WP 095
Version september 2007

GASR
WORKING GROUP

GAR
Subpart F – Physical Characteristics

Reminder 1: the specifications of this subpart concern also virtual lines (holding positions...)which are useful for safety issues.

Reminder 2: it is considered that for all the specifications of the GAR, non compliance could be admitted when an aeronautical study (or safety assessment) has demonstrated that the safety is not compromised (with possible mitigations measures).

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SECTION 1

SUBPART F – Physical Characteristics

GAR 1.F001 Infrastructure reference code
The aerodrome operator shall determine a reference code for each part of infrastructure used by aircraft

GAR 1.F002 Runways

(a) Threshold
A runway used for landing shall have a threshold.

(b) Width of runways
(1) The width of a runway shall be not less than the appropriate dimension specified in the following tabulation:

Table 1.F002 Runway Widths

Code Number	Code letter A	B	C	D	E	F
1	18 m	18 m	23 m	–	–	–
2	23 m	23 m	30 m	–	–	–
3	30 m	30 m	30 m	45 m	–	–
4	–	–	45 m	45 m	45 m	60 m

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

(c)Slopes on runways
The transverse and longitudinal slopes and slopes changes of a runway shall prevent the accumulation of water on the surface of the runway.

The longitudinal slope shall not hinder adversely affect the performances of air navigation aids. Longitudinal slopes and slope changes shall be a minimum consistent with providing unobstructed line of sight along the runway.

(d) Surface of runways
(1) The surface of a runway shall be without irregularities that would result in loss in friction characteristics or otherwise adversely affect the take-off or landing of an aircraft.

(2) The surface of a paved runway shall provide sufficient friction characteristics to allow safe aircraft operations.

The bearing strength of the runway pavement shall be determined (idem for taxiway and apron)

GAR 1.F005 Runway shoulders

The edges of runways or shoulders (where provided) shall be so prepared as to provide a safe transition between the pavement and the adjacent surface for aircraft running off the pavement. If a shoulder is provided, it shall prevent object ingestion by engines and jet blast.

GAR 1.F010 Runway turn pads

The surface of a runway turn pad, when provided, shall not have irregularities that may cause damage to an aeroplane using the turn pad.

GAR 1.F015 Runway strips

(a) General
A runway and any associated stopways, if provided, shall be included in a strip.

(b) Length of runway strips
A strip shall extend before the threshold and beyond the end of the runway or stopway for a distance of at least:

(i) 60 m where the code number is 2, 3 or 4;
(ii) 60 m where the code number is 1 and the runway is an instrument one;
(iii) 30 m where the code number is 1 and the runway is a non-instrument one.

(c) Width of runway strips
(1) A strip including a precision approach runway shall extend laterally to a distance of at least:

(i) 150 m where the code number is 3 or 4; and
(ii) 75 m where the code number is 1 or 2;

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

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

(i) 150 m where the code number is 3 or 4; and
(ii) 75 m where the code number is 1 or 2;

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

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(3) A strip including a non- instrument runway shall 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:

(i) 75 m where the code number is 3 or 4;

(ii) 40 m where the code number is 2; and

(iii) 30 m where the code number is 1.

(d) Grading of runway strips

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

Note: objects around the runway are dealt with in subpart G

GAR 1.F020 Runway end safety areas

(a) General

(1) The runway end safety area is an area intended to minimise risk to aircraft in the event of an aircraft undershooting or overrunning the runway.

(2) A runway end safety area shall be provided at each end of a runway strip where:

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

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

(b) *Dimensions of the RESA*

(1) A runway end safety area shall extend from the end of a runway strip to a distance of at least 90m,

(2) The width of a runway end safety area shall be at least twice that of the associated runway.

GAR 1.F025 Clearways

(a) Location of clearways

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

(b) Width of clearways

A clearway when provided shall extend laterally to a distance of at least 75 m on each side of the extended centre line of the runway or equal to the width of the strip when this is narrower.

(c) Length of clearway

The aerodrome operator shall determine the limits of the clearway

GAR 1.F030 Stopways

(a) General

The stopway shall be capable, in the event of an abandoned take-off (accelerate-top) of supporting the aircraft which the stopway is intended to serve without inducing structural damage to the aircraft

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(b) Width of stopways

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

(c) Surface of stopways

The surface of a paved stopway shall provide sufficient friction characteristics and be compatible with that of the associated runway.

GAR 1.F035 Radio altimeter operating area

A radio altimeter operating area shall be established for a precision approach runway

GAR 1.F040 Taxiways

(a) General

Taxiways shall be provided to permit the safe surface movement of aircraft.

(b) Taxiway curves

The radii of the curves shall be compatible with the maneuvering capability of the aircraft for which the taxiway is intended.

(c) Surface of taxiways

(1) The surface of a taxiway shall not have irregularities that cause damage to aircraft structures.

