.

102. Notwithstanding the provisions in this RA, the length of the RESA may be reduced where an arresting system is installed, based on the design specifications of the system:

a. 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 needs to be based on the type of Air System anticipated to use the associated runway that imposes the greatest demand upon the arresting system. The system design needs to be based on a critical (or design) Air System which is defined as the Air System using the associated runway that imposes the greatest demand upon the arresting system. This is usually but not always, the heaviest/largest Air System that regularly uses the runway. Arresting system performance is dependent not only on Air System weight but landing gear configuration and tyre pressure. All configurations need

Guidance Material 3511(5)

to be considered in optimizing the arresting system design. The aerodrome operator and arresting system manufacturer need to consult regarding the selection of the design Air System that will optimise the arresting system for a particular aerodrome.

103. A RESA could provide an area long and wide enough, and suitable to contain overruns and undershoots resulting from adverse operational factors. On a precision approach runway, the Instrument Landing System (ILS) localiser is normally the first upstanding obstacle, and the RESA could extend up to this facility. In other circumstances and on a non-precision approach runway, the first upstanding obstacle may be a road, a railroad, or other constructed or natural feature. In such circumstances, the RESA could extend as far as the obstacle.

104. Whatever length of RESA is provided, it is important to ensure that likelihood of, and potential impacts arising from, an overrun are minimised as far as reasonably practicable.

105. The overrun is a complex risk to assess because there are several variables, such as prevailing weather, type of Air System, the landing aids available, runway characteristics and available distances, the surrounding environment, and human factors. Each of these can have a significant contribution to the overall hazard; furthermore, the nature of the hazard and level of risk needs to be different for each aerodrome and even for each runway direction at any one aerodrome. The aerodrome may address some, and these are included below. Additionally, Air System operating procedures may impact but the aerodrome may have little ability to influence these. This need not prevent aerodromes from working with Air System operators so that the operations are conducted to minimise the likelihood of an overrun occurring.

106. Aerodromes need to try to maximise the length of RESA available on all applicable runways. When considering the RESA distance required for individual circumstances, aerodrome operators need to consider factors, such as:

a. The runway length and slope, in particular, the general operating lengths required for take-off and landing versus the runway distances available, including the excess of available length over that required;

b. Current RESA provision (length and width – how much the RESA complies with the recommended distance) and options to increase or improve this;

c. The nature and location of any hazard beyond the runway end, including the topography and obstruction environment in and beyond the RESA and outside the runway strip;

d. The type of Air System and level of traffic at the aerodrome, and actual or proposed changes to either;

e. Air System performance limitations arising from runway and RESA length – high performance Air Systems, operating at high loads and speeds have greater length requirements than smaller, low-performance Air Systems, the relationship between required balanced field length and available distances;

f. Navigation aids available (Performance Based Navigation (PBN)), instrument or visual - if an ILS is only available on one runway direction, a downwind approach and landing may be necessary in poor weather, and the availability of vertical guidance;

g. Friction and drainage characteristics of the runway, which impact on runway susceptibility to surface contamination and Air System braking action;

h. Traffic density, which may lead to increased pressure to vacate so increased speed;

i. Aerodrome weather patterns, including wind shear;

j. Aerodrome overrun history; and

k. Overrun/undershoot causal factors.

Guidance Material 3511(5)

107. Measures may be considered that would reduce the severity of the consequences if an event occurs. Wherever practicable, aerodrome operators need to seek to optimize the RESA. This may be achieved through a combination of:

a. Relocation, shifting or realignment of the runway — it may be possible to construct additional pavement at the start of take-off end to make more pavement available to retain the declared distances. The start and end of declared distances can be moved towards the downwind (start of take-off) end, thereby retaining the declared distance and creating space for a longer RESA.

b. In the case where undershoot RESA is limited and the runway has a displaced landing threshold, examine whether the threshold can be moved (downwind) to increase the RESA and/or runway length;

c. Reducing runway declared distances to provide the necessary RESA may be a viable option where the existing runway length exceeds that required for the existing or projected design Air System. If the take-off distance required for the critical Air System operating at the aerodrome is less than the take-off distance available, there may be an opportunity to reduce the relevant runway declared distances;

d. Increasing the length of a RESA, and/or minimising the obstruction environment in the area beyond the RESA. Means to increase the RESA provision include land acquisition, improvements to the grading, realigning fences or roads to provide additional area;

e. Installing suitably positioned and designed arresting systems, to supplement, or as an alternative to, a RESA where an equivalent level of safety is demonstrated;

f. Improving the slopes in the RESA to minimise or remove downward slopes; and

g. Providing paved RESA with known friction characteristics.

Civil Equivalence.

