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GCAA
ADVISORY CIRCULAR

AERODROME & GROUND AIDS
AC NO: GCAA AC/AGA/007

SUBJECT: **AIRCRAFT/AERODROME COMPATIBILITY**

DATE INITIATED: JULY 15, 2016
INITIATED BY: DIRECTOR AVIATION SAFETY REGULATION

1. PURPOSE

The purpose of this Advisory Circular (AC) is to provide guidance on the methodology and procedures to be used when assessing compatibility between aircraft operations and aerodrome infrastructure regarding aircraft that exceeds the approved design characteristics of an aerodrome.

2. APPLICABILITY

This is an initial Advisory Circular GCAA AC/AGA/007 is an initial issue and the effective date is January 1, 2017.

3. GENERAL INFORMATION

It is required that aerodromes are designed to accommodate the size, weight and operational characteristics of all aircraft that are to be operated into and out of the aerodrome. Consequently, a compatibility study must be performed collaboratively between affected stakeholders, such as, the aerodrome operator, aircraft operators, ground handling agencies and the air navigation service provider (ANSP).

4. RELATED REFERENCES

a. International Civil Aviation Organisation (ICAO) Annex 14 to the Convention on International Civil Aviation – International Standards and Recommended Practices: Aerodromes.

b. ICAO – Document 9157 – AN/901 – Aerodrome Design Manual – Part 3 – Pavements.

5. CONTACT INFORMATION

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6. ACCOMODATION OF NEW AIRCRAFT TYPE OR SUBTYPE

a. Aerodrome operators must methodically assess the compatibility between an aircraft operational characteristics versus the prevailing aerodrome infrastructure before considering allowing new type or subtype of aircraft to operate into the aerodrome, especially, if the aircraft will, or likely to, exceed the certified design of the aerodrome.

b. When introducing new aircraft types or subtypes to an aerodrome, both aircraft and aerodrome operator shall take the following course of action:

1) the aircraft operator shall submit a request in writing to the aerodrome operator requesting permission to operate the new type or subtype of aircraft into the aerodrome;

2) the aerodrome operator shall do a compatibility study which shall identify possible means for accommodating the new aircraft type or subtype, as requested, including, provision for access to movement areas and, if necessary, consider the feasibility and economic viability of upgrading the aerodrome infrastructure to meet the requirement of the new aircraft type or subtype; and

3) both, the aerodrome and aircraft operators shall discuss the aerodrome operator's assessment. The assessment shall take into consideration the following:

i. likely resultant consequences that may evolve during operation of the new aircraft type or subtype;

ii. whether the aerodrome will be able to accommodate the aircraft size, weight and operational specifications/characteristics; and

iii. the conditions under which it would operate safely.

7. COMPATIBILITY STUDY

a. An aerodrome operator along with the aircraft operator shall carry out a compatibility study to ascertain whether an aircraft can operate safety at the aerodrome. This is especially so if it is indeterminate whether the physical and operational characteristics of the aircraft is compatible with the physical features and characteristics of the aerodrome.

b. The compatibility study shall include the following procedures:

1) identify the aircraft's physical and operational characteristics;

2) identify the applicable regulatory requirements;

3) establish the adequacy of the aerodrome infrastructure and facilities vis-à-vis the requirements of the new aircraft;

4) identify the changes required to the aerodrome;

5) document the compatibility study; and

6) perform the required safety assessments identified during the compatibility study.

c. A compatibility study shall require a review of the obstacle limitation surfaces at an aerodrome.

d. For aerodrome operations in low visibility conditions, additional procedures shall be implemented in order to safeguard the operation of all aircraft.

e. Additional processes that ensure suitable measures are in place to protect the signal produced by the ground-based radio navigation equipment may be necessary at aerodromes with precision instrument approaches.

f. The result of the compatibility study shall provide the aerodrome operator with the necessary information to make a proper decision, as follows:

   1) whether to permit the type or subtype of aircraft to operate at the aerodrome; and

   2) whether the changes required to the aerodrome infrastructure and facilities will ensure safe aircraft operations at the aerodrome, as well as, harmonious future development of the aerodrome.

g. The result of the compatibility study shall also provide the GCAA with the information necessary for safety oversight and the continued monitoring of the conditions specified in the approved aerodrome operations manual and approval certificate.

h. Each compatibility study shall be specific to a particular operational context and to a particular type of aircraft. Information resulting from the compatibility study that is considered to be of operational significance shall be published in accordance with GCAA Regulations.