(2) The surface of a paved taxiway shall to provide good friction characteristics

(d) Taxiways on bridges

(1) Either side of the centerline, the portion of a taxiway bridge capable of supporting aircraft, as measured perpendicularly to the taxiway centre line, shall extend not less than the figures provided in table B, unless an adequate method of lateral restraint is provided which shall not be hazardous for aeroplanes for which the taxiway is intended.

Code letter	In metres
A	11
B	12.5
C	12.5
D	19
E	22
F	30

Table B

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

GAR 1.F045 Taxiway Shoulders

When a taxiway is intended to be used by turbine-engined aeroplanes, the surface of the taxiway shoulder shall be so prepared as to resist erosion and the ingestion of the surface material by aeroplane engines.

GAR 1.F050 Taxiway strips

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

(2) A taxiway strip shall include a taxiway graded area.

GAR 1.F055 Holding bays, runway-holding positions, intermediate holding positions and road-holding positions

(a) General

(1) A runway-holding position or positions shall be established:

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

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

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

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

(b) Location

(1) 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 shall be in accordance with Table GAR 1.F055 and, in the case of a precision approach runway, such that a holding aircraft or vehicle will not interfere with the operation of radio navigation aids.

(2) The location of a runway-holding position established in accordance with GAR 1.F055 (a) (2) shall be such that a holding aircraft or vehicle will not infringe the obstacle free zone, approach surface, take-off climb surface or ILS/MLS critical/sensitive area or interfere with the operation of radio navigation aids.

GAR 1.F060 Apron

Where an apron is provided, it shall be of sufficient size and adequate construction to permit the safe on-and off-loading of passengers, cargo and mail as well as the safe servicing of aircraft and without causing damage to aircraft.

GAR 1.F065 Isolated aircraft parking position

An isolated aircraft parking position shall be designated and the aerodrome control tower, when existing, shall be advised of an area or areas suitable for the parking of an aeroplane which needs isolation.

Table 1.F055 - 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

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 meter the bay or holding position is lower than the threshold, contingent upon not infringing the inner transitional surface.

b. This distance shall be increased if there is a need to avoid interference with radio navigation aids, particularly the glide path and localizer facilities.

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

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SECTION 2

SUBPART F – Physical Characteristics

AMC-GAR 1.F001
Infrastructure reference code

An infrastructure intended to accommodate a specific type of aircraft related to a higher code than the established infrastructure reference code, can be used by such aircraft when an aeronautical study (or safety assessment) has demonstrated that the safety is not compromised (with possible mitigations measures).

AMC-GAR 1.F002
Runways

(a) Location of threshold
(1) A threshold should normally be located at the extremity of a runway unless operational considerations justify the choice of another location.

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

(b) Minimum distance between parallel runways
(1) Where parallel non-instrument runways are intended for simultaneous use, the minimum distance between their centre lines should be:
— 210 m where the higher code number is 3 or 4;
— 150 m where the higher code number is 2; and
— 120 m where the higher code number is 1.

(2) Where parallel instrument runways are intended for simultaneous use the minimum distance between their centre lines should be:
— 1 035 m for independent parallel approaches;
— 915 m for dependent parallel approaches;
— 760 m for independent parallel departures;
— 760 m for segregated parallel operations;
except that for segregated parallel operations the specified minimum distance:
1) May be decreased by 30 m for each 150 m that the arrival runway is staggered toward the arriving aircraft, to a minimum of 300 m; and
2) Should be increased by 30 m for each 150 m that the arrival runway is staggered away from the arriving aircraft;

(c) Slopes on runway
(1) Consideration should be given to providing an unobstructed line of sight over the entire length of a single runway where a full-length parallel taxiway is not available. Where an aerodrome has intersecting runways, additional criteria on the line of sight of the intersection area would need to be considered for operational safety.

(2) The transverse slope should ideally be:
(i) 1.5 per cent where the code letter is C, D, E or F;
(ii) 2 per cent where the code letter is A or B;
and should not be less than 1 per cent, except at runway or taxiway intersections where flatter slopes may be necessary.

(3) For a cambered surface, the transverse slope on each side of the centre line should be symmetrical.

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(4) The longitudinal slope computed by dividing the difference between the maximum and minimum elevation along the runway centre line by the runway length should not exceed:

(i) 1 per cent where the code number is 3 or 4; and
(ii) 2 per cent where the code number is 1 or 2.

(5) Where slope changes cannot be avoided, a slope change between two consecutive slopes shall not exceed:
(i) 1.5 per cent where the code number is 3 or 4; and
(ii) 2 per cent where the code number is 1 or 2.

(6) The transition from one slope to another shall be accomplished by a curved surface with a rate of change not exceeding:
(i) 0.1 per cent per 30m (minimum radius of curvature of 30 000 m) where the code number is 4;
(ii) 0.2 per cent per 30m (minimum radius of curvature of 15 000 m) where the code number is 3; and
(iii) 0.4 per cent per 30m (minimum radius of curvature of 7 500 m) where the code number is 1 or 2.