108. This regulation is in line with ICAO Annex 14 Vol I para 3.5.

Regulation 3511(6)

Taxiway - Characteristics

3511(6) HoEs and ADH-Facing Organizations **shall** ensure that the Taxiway physical characteristics are designed to enable the stabilised and safe use of the taxiway by the Air System for which the aerodrome is intended.

Acceptable Means of Compliance 3511(6)

Taxiway - Characteristics

Width.

109. The minimum clearance from the taxiway edge to the outer main wheel, with the Air System cockpit remaining on the taxiway centre-line **should** be:

a. Aerodrome Code A - 1.5 m;

b. Aerodrome Code B - 2.25 m;

c. Aerodrome Code C – 3 m (wheel base less than 18 m);

d. Aerodrome Code C - 4.5 m (wheel base greater than 18 m); and

e. Aerodrome Code D or greater - 4.5 m.

110. Fillets **should** be provided at junctions and intersections of taxiways with runways, aprons, and other taxiways to ensure that the minimum wheel clearances are maintained.

111. Straight portions of taxiway **should** have a width not less than:

a. Aerodrome Code A - 7.5 m;

Acceptable Means of Compliance 3511(6)

b. Aerodrome Code B - 10.5 m;

c. Aerodrome Code C – 15 m (wheel base less than 18 m);

d. Aerodrome Code C – 18 m (wheel base greater than 18 m);

e. Aerodrome Code D – 18 m (wheel base less than 18 m);

f. Aerodrome Code D – 23 m (wheel base greater than 18 m);

g. Aerodrome Code E – 23 m; and

h. Aerodrome Code F – 25 m.

112. Changes in direction of taxiways **should** be as few and small as possible.

113. The radii of the curves **should** be compatible with the manoeuvring capability and normal taxiing speeds of the Air System for which the taxiway is intended and not less than 60 m.

Strength.

114. The strength of taxiways **should** be at least equal to that of the runways that they serve.

Surface.

115. The surface of a taxiway **should not** have irregularities that cause damage to Air System structures.

Longitudinal Slope.

116. The longitudinal slope of a taxiway **should not** exceed:

a. 1.5% where the aerodrome code letter is C, D, E, or F.

b. 3% where the aerodrome code letter is A or B.

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

a. 1% per 30 m (minimum radius of curvature of 3000 m) where the aerodrome code letter is C, D, E, or F.

b. 1% per 25 m (minimum radius of curvature of 2500 m) where the aerodrome code letter is A or B.

118. Where a change in slope on a taxiway cannot be avoided, the change **should** be such that, from any point:

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

b. 2 m above the taxiway, it **should** be possible to see the whole surface of the taxiway for a distance of at least 200 m from that point where the aerodrome code letter is B.

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

119. The distance between the tangent points of gradient changes **should** be no less than 150 m.

Transverse Slope.

120. The transverse slopes of a taxiway **should** be sufficient to prevent the accumulation of water on the surface of the taxiway but **should** be no greater than:

a. 1.5% where the aerodrome code letter is C, D, E, or F.

b. 2% where the aerodrome code letter is A or B.

Acceptable Means of Compliance 3511(6)

Strips.

121. A taxiway strip **should** extend symmetrically on each side of the centre-line of the taxiway throughout the length of the taxiway to at least the distance from the centre-line given in Table 5.

Table 5. Taxiway minimum separation distances

Code letter	Distance between taxiway centre-line and runway centre-line (metres)								Taxiway centre-line to taxiway centre-line (metres)	Taxiway, other than Air System stand taxilane, centre-line to object (metres)	Air System stand taxilane centre line to aircraft stand taxilane centre line (metres)	Air System stand taxilane centre-line to object (metres)
	Instrument runways Code number				Non-instrument runways Code number							
	1	2	3	4	1	2	3	4				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
A	82.5	82.5	-	-	37.5	47.5	-	-	23	15.5	19.5	12
B	87	87	-	-	42	52	-	-	32	20	28.5	16.5
C	-	-	168	-	-	-	93	-	44	26	40.5	22.5
D	-	-	176	176	-	-	101	101	63	37	59.5	33.5
E	-	-	-	182.5	-	-	-	107.5	76	43.5	72.5	40
F	-	-	-	190	-	-	-	115	91	51	87.5	47.5

Note 1 ►◄

Note 2 – 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 (ICAO Doc 9157), Part 2.

Note 3 – The distances in columns (2) to (9) do not guarantee sufficient clearance behind a holding aircraft to permit the passing of another aircraft on a parallel taxiway. See the Aerodrome Design Manual (ICAO Doc 9157), Part 2.

122. The centre portion of a taxiway strip **should** provide a graded area to a distance from the centre-line of the taxiway of at least:

a. 11 m where the aerodrome code letter is A;

b. 12.5 m where the aerodrome code letter is B or C;

c. 19 m where the aerodrome code letter is D;

d. 22 m where the aerodrome code letter is E; and

e. 30 m where the aerodrome code letter is F.