8. IMPACT OF AIRCRAFT CHARACTERISTICS ON THE AERODROME INFRASTRUCTURE

a. Introducing new types of aircraft into existing aerodromes may have an impact on the aerodrome facilities and services, in particular, when the aircraft characteristics exceed the parameters that were used for planning the aerodrome.

b. The parameters used in aerodrome planning are defined in ICAO Annex 14, which specifies the use of the aerodrome reference code determined in accordance with the characteristics of the aircraft for which an aerodrome facility is intended. The aerodrome reference code provides a starting point for the compatibility study and may not be the sole means used to conduct the analysis.

c. The individual facilities required at an aerodrome are interrelated by the aerodrome reference code. The design of these facilities can be found in ICAO Annex 14.

9. CONSIDERATION OF THE AIRCRAFT'S PHYSICAL CHARACTERISTICS

9.1 General Statement

The new type or subtype aircraft's physical characteristics may influence the aerodrome dimensions, facilities and services in the movement area.

9.2 Aircraft Physical Characteristics

a. **Fuselage length.** The fuselage length may have an impact on:

   1) the dimensions of the movement area (taxiway, holding bays and aprons), passenger gates and terminal areas;

2) the aerodrome category for rescue and firefighting (RFF);

3) ground movement and control (e.g. reduced clearance behind a longer aircraft holding at an apron or a runway/intermediate holding position to permit the passing of another aircraft); and

4) clearances at the aircraft stand.

b. **Fuselage width.** The fuselage width is used to determine the aerodrome category for RFF.

c. **Door sill height.** The door sill height may have an impact on:

1) the operational limits of the air bridges;

2) mobile steps;

3) catering trucks;

4) persons with reduced mobility; and

5) dimensions of the apron.

d. **Aircraft nose characteristics.** The aircraft nose characteristics may have an impact on the location of the runway-holding position of the aircraft which should not infringe the obstacle free zone (OFZ).

e. **Tail height.** The tail height may have an impact on:

1) the location of the runway-holding position;
2) instrument landing system (ILS) critical and sensitive areas:
   i. in addition to the tail height of the critical aircraft,
   ii. tail composition, tail position, and
   iii. fuselage height and length can have an effect on ILS critical and sensitive areas;
3) the dimensions of aircraft maintenance services;
4) aircraft parking position (in relation to aerodrome obstacle limitation surface [OLS]);
5) runway/parallel taxiway separation distances; and
6) the clearance of any aerodrome infrastructure or facilities built over stationary or moving aircrafts.

f. **Wingspan.** The wingspan may have an impact on:

1) Runway/taxiway/taxi lane separation distances;

2) the dimensions of the OFZ;

3) the location of the runway-holding position (due to the impact of the wingspan on OFZ dimensions);

4) the dimensions of aprons and holding bays;

5) wake turbulence;

6) gate selection;

7) aerodrome maintenance services (hangar and maintenance equipment) around the aircraft; and

8) equipment for disabled aircraft removal.

g. **Wing tip vertical clearance.** The wing tip vertical clearance may have an impact on:

1) taxiway separation distances with height-limited objects;
2) apron and holding bay clearances with height-limited objects;
3) aerodrome maintenance services (hangar and maintenance equipment clearances);
4) airfield signage clearances; and
5) service road locations.

h. **Cockpit view.** The relevant geometric parameters to assess the cockpit view are cockpit height, cockpit cut-off angle and the corresponding obscured segment. The cockpit view may have an impact on:

1) runway visual references (aiming point);
2) runway sight distance;
3) taxiing operations on straight and curved sections;
4) markings and signs on runways, turn pads, taxiways, aprons and holding bays;
5) lights:
   i. in low visibility conditions,
   ii. the number and spacing of visible lights when taxiing may depend on the cockpit view; and
6) calibration of PAPI/VASIS (pilot eye height above wheel height on approach).