(7) Where slope changes cannot be avoided, they should be such that there will be an unobstructed line of sight from:
(i) 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.
(ii) Any point 2 m above a runway to all other points 2 m above the runway within a distance of at least half the length of the runway where the code letter is B; and
(iii) 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.

(8) Undulations or appreciable changes in slopes located close together along a runway should be avoided.

(9) Along no portion of a runway should the longitudinal slope exceed:
— 1.25 per cent where the code number is 4, except that for the first and last quarter of the length of the runway the longitudinal slope should not exceed 0.8 per cent;
— 1.5 per cent where the code number is 3, except that for the first and last quarter of the length of a precision approach runway category II or III the longitudinal slope should not exceed 0.8 per cent; and
— 2 per cent where the code number is 1 or 2.

(10)The bearing strength of the unpaved runway should be determined.

(11) The bearing strength of a pavement intended for aircraft of apron (ramp) mass equal to or less than 5 700 kg should be made available by reporting the following information:
a) maximum allowable aircraft mass; and
b) maximum allowable tire pressure.
Example: 4 000 kg/0.50 MPa.

(e) Runway surface

(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.

(2) Isolated irregularities of the order of 2.5 cm to 3 cm over a 45 m distance are tolerable. Even though maximum acceptable deviations vary with the type and speed of an aircraft, the limits of acceptable surface irregularities can be estimated to a reasonable extent. The following table describes excessive limits. If the excessive limits are exceeded, the portions of the runway that exhibit such roughness should have corrective measures taken immediately if continued aircraft operations are to be maintained.

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

"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 understood to be from 30 to 60 meters in length (or longer) throughout which, a continuing general uphill, downhill or flat slope is prevalent. This criterion addresses single event roughness, not long wave length harmonic effects nor the effect of repetitive surface undulations.

(3) Caution should also be exercised when inserting runway lights or drainage grilles.

(e) Determination of friction characteristics of paved runways

(1) The friction of a paved runway should be measured to:

- Verify the friction characteristics of new or resurfaced paved runways

(2) Runways should be evaluated when first constructed or after resurfacing to determine the runway surface friction characteristics. 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 should 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.

(3) Measurements of the intrinsic friction characteristics of a new or resurfaced runway should be made with a continuous friction measuring device using self-wetting features in order to assure that the design objectives with respect to its friction characteristics have been achieved., The device should have a capability of using self-wetting features to enable measurements of the friction characteristics of the surface to be made at a water depth of at least 1 mm.

(4)See also GAR (AMC) 1.D125 Maintenance of Movement area surfaces

(f) Runway surface texture

(1) The average surface texture depth of a runway should be more than 1.0 mm, or the surface should be grooved.

(2) Grooves that should meet the requirement for good breaking action when the surface is wet, should be cut with a tool that leaves a clean cutting edge, the width of each groove should be 5 – 7 mm and the spacing between grooves should be approximately 125 mm.

(3) The average surface texture depth and/or grooving of a runway should be given in the AIP for the aerodrome together with data on surface type (class A, B, C, D or E).

(4) Surface texture shall be measured periodically. If the runway is grooved, the grooved shall be checked periodically for evenness and depth.

IEM-GAR 1.F002
Runways

(a) Runway length

(1) There is a relationship between runway length and operational criteria, notably declared distances (TORA, TODA, ASDA and LDA). See GAR E.1.035

(2) The accuracy for the runway length is 1m.

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(b) Runway width
(1) The width of the runway shall be measured between markings or markers (for unpaved runways) when existing or shall be the pavement width when there are no markings.

(2) The measurement for the runway width is made between outer edges of markings or markers.

(3) The accuracy for the runway width is 1m.

(c) Minimum distance between parallel runways
(1) Procedures and facilities requirements for simultaneous operations on parallel or near-parallel instrument runways are contained in the PANS-ATM (Doc 4444), Part IV and the PANS-ATM (Doc 4444), PANS-OPS (Doc 8168), Volume I, Part VII and Volume II, Parts II and III and relevant guidance is contained in the Manual of Simultaneous Operations on Parallel or Near-Parallel Instrument Runways (Doc 9643).

(2) Procedures for wake turbulence categorization of aircraft and wake turbulence separation minima are contained in the procedures for Air Navigation Services – Air Traffic Management (PANS-ATM), Doc 4444, Part V, Section 16.

(d)Slopes on runway
Guidance on transverse slope is given in ICAO Aerodrome Design Manual, Part 1.

(e) Determination of friction characteristics of wet paved runways
See GAR (IEM) 1.D125 Maintenance of Movement area surfaces

(f) Impact of the runway strength on runway surface
A defect of pavement strength can cause runway surface problems (cracks, deflections….) leading to a defect of the runway surface.

AMC-GAR 1.F005
Runway Shoulders

(a)General
(1) The shoulder of a runway or stopway should be prepared or constructed so as to minimize any hazard to an aeroplane running off the runway or stopway. Some guidance is given in AMC-GAR 1.F005 Runway Shoulders 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.