123. The surface of the taxiway strip **should** be flush at the edge of the taxiway or shoulder if provided.

124. The graded portion of a taxiway strip **should** have an upward transverse slope no greater than:

a. 2.5% for strips where the aerodrome code letter is C, D, E, or F; and

b. 3% for strips of taxiways where the aerodrome code letter is A or B.

125. The upward slope **should** be measured with reference to the transverse slope of the adjacent taxiway surface and not the horizontal.

126. The graded portion of a taxiway strip **should** have a downward transverse slope no greater than 5% measured with reference to the horizontal slope.

127. The transverse slopes on any portion of a taxiway strip beyond that to be graded **should** have an upward or downward slope no greater than 5% as measured in the direction away from the runway.

Acceptable Means of Compliance 3511(6)

Shoulders.

128. Straight portions of a taxiway **should** be provided with shoulders which extend symmetrically on each side of the taxiway so that the overall width of the taxiway and its shoulders is not less than:

a. 44 m where the aerodrome code letter is F.

b. 38 m where the aerodrome code letter is E.

c. 34 m where the aerodrome code letter is D.

d. 25 m where the aerodrome code letter is C.

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

130. When a taxiway is intended to be used by turbine-engine Air Systems, the surface of the taxiway shoulder **should** be prepared to resist erosion and the ingestion of the surface material by Air System engines.

131. Taxiway shoulder transverse slopes **should** be between -1.5 and +3%.

132. Longitudinal slopes of shoulders **should** be as for the associated taxiway iaw RA 3511(4).

Parallel Taxiways.

133. A Risk Assessment **should** be completed to support operations from a parallel taxiway.

134. If provided, an aerodrome **should** have only one parallel taxiway assigned for the purpose of allowing take-offs and landings.

135. The design of a parallel taxiway that can be used for take-off and landing, **should** conform to the specifications as detailed in Table 6.

136. The surface of a paved parallel taxiway that can be used for take-off and landing **should** be constructed to provide good friction characteristics when the runway is wet.

137. The taxiway **should** be of sufficient strength to support normal operations of the Air System intended for use at the aerodrome without risk of damage either to the Air System or the taxiway.

Table 6. Parallel Taxiways

Facility	**Length**	**Width**	**Slopes**	
			Longitudinal	**Transverse**
Parallel Taxiway	As for main runway	≥23 m	As for main runway	
Shoulders	Full length	≥30 m from taxiway edge		
Clearway[ab]	≤150 m	52.5 m	Not to project above plane through end of taxiway with slope = 2%	≤3%
Stopway	Not Required			
Strip	60 m beyond parallel taxiway ends	100 m to each side of parallel taxiway centre-line	As for main runway	
Separation Distances	a. To runway centre-line – 150 m b. To ►Aprons◄ – 100 m c. To nearest building, facility etc. – 100 m d. To the centre-line of nearest taxiway – 100 m			

[a] At both ends of the taxiway
[b] Not to extend beyond runway clearway

Acceptable Means of Compliance 3511(6)

Separation Distances.

138. The separation distance between the centre-line of a taxiway and the centre-line of a runway, the centre-line of a parallel taxiway, the centre-line of an Air System stand, or an object **should** be no less than the appropriate dimension specified in Table 5.

Holding Positions.

139. Holding bays or other bypasses of sufficient size and adequate construction **should** be provided where necessary, to allow for sequencing departing Air Systems.

140. A runway-holding position or positions **should** be established:

a. On the taxiway, if the location or alignment of the taxiway is such that a taxiing Air System or vehicle can infringe an obstacle limitation surface or interfere with the operation of radio navigation aids; and

b. On the taxiway, at the intersection of a taxiway and a runway; and

c. At an intersection of a runway with another runway when the former runway is part of a standard taxi-route.

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

142. An emergency access road **should** be equipped with road-holding positions at all intersections with runways and taxiways.

143. A road-holding position **should** be established at each intersection of a road with a runway.

144. The distance between a holding bay, runway-holding position established at a taxiway/runway intersection or road-holding position and the centre-line of a runway **should** be iaw Table 7 and such that a holding Air System or vehicle **should not** infringe obstacle free zones, approach surfaces, or the take-off climb surface, nor interfere with the operation of radio navigation aids.

145. At elevations greater than 700 m, the distance of 90 m specified in Table 7 for a precision approach runway code number 4 **should** be increased as follows:

a. Up to an elevation of 2000 m; 1 m for every 100 m in excess of 700 m; and

b. Elevation in excess of 2000 m and up to 4000 m; 13 m plus 1.5 m for every 100 m in excess of 2000 m; and

c. Elevation in excess of 4000 m and up to 5000 m; 43 m plus 2 m for every 100 m in excess of 4000 m.