Cockpit view with reference to the obscured segment is also affected by the attitude of the aircraft on approach.

i. **Distance from the pilot's eye position to the nose landing gear.** The design of taxiway curves is based on the cockpit-over-centre-line concept. The distance from the pilot's eye position to the nose landing gear is relevant for:

1) taxiway fillets (wheel track);
2) the dimensions of aprons and holding bays; and
3) the dimensions of turn pads.

j. **Landing gear design.** The aircraft landing gear design is such that the overall mass of the aircraft is distributed so that the stresses transferred to the soil through a well-designed pavement are within the bearing capacity of the soil. The landing gear layout also has an effect on the manoeuvrability of the aircraft and the aerodrome pavement system.

k. **Outer main gear wheel span.** The outer main gear wheel span may have an impact on:

1) runway width;
2) the dimensions of turn pads;
3) taxiway width;
4) taxiway fillets;
5) the dimensions of aprons and holding bays; and
6) the dimension of the OFZ.

l. **Wheelbase.** The wheelbase may have an impact on:

1) the dimensions of turn pads;
2) taxiway fillets;
3) the dimensions of aprons and holding bays; and
4) terminal areas and aircraft stands.

m. **Gear steering system.** The gear steering system may have an impact on the dimensions of turn pads, and the dimensions of aprons and holding bays.

n. **Maximum aircraft mass.** The maximum mass may have an impact on:

1) the mass limitation on existing bridges, tunnels, culverts and other structures under runways and taxiways;
2) disabled aircraft removal;
3) wake turbulence; and
4) arresting systems when provided as an element of kinetic energy.

o. **Landing gear geometry, tyre pressure and aircraft classification number (ACN) values.** Landing gear geometry, tyre pressure and ACN values may have an impact on the airfield pavement and associated shoulders.

p. **Engine characteristics.** The engine characteristics include engine geometry and engine airflow characteristics, which may affect aerodrome infrastructure as well as ground handling of the aircraft and operations in adjacent areas which are likely to become affected by jet blast:

1) The engine geometry aspects are:
   i. the number of engines;
   ii. the location of engines (span and length);
   iii. the vertical clearance of engines; and
   iv. the vertical and horizontal extent of possible jet blast or propeller wash.
2) The engine airflow characteristics are:
   i. idle, breakaway and take-off thrust exhaust velocities;
   ii. thrust reverser fitment and flow patterns; and
   iii. inlet suction effects at ground level.
3) The engine characteristics may be relevant for the following aerodrome infrastructure and operational aspects:
   i. runway shoulder width and composition (jet blast and ingestion issues during take-off and landing);
   ii. shoulder width and composition of runway turn pads;
   iii. taxiway shoulder width and composition (jet blast and ingestion issues during taxiing);
   iv. bridge width (jet blast under the bridge);
   v. the dimensions and location of blast protection fences;

vi. the location and structural strength of signs;

vii. the characteristics of runway and taxiway edge lights;

viii. the separation between aircraft and adjacent ground service personnel, vehicles or passengers;

ix. the design of engine run-up areas and holding bays;

x. the design and use of functional areas adjacent to the manoeuvring area;

xi. the design of air bridges; and

xii. the location of refuelling pits on the aircraft stand.

4) **Maximum passenger- and fuel-carrying capacity.** Maximum passenger-and fuel-carrying capacity may have an impact on:

i. terminal facilities;

ii. fuel storage and distribution;

iii. aerodrome emergency planning;

iv. aerodrome rescue and firefighting; and

v. air-bridge loading configuration.

5) **Flight performance.** Flight performance may have an impact on:

i. runway width;

ii. runway length;

iii. the OFZ;

iv. runway/taxiway separation;

v. wake turbulence;

vi. noise; and

vii. aiming point marking.

6) **Consideration of the aircraft's operational characteristics.** In order to adequately assess aerodrome compatibility, aircraft operational characteristics shall be included in the evaluation process. The operational characteristics shall include the infrastructure requirements of the aircraft as well as ground servicing requirements. These characteristics are detailed below:

i. ***Aircraft ground servicing requirements.*** The following list of aircraft ground servicing characteristics and requirements may affect the available aerodrome infrastructure. This list is not exhaustive; additional items may be identified by the stakeholders involved in the compatibility assessment process:

- ground power;
- passengers embarking and disembarking;
- cargo loading and unloading;
- fuelling;
- pushback and towing;

- taxiing and marshalling;
- aircraft maintenance;
- rescue and firefighting;
- equipment areas;
- stand allocation; and
- disabled aircraft removal.

ii. ***Physical characteristics of aerodrome.*** In order to adequately assess the aircraft's compatibility, aerodrome physical characteristics should be included in the evaluation process.