(2) Attention should also be paid when designing shoulders to prevent the ingestion of stones or other objects by turbine engines.

(3) 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.

(4) Runway shoulders should be provided for a runway where the code letter is D or E, and the runway width is less than 60 m. Runway shoulders should be provided for a runway where the code letter is F.
The runway shoulders shall extend symmetrically on each side of the runway so that the overall width of the runway and its shoulders is not less than:
(i) 60 m where the code letter is D or E; and
(ii) 75 m where the code letter is F.

(b) Surface and transverse slopes on runway shoulders
The surface of the shoulder that abuts the runway should be flush with the surface of the runway and its transverse slope should not exceed 2.5 per cent.

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(c) Strength of runway shoulders
(1) Runway shoulders should be capable, in the event of an aeroplane running off the runway, of supporting the aeroplane without inducing structural damage to the aeroplane and of supporting ground vehicles which may operate on the shoulder.

(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, light paving).

(3) Prevention of the ingestion of stones or other objects by turbine engines should be considered. The rate of damage caused to engines from ingesting foreign objects can be substantial. The surface of the shoulder should be adequate to resist erosion from engine blast.

(4) See AMC GAR 1.E025 Strength of pavements for ACN/PCN specifications

IEM-GAR 1.F005
Runway Shoulders

(a) Strength of runway shoulders
Guidance on strength of runway shoulders is given in the ICAO Aerodrome Design Manual, Part 1.

(b) Characteristics and treatment of runway shoulders
Guidance on characteristics and treatment of runway shoulders is given in ICAO Aerodrome Design Manual, Part 1.

AMC-GAR 1.F010
Runway turn pad

(a) General
(1) When provided, a runway turn pad should be such that when the cockpit of the aeroplane for which the turn pad is intended remains over the turn pad marking, the clearance distance between any wheel of the aeroplane landing gear and the edge of the turn pad should be not less than that given by the following tabulation:

Code letter	Clearance
A	1.5 m
B	2.25 m
C	3 m if the turn pad is intended to be used by aeroplanes with a wheel base less than 18 m 4.5 m if the turn pad is intended to be used by aeroplanes 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.

(2) The intersection angle of the runway turn pad with the runway should not exceed 30 degrees.

(b) Slopes on runway turn pad
(1) The longitudinal and transverse slopes on a runway turn pad should be sufficient to prevent the accumulation of water on the surface and facilitate rapid drainage of surface water. The slopes should be the same as those on the adjacent runway pavement surface.

(c) Strength on runway turn pad
(1) The strength of a runway turn pad should be at least equal to that of the adjoining runway which it serves.

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(d) Surface of runway turn pad

(1)The friction characteristics of the runway turn pad should be the same as that of the adjoining runway which it serves.

IEM-GAR 1.F010
Runway turn pad

(a) General

(1) Where the end of a runway is not served by a taxiway, it may be necessary to provide additional pavement at the end of the runway for the turning of aeroplanes. Such areas may also be useful along the runway to reduce taxiing time and distance for some aeroplanes.

(2) The runway turn pad is not considered as a part of the runway. So, the runway width calculation and measurement do not take into account the turn pad when existing.

AMC-GAR 1.F015
Runway strips

(a) General

(1) A runway strip has two distinct safety functions:

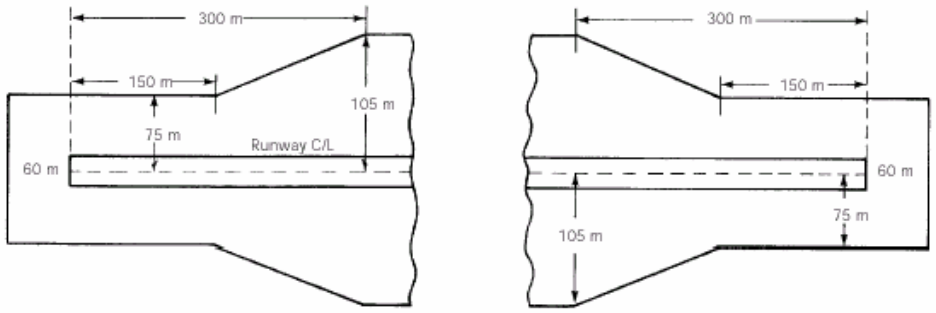
i) the protection of aircraft from collision on the ground in the event of a lateral veer-off during landing or take-off;

ii) the protection of airborne aircraft from collision whilst over-flying the runway strip, for example during a missed approach/balked landing

(b) Grading of runway strip

(1) The portion of a strip of an instrument runway within at least 75 m from the centre line should 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 .4.1 shows the shape and dimension 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 4.1 Graded area of runway strip
Precision approach runway code number 3 or 4.



(2) That portion of a strip to at least 30 m before a threshold should be prepared against blast erosion in order to protect a landing aeroplane from the danger of an exposed edge.

(3) In the case of the former, the relevant portion of the runway strip should be adequately load bearing to accommodate the aircraft using the aerodrome though not necessarily prepared to the same standards as the graded area.