Table 7. Minimum distance from the runway centre-line to a holding bay, runway-holding position or road-holding position

	Code number			
Type of runway	**1**	**2**	**3**	**4**
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

Acceptable Means of Compliance 3511(6)

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

b. This distance may need to be increased to avoid interference with radio navigation aids, particularly the glide path and localizer facilities.

Note 1 – The distance of 90 m for code number 3 or 4 is based on an Air System 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.

Note 2 – The distance of 60 m for code number 2 is based on an Air System 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.

c. Where the code letter is F, this distance **should** be 107.5 m.

Note 3 – The distance of 107.5 m for code number 4 where the code letter is F is based on an Air System 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.

Guidance Material 3511(6)

Taxiway - Characteristics

146. Due consideration needs to be given to the fact that a taxiway may be subjected to a greater density of traffic and as a result of slow moving and stationary Air Systems, leading to higher stresses than the runway it serves.

147. Where slope changes specified above are not achieved and slopes on a taxiway cannot be avoided, the transition from one slope to another slope needs to be accomplished by a curved surface which needs to allow the safe operation of all Air Systems in all weather conditions.

148. Paved shoulders may be authorized in special cases (eg for Air Systems with outrigger wheels on the wing-tips or where jet blast from large Air Systems with wing-mounted engines overhanging the pavement edge causing possible FOD problems or where the topsoil/climate will not support grassed shoulders).

Civil Equivalence.

149. This regulation is in line with ICAO Annex 14 Vol I paras 3.9 – 3.12.

Regulation 3511(7)

Aprons

3511(7) HoEs and ADH-Facing Organizations **shall** ensure that Aprons are adequate to permit safe and expeditious handling of aerodrome traffic at its maximum anticipated density.

Acceptable Means of Compliance 3511(7)

Aprons

Size.

150. For Dispersed Stands and Hangar/Hardened Aircraft Shelter (HAS) Aprons, the size of the apron **should** be no less than the turning radius of the Air System's outer wheels plus 3 m.

Clearance.

151. An Air System stand **should** provide the following minimum clearances between an Air System using the stand and any adjacent objects as follows:

a. Aerodrome code letter A and B: 3 m.

b. Aerodrome code letter C: 4.5 m.

Acceptable Means of Compliance 3511(7)

c. Aerodrome code letter D or greater: 7.5 m.

Strength.

152. The strength of aprons **should** be at least equal to that of the runways that they serve.

Surface.

153. The surface of an apron **should** be constructed or resurfaced to provide suitable surface friction characteristics iaw ICAO Annex 14 Vol I Attachment A, section 7.

Slope.

154. The design of slopes **should** direct spilled fuel away from buildings and apron service areas. Where such slopes are unavoidable, special measures **should** be taken to reduce the fire hazard resulting from fuel spillage.

155. On an Air System stand the maximum slope **should** be no greater than 1% in any direction.

156. Where the slope limitation of 1% on the stands cannot be achieved, the slope **should** be kept as shallow as possible and **should** be such that the operation of the Air Systems and vehicles is not compromised.

Strip.

157. For aprons and dispersed stands, the apron strip **should** extend no less than 15 m from edge of paved surface.

158. For Hangar/HAS aprons, the apron strip **should** extend no less than the greater of:

a. 5m from the edge of the paved surface; or

b. Half the wingspan of the Air System the Apron is intended to serve from the edge of the paved surface.

Shoulder.

159. Apron shoulders **should** extend no less than 3 m from the edge of the paved surface.

Guidance Material 3511(7)

Aprons

160. The amount of area required for an apron layout will depend upon the following factors:

a. The size and manoeuvrability characteristics of the Air System using the apron.

b. The volume of traffic using the apron.

c. Clearance requirements.

d. Type of ingress and egress to the Air System stand.

e. Aerodrome layout or other aerodrome use.

f. Air System ground activity requirements.

g. Taxiways and service roads.

161. Due consideration needs to be given to the fact that an apron may be subjected to a greater density of traffic and as a result of slow moving and stationary Air Systems, to higher stresses than the runway it serves.

162. Slopes on aprons have the same purpose as other pavement slopes, to prevent the accumulation of water (or possible fluid contaminant) on the surface and to facilitate rapid drainage of surface water (or possible fluid contaminant). Nevertheless, the design of the apron, especially for the parts containing Air System stands, must specifically consider the impact of the slopes on the Air System during its braking at the stand and during its start for departure (with push-back or with its own engines). The aim is to avoid an Air System passing its stop point and going on the service road

Guidance Material 3511(7)

or to the closest building and to save fuel and optimize the manoeuvrability of the Air System or of the push-back device.

Civil Equivalence.

163. This regulation is in line with ICAO Annex 14 Vol I 3.13.