7) **Runway length.** Runway length is a limiting factor on aircraft operations and should be assessed in collaboration with the aircraft operator.

8) **Selected aircraft characteristics.** Information on aircraft reference field length can be found in the table below. The data therein are provided for convenience, are subject to change and should be used only as a guide. Accurate data should be obtained from the aircraft manufacturer's documentation. Many aircraft types have optional weights and different engine models and engine thrusts; therefore, pavement aspects and reference field lengths will vary, in some cases enough to change the aircraft category. Reference field length should not be used for the design of aerodrome runway length, as the required length will vary depending on various factors such as aerodrome elevation, reference temperature, runway slope, etc. Longitudinal slopes can also have an effect on aircraft performance.

AIRCRAFT MODEL	TAKE-OFF WEIGHT (KG)	CODE	REFERENCE FIELD LENGTH (M)*	WINGSPAN (M)	OUTER MAIN GEAR WHEEL SPAN (M)	NOSE GEAR TO MAIN GEAR DISTANCE (WHEEL BASE) (M)	COCKPIT TO MAIN GEAR DISTANCE (M)	FUSELAGE LENGTH (M)	OVERALL (MAXIMUM) LENGTH (M)	MAXIMUM TAIL HEIGHT (M)	APPROACH SPEED (1.3 × VS) (KT)	MAXIMUM EVACUATION SLIDE LENGTH (M)*****
AIRBUS												
A310-300	164 000	4D	2 350	43.9	11	15.2 2	1.9	45.9	46.7	16	139	6.9
A330-200	233 000	4E	2 479	60.3	12.6	22.2	28.9	57.3	58.4	18.2	136	11.5
A330-300	233 000	4E	2 490	60.3	12.6	25.4	32	62.6	63.7	17.2	137	11.5
A340-200	275 000	4E	2 906	60.3	12.6	22.2	28.9	58.3	59.4	17	136	11
A340-300	276 500	4E	2 993	60.3	12.6	25.4	32	62.6	63.7	17	139	11
A340-500	380 000	4E	3 023	63.4	12.6	28	34.5	66	67.9	17.5	142	10.9
A340-600	380 000	4E	2 864	63.4	12.6	33.1	39.8	73.5	75.4	17.9	148	10.5
A380-800	560 000	4F	2 779	79.8	14.3	29.7	36.4	70.4	72.7	24.4	138	15.2
ANTONOV												
An-2	5 500	1B	500	18.2	3.4	8.3	–0.6	12.7	12.4	4.1	62	
An-3	5 800	1B	390	18.2	3.5	8.3	–0.6	14	13.9	4.9	65	
An-28	6 500	1B	585	22.1	3.4	4.4	3.1	12.7	13.1	4.9	89	
An-38-100	9 500	2B	965	22.1	3.4	6.2	4.9	15.3	15.7	5.5	108	
An-38-200	9 930	2B	1 125	22.1	3.4	6.2	4.9	15.3	15.7	5.5	119	
An-24	21 000	3C	1 350	29.2	7.9	7.9	7.6	23.8	23.8	8.6	119	
An-24PB	22 500	3C	1 600	29.2	7.9	7.9	7.6	23.8	23.8	8.6	119	
An-30	22 100	3C	1 550	29.2	7.9	7.4	7.6 2	4.3	24.3	8.6	113	
An-32	27 000	3C	1 600	29.2	7.9	7.9	7.6	23.7	23.7	8.8	124	
An-148-100A	38 950	3C	1 740	28.9	4.6	10.6	10.6	26.1	29.1	8.2	124	
An-70	139 000	3D	1 610	44.1	5.9	14	14.9	39.7	40.6	16.4	151	
An-26B	25 000	4C	2 200	29.2	7.9	7.7	7.6	23.8	23.8	8.8	124	