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(c) Slopes on runway strip
(1) The longitudinal slopes of runway strips should be sufficient to prevent the accumulation of water on the surface and not endanger an aircraft in the event of a run-off or hinder the movement of vehicles.

(2) A longitudinal slope along that portion of a strip to be graded should not exceed:
(i) 1.5 per cent where the code number is 4;
(ii) 1.75 per cent where the code number is 3; and
(iii) 2 per cent where the code number is 1 or 2.

(3) Longitudinal slope changes on that portion of a strip to be graded should be as gradual as practicable and abrupt changes or sudden reversals of slopes avoided.

(4) Transverse slopes on that portion of a strip to be graded should be adequate to prevent the accumulation of water on the surface.

(5) The transverse slope should not exceed:
(i) 2.5 per cent where the code number is 3 or 4; and
(ii) 3 per cent where the code number is 1 or 2;
except that to facilitate drainage the slope for the first 3 m outward from the runway, shoulder or stopway edge should be negative as measured in the direction away from the runway and may be as great as 5 per cent.

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

IEM-GAR 1.F015
Runway strips

(a) Preparation of runway strips
Guidance on preparation of runway strips is given in the ICAO Aerodrome Design Manual, Part 1.

(b) Sitting and construction of equipment and installations on runway strips
(1) See subpart K Sitting of equipment and installations on operational areas for information regarding sitting and construction of equipment and installations on runway strips.

(2) See GAR subpart G for objects on runway strip

AMC-GAR 1.F020
Runway end safety areas

(a) general
(1) A runway end safety area should reduce the risk of damage to an aircraft undershooting or overrunning the runway, enhance the deceleration and facilitate the movement of rescue and fire fighting vehicles.

(2) Where a runway end safety area is provided, consideration should 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 should extend up to this facility. In other circumstances and on a non-precision approach or non-instrument runway, the first upstanding obstacle may be a road, a railroad or other constructed or natural feature. In such circumstances, the runway end safety area should extend as far as the obstacle.

(2) Where provision of a runway end safety area may involve encroachment in areas where it would be particularly prohibitive to implement, and the appropriate authority considers a runway end safety area essential, consideration may have to be given to reducing some of the declared distances.

(3) The surface of the ground in the runway end safety area does not need to be prepared to the same quality as the runway strip.

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(4) The aerodrome operator should strive for a 240 m length RESA (120 m for code 1 and 2). If it is not practicable the procedure given below should apply.
Aerodrome operators should review and determine the RESA dimensions required for individual circumstance, taking into account in their risk assessments factors such as:

- the nature and location of any hazard beyond the runway end;
- the type of aircraft and level of traffic at the aerodrome, and actual or proposed changes to either;
- aerodrome overrun history;
- overrun causal factors;
- friction and drainage characteristics of the runway;
- navigation aids available;
- scope for procedural risk mitigation measures;
- the net overall effect on safety of any proposed changes, including reduction of declared distances, and
- mitigation measures (as arresting systems, reduction of declared distances…).

(b) Slopes on runway end safety areas
(1) A runway end safety area surface should not penetrate Obstacle limitation surfaces.

(2) The longitudinal slopes of a runway end safety area should not exceed a downward slope of 5 per cent. Longitudinal slope changes should be as gradual as practicable and abrupt changes or sudden reversals of slopes avoided.

(3) Transverse slopes
The transverse slopes of a runway end safety area should not exceed an upward or downward slope of 5 per cent. Transitions between differing slopes should be as gradual as practicable.

IEM-GAR 1.F020
Runway end safety areas

(1) See subpart G for information regarding; objects, siting and construction of equipment and installations on runway end safety areas

(2) Guidance on strength of a runway end safety area is given in the ICAO Aerodrome Design Manual, Part 1.

AMC-GAR 1.F025
Clearways

(a) Slopes on clearway

(1) The ground in a clearway should not project above a plane having an upward slope of 1.25 per cent, the lower limit of this plane being a horizontal line which:
a) is perpendicular to the vertical plane containing the runway centre line; and
b) passes through a point located on the runway centre line at the end of the take-off run available.

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

(3) Abrupt upward changes in slope should 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

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slopes, slope changes and the transition from runway to clearway should generally conform with those of the runway with which the clearway is associated.

IEM-GAR 1.F025
Clearways

(1) Annex 14 Attachment A 2.1 give guidance for providing a clearway.

(2) Information regarding sitting and construction of equipment and installations on clearways is in subpart K.

AMC-GAR 1.F030
Stopways

(a) Slopes on stopways
(1) Slopes and changes in slope on a stopway, and the transition from a runway to a stopway, should comply with the specifications of GAR 1.F002 Runways and AMC-GAR 1.F002 for the runway with which the stopway is associated except that:

(i) the limitation of a 0.8 per cent slope for cat II and cat III runway for the first and last quarter m of the length of a runway would need not be applied to the stopway; and

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

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IEM-GAR 1.F030
Stopways

(1) Annex 14 Attachment A 2.1 give guidance for providing a stopway.

AMC-GAR 1.F035
Radio altimeter operating area

(a) Characteristics of the terrain
(1) The ground below the last part of the final approach of a precision approach runway should be sufficiently regular and level for the safety of the approaches making use of a radio altimeter.

(2) When underlying terrain is irregular, consideration should be given to alterations of terrain or use of radar reflectors to stabilize radio altimeter signals in the area preceding the runway.
Any additions or alterations to existing structures or terrain in the prethreshold area should be monitored to determine any effect on published information. In the event that an alteration has a significant effect on radio altimeters, then the amended data relating to the terrain profile should be rapidly disseminated.

(3) Characteristics of the terrain prior to the radio operating area should be in relation to the precision approach category and the aircraft types expected to use the runway for precision approaches.

(4) Where the characteristics of the terrain are considered marginal for a particular aircraft type, the performance or function of the automatic flight control system or other use of the radio altimeter should not be adversely affected.
This may be demonstrated by flight trials or a suitable analysis.

(b) Length of the area
(1) A radio altimeter operating area should extend before the threshold for a distance of at least 300 m.

(2) A radio altimeter operating area should extend laterally, on each side of the extended centre line of the runway, to a distance of 60 m, except that, when special circumstances so warrant, the distance may be reduced

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to no less than 30 m if an aeronautical study indicates that such reduction would not affect the safety of operations of aircraft.

IEM-GAR 1.F035
Radio altimeter operating area

(a) Purposes of Radio altimeter
(1) Radio altimeter is used by the pilot particularly to determine the decision height. The determination of decision height by means of the radio altimeter may require consideration of the approach terrain out to 1 000 m from the threshold.

(2) Radio altimeter inputs may also be required when the aircraft is on final approach as much as 8 km (5 NM) from touchdown; at aerodromes where the terrain beneath the approach flight path is not approximately level, abnormal autopilot behavior may result.
Input from radio altimeter(s) is also used for the operation of the ground proximity warning system (GPWS).

AMC-GAR 1.F040
Taxiways

(a) Width of taxiways
(1) The design of a taxiway should be such that, when the cockpit of the aeroplane for which the taxiway is intended remains over the taxiway centre line markings, the clearance distance between the outer main wheel of the aeroplane and the edge of the taxiway shall be not less than that given by the following tabulation:

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

Note1. — Wheel base means the distance from the nose gear to the geometric centre of the main gear.

(2) A straight portion of a taxiway should have a width of not less than that given by the following tabulation:

Code letter	Taxiway width
A	7.5 m
B	10.5 m
C	15 m if the taxiway is intended to be used by aeroplanes with a wheel base less than 18 m; 18 m if the taxiway is intended to be used by aeroplanes with a wheel base equal to or greater than 18 m.
D	18 m if the taxiway is intended to be used by aeroplanes with an outer main gear wheel span of less than 9 m; 23 m if the taxiway is intended to be used by aeroplanes with an outer main gear wheel span equal to or greater than 9 m.
E	23 m
F	25 m

(2) Where the code letter is F and the traffic density is high, a wheel-to-edge clearance greater than 4.5 m may be necessary to permit higher taxiing speeds.

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(b) Taxiways curves

(1) The radii of the curves should be compatible with the manoeuvring capability of the aeroplanes for which the taxiway is intended. The design of the curve should be such that, when the cockpit of the aeroplane remains over the taxiway centre line markings, the clearance distance between the outer main wheels of the aeroplane and the edge of the taxiway should not be less than those specified in AMC-GAR 1.F040 (b).

Note 1. — An example of widening taxiways to achieve the wheel clearance specified is illustrated in Figure 3-2.

Note 2. — Compound curves may reduce or eliminate the need for extra taxiway width.