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ANTANOV												
An-32B-100	28 500	4C	2 080	29.2	7.9	7.9	7.6	23.7	23.7	8.8	127	
An-74	34 800	4C	1 920	31.9	4.1	8	8.5	28.1	28.1	8.7	108	
An-74TK-100	36 500	4C	1 920	31.9	4.1	8	8.5	28.1	28.1	8.8	108	
An-74T-200	36 500	4C	2 130	31.9	4.1	8	8.5	28.1	28.1	8.8	108	
An-148-100E	43 700	4C	2 060	28.9	4.6	10.6	10.6	26.1	29.1	8.2	124	
An-168***	43 700	4C	2 060	28.9	4.6	10.6	10.6	26.1	29.1	8.2	124	
An-12	61 000	4D	1 900	38	5.4	9.6	11.1	33.1	33.1	10.5	151	
An-22	225 000	4E	3 120	64.4	7.4	17.3	21.7	57.8	57.8	12.4	153	
An-124-100	392 000	4F	3 000	73.3	9	22.8	25.6	69.1	69.1	21.1	154	
An-124-100M15	402 000	4F	3 200	73.3	9	22.8	25.6	69.1	69.1	21.1	160	
An-225	640 000	4F	3 430	88.4	9.01	29.3	16.27	76.62	84	18.1	167	
An-74TK-300	37 500	4C	2 200	31.9	4.1	8	8.5	28.1	28.1	8.7	116	
An-140	21 000	4C	1 880	24.5	3.7	8.1	7.8	21.6	22.6	8.2	124	
An-140-100	21 500	4C	1 970	25.5	3.7	8.1	7.8	21.6	22.6	8.2	124	
An-148-100B	41 950	4C	2 020	28.9	4.6	10.6	10.6	26.1	29.1	8.2	124	
BOEING												
707-320C	152 407	4D	3 079	44.4	8	18	20.9	44.4	46.6	13	137	6.6
717-200	54 885	3C	1 670	28.4	5.9	17.6	17	34.3	37.8	9.1	139	5.3
727-200	95 254	4C	3 176	32.9	7.1	19.3	21.4	41.5	46.7	10.6	136	6.1
727-200W	95 254	4C	3 176	33.3**	7.1	19.3	21.4	41.5	46.7	10.6	136	6.1
737-300	62 823	4C	2 170	28.9	6.4	12.4	14	32.2	33.4	11.2	133	7
737-300/W	62 823	4C	2 550	31.2**	6.4	12.4	14	32.2	33.4	11.2	133	7
737-400	68 039	4C	2 550	28.9	6.4	12.4	15.9	35.2	36.4	11.2	139	7
737-500	60 555	4C	2 470	28.9	6.4	11.1	12.7	29.8	31	11.2	128	7
737-600	65 091	3C	1 690	34.3	7	11.2	12.8	29.8	31.2	12.7	125	7
737-600/W	65 544	3C	1 640	35.8**	7	11.2	12.9	29.8	31.2	12.7	125	7
737-700	70 080	3C	1 600	34.3	7	12.6	14.2	32.2	33.6	12.7	130	7
737-700/W	70 080	3C	1 610	35.8**	7	12.6	14.2	32.2	33.6	12.7	130	7
737-800	79 016	4C	2 090	34.3	7	15.6	17.2	38	39.5	12.6	142	7
737-800/W	79 016	4C	2 010	35.8**	7	15.6	17.2	38	39.5	12.6	142	7
737-900	79 016	4C	2 240	34.3	7	17.2	18.8	40.7	42.1	12.6	141	7
737-900ER/W	84 912	4C	2 470	35.8**	7	17.2	18.8	40.7	42.1	12.6	141	7
747-SP	318 875	4E	2 710	59.6	12.4	20.5	22.9	53.9	56.3	20.1	140	14.3
747-100	341 555	4E	3 060	59.6	12.4	25.6	28	68.6	70.4	19.6	144	11.8
747-200	379 203	4E	3 150	59.6	12.4	25.6	28	68.6	70.4	19.6	150	11.8
747-300	379 203	4E	3 292	59.6	12.4	25.6	28	68.6	70.4	19.6	152	14.3
747-400ER	414 130	4E	3 094	64.9	12.6	25.6	27.9	68.6	70.7	19.6	157	14.3
747-400	396 893	4E	3 048	64.9	12.6	25.6	27.9	68.6	70.7	19.5	157	14.3
747-8	442 253	4F	3 070	68.4	12.7	29.7	32	74.2	78	19.2	150***	15.7
747-8F	442 253	4F	3 070	68.4	12.7	29.7	32	74.2	78	19.2	159***	11.7
757-200/W	115 666	4D	1 980	41.1**	8.6	18.3	22	47	47.3	13.7	137	9.3
757-300	122 470	4D	2 400	38.1	8.6	22.3	26	54.4	54.4	13.7	143	9.3
767-200	163 747	4D	1 981	47.6	10.8	19.7	24.3	47.2	48.5	16.1	135	8.7
767-200ER	179 623	4D	2 743	47.6	10.8	19.7	24.3	47.2	48.5	16.1	142	8.7
767-300	163 747	4D	1 981	47.6	10.9	22.8	27.4	53.7	54.9	16	140	8.7
767-300ER	186 880	4D	2 540	47.6	10.9	22.8	27.4	53.7	54.9	16	145	8.7
767-300ER/W	186 880	4D	2 540	50.9**	10.9	22.8	27.4	53.7	54.9	16	145	8.7
767-400ER	204 117	4D	3 140	51.9	11	26.2	30.7	60.1	61.4	17	150	9.7
777-200	247 208	4E	2 380	60.9	12.9	25.9	28.9	62.9	63.7	18.7	136	12
777-200ER	297 557	4E	2 890	60.9	12.9	25.9	28.9	62.9	63.7	18.7	139	12