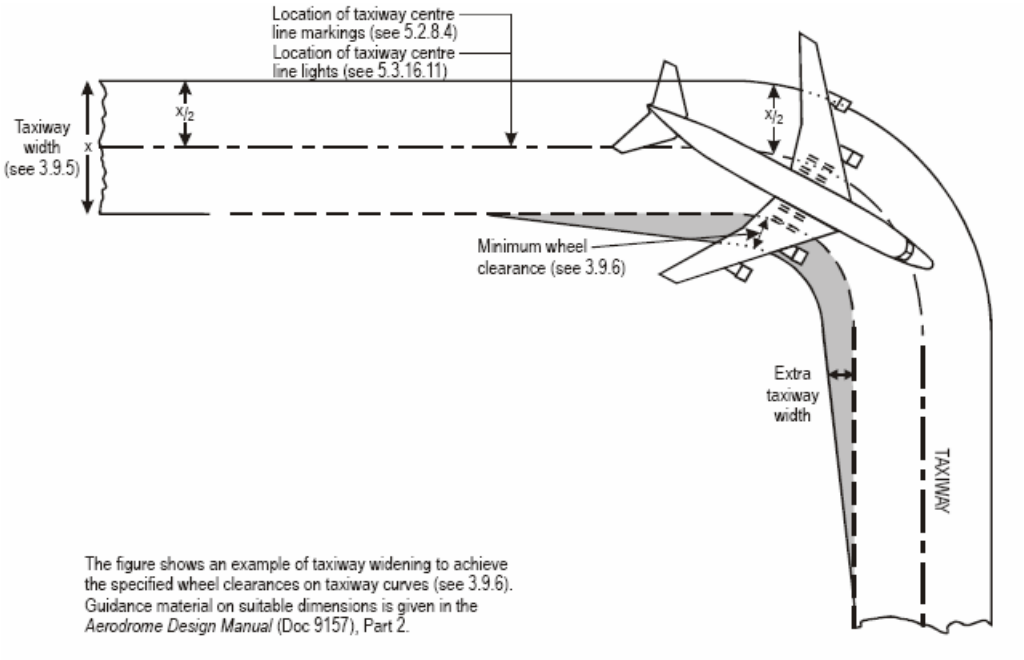

Figure 3.2: Taxiway curve

(c) Slopes on taxiways

(1) The longitudinal slope of a taxiway should not exceed:

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

(ii) 3 per cent where the code letter is A or B.

(2) 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:

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

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

(3) Where a change in slope on a taxiway cannot be avoided, the change should be such that, from any point:

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

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

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

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

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

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(ii) 2 per cent where the code letter is A or B.

(d) Junctions and intersections

(1) Consideration should be given to the aeroplane datum length when designing fillets. The design of the fillets should ensure that the minimum wheel clearances specified in AMC-GAR 1.F040 (b) are maintained when aeroplanes are manoeuvring through the junctions or intersections.

(2) An aeroplane pilot may negotiate a taxiway turn by either maintaining the cockpit over centre line or by judgmental over steering. Existing junctions and intersections may have been designed to accommodate judgmental over steering. Existing junctions and intersections should be provided with fillets to the extent practicable and at the latest when runway centre line lights are installed.

(e) Taxiway minimum separation distances

(1) The separation distance between the centre line of a taxiway and the centre line of a runway, the centre line of a parallel taxiway or an object should not be less than the appropriate dimension specified in Table 1. F040, except that it may be permissible to operate with lower separation distances at an existing aerodrome if an aeronautical study indicates that such lower separation distances would not adversely affect the safety or significantly affect the regularity of operations of aeroplanes. For example, at aerodromes where the separation distances in 1.F040 (a) are not achieved, operational restrictions may include a limitation on the size of aircraft using a particular taxiway, or the sterilization on a taxiway when the runway is in use.

(2) ILS and MLS installations may also influence the location of taxiways due to interferences to ILS and MLS signals by a taxiing or stopped aircraft.

(3) The separation distances of Table 1.F040, column 10, do not necessarily provide the capability of making a normal turn from one taxiway to another parallel taxiway.

(4) The separation distance between the centre line of an aircraft stand taxilane and an object shown in Table 1.F040, column 12, may need to be increased when jet exhaust wake velocity may cause hazardous conditions for ground servicing.

Table 1.F040 Taxiway minimum separation distances

	Distance between taxiway centreline and runway centre line (metres)								Taxiway centre line to taxiway centre line	Taxiway other than aircraft stand taxilane, centre line to object	Aircraft stand taxilane centre line to object
	Instrument runways				Non-instrument runways						
	Code number				Code number						
Code Letter	1	2	3	4	1	2	3	4	(metres)	(metres)	(metres)
(1)	(2) (12)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	
A	82.5	82.5	–	–	37.5	47.5	–	–	23.75	16.25	12
B	87	87	–	–	42	52	–	–	33.5	21.5	16.5
C	–	–	168	–	–	–	93	–	44	26	24.5
D	–	–	176	176	–	–	101	101	66.5	40.5	36
E	–	–	–	182.5	–	–	–	107.5	80	47.5	42.5
F	–	–	–	190	–	–	–	115	91	49	47.5

Note 1. — The separation distances shown in columns (2) to (9) represent ordinary combinations of runways and taxiways.

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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

(f) Strength of taxiways
(1)The bearing strength of the unpaved taxiway should be determined.

(2) Due consideration should be given to the fact that a taxiway will be subjected to a greater density of traffic and, as a result of slow moving and stationary aeroplanes, to higher stresses than the runway it serves.

(g) Rapid exit taxiways
(1) Provision of rapid exit taxiways should be considered when traffic volumes are high.

(2) A rapid exit taxiway should be designed with a radius of turn-off curve of at least:
(i) 550 m where the code number is 3 or 4; and
(ii) 275 m where the code number is 1 or 2;
to enable exit speeds under wet conditions of:
(i) 93 km/h where the code number is 3 or 4; and
(ii) 65 km/h where the code number is 1 or 2.

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

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

(5) The intersection angle of a rapid exit taxiway with the runway should be preferably 30°, and should not be greater than 45° nor less than 25°.

(h)Taxiways on bridges
(1) If aeroplane engines overhang the bridge structure, protection of adjacent areas below the bridge from engine blast may be required.

IEM-GAR 1.F040
Taxiways

(a) Taxiways curves
Guidance on the values of suitable dimensions for taxiway curves is given in the Aerodrome Design Manual (Doc 9157), Part 2.

(b) Junctions and intersections
Guidance on the design of fillets and the definition of the term aeroplane datum length are given in the Aerodrome Design Manual (Doc 9157), Part 2.

(c) Taxiway minimum separation distances
(1) Guidance on factors which may be considered in the aeronautical study is given in the Aerodrome Design Manual, Part 2.

(2) Information on critical and sensitive areas surrounding ILS and MLS installations is contained in ICAO Annex 10, Volume I, Attachments C and G (respectively) to Part 1

(3) Guidance for the capability of making a normal turn from one taxiway to another parallel taxiway is given in the Aerodrome Design Manual, Part 2.

(4) The basis for development of these distances is given in the Aerodrome Design Manual, Part 2.

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AMC-GAR.1.F045
Taxiway shoulder

(a) General
(1) The main purpose of the provision of a taxiway shoulder is to prevent jet engines that overhang the edge of a taxiway from ingesting stones or other objects that might damage the engine and to prevent erosion of the area adjacent to the taxiway.

(b) Taxiway shoulder width
(1) The widths that should be provided for taxiway shoulders are as in the following table:

	A	B	C	D	E	F
Taxiway pavement with shoulders	-	-	25	38	44	60

(2) The surface of the shoulder that abuts the taxiway should be flush with the surface of the taxiway. The type of surface of the taxiway shoulder will depend on local conditions and contemplated methods and cost of maintenance.

(3) These areas should thus be prepared or constructed so as to reduce the risk of damage to an aircraft running off the taxiway and be capable of supporting access by rescue and fire fighting vehicles and other ground vehicles, as appropriate, over its entire area.

(4) The taxiway shoulder should, on both side of the taxiway extend from the taxiway centreline to a distance not less than in figures from table B GAR.1FO45

AMC-GAR 1.F050
Taxiway strips
(a)Width of the taxiway strip
The width of the taxiway strip should not be less than the distances provided in table F1.040 column 11.

(b) Width of taxiway strip graded area
Either side of the taxiway centerline (measured perpendicularly to the centerline) should not be less than figure provided in table B

(a) Slopes on taxiway strips
(1) The graded portion should not have an upward transverse slope exceeding:
(i) 2.5 per cent for strips where the code letter is C, D, E or F; and
(ii) 3 per cent for strips of taxiways where the code letter is A or B;
the upward slope being measured with reference to the transverse slope of the adjacent taxiway surface and not the horizontal.

(2) The downward transverse slope should not exceed 5 per cent measured with reference to the horizontal.

(3) The transverse slopes on any portion of a taxiway strip beyond that to be graded should not exceed an upward slope of 5 per cent as measured in the direction away from the taxiway.

(b) Drainage
Consideration will have to be given to the location and design of drains on a taxiway strip to prevent damage to an aeroplane accidentally running off a taxiway. Suitably designed drain covers may be required.

AMC-GAR 1.F055
Holding bays, runway-holding positions, intermediate holding positions and road-holding positions

(a) General
(1) Holding bay(s) should be provided when the traffic density is medium or heavy.

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(2) 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.

(b) ***Location***
(1) At elevations greater than 700 m (2300 ft) the distance of 90 m specified in Table 1.F055 for a precision approach runway code number 4 should be increased as follows:

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

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

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

(2) If a holding bay, runway-holding position or road-holding position for a precision approach runway code number 4 is at a greater elevation compared to the threshold, the distance of 90 m or 107.5 m, as appropriate, specified in Table 1.F055 should be further increased 5 m for every meter the bay or position is higher than the threshold.

IEM-GAR 1.F055
Holding bays, runway-holding positions, intermediate holding positions and road-holding positions

(a) Location
(1) The distance of 90 m for code number 3 or 4 is based on an aeroplane 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.

(2) The distance of 60 m for code number 2 is based on an aeroplane 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.
(3) 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.

AMC -GAR 1.F060
Apron

(a) Slopes on apron
(1) Slopes on an apron, including those on an aircraft stand taxilane, should be sufficient to prevent accumulation of water on the surface of the apron but should be kept as level as drainage requirements permit.

(2) On an aircraft stand the maximum longitudinal slope should not exceed 1 per cent.

(b) Clearances on apron
(1) An aircraft stand should provide the following minimum clearances between an aircraft using the stand and any adjacent building, aircraft on another stand and other objects:

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

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

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

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

(c) Bearing strength

(1) The bearing strength of the unpaved apron should be determined.

IEM -GAR 1.F060
Apron

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

(2) On aprons, consideration also should be given to the provision of service roads and to maneuvering and storage area for ground equipment.

AMC-GAR 1.F065
Isolated aircraft parking position

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

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