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BOEING												
777-200LR	347 815	4E	3 390	64.8	12.9	25.9	28.9	62.9	63.7	18.7	140	12
777-300	299 371	4E	3 140	60.9	12.9	31.2	32.3	73.1	73.9	18.7	149	12.6
777-300ER	351 534	4E	3 060	64.8	12.9	31.2	32.3	73.1	73.9	18.8	149	12.6
B787-8	219 539	4E	2 660	60.1	11.6	22.8	25.5	55.9	56.7	16.9	140***	11.1
McDONALD DOUGLAS												
MD-81	MD-81	MD-81	MD-81	MD-81	MD-81	MD-81	MD-81	MD-81	MD-81	MD-81	MD-81	MD-81
MD-82	MD-82	MD-82	MD-82	MD-82	MD-82	MD-82	MD-82	MD-82	MD-82	MD-82	MD-82	MD-82
MD-83	MD-83	MD-83	MD-83	MD-83	MD-83	MD-83	MD-83	MD-83	MD-83	MD-83	MD-83	MD-83
MD-87	MD-87	MD-87	MD-87	MD-87	MD-87	MD-87	MD-87	MD-87	MD-87	MD-87	MD-87	MD-87
MD-90	70 760	3C	1 800	32.9	6.2	23.5	22.9	43	46.5	9.5	138	5.3
MD-11	285 990	4D	3 130	51.97	12.6	24.6	31	58.6	61.6	17.9	153	9.8
DC8-62	158 757	4D	3 100	45.2	7.6	18.5	20.5	46.6	48	13.2	138	6.7
DC9-15	41 504	4C	1 990	27.3	6	13.3	12.7	28.1	31.8	8.4	132	5.3
DC9-20	45 813	3C	1 560	28.4	6	13.3	12.7	28.1	31.8	8.4	126	5.3
DC9-50	55 338	4C	2 451	28.5	5.9	18.6	18	37	40.7	8.8	135	5.3
BOMBARDIER												
CS100****	54 930	3C	1 509	35.1	8	12.9	13.7	34.9	34.9	11.5	127	
CS300****	59 783	4C	1 902	35.1	8	14.5	15.3	38.1	38.1	11.5	133	
CS300 XT****	59 783	3C	1 661	35.1	8	14.5	15.3	38.1	38.1	11.5	133	
CS300 ER****	63 321	4C	1 890	35.1	8	14.5	15.3	38.1	38.1	11.5	133	
CRJ200ER	23 133	3B	1 680	21.2	4	11.4	10.8	24.4	26.8	6.3	140	
CRJ200R	24 040	4B	1 835	21.2	4	11.4	10.8	24.4	26.8	6.3	140	
CRJ700	32 999	3B	1 606	23.3	5	15	14.4	29.7	32.3	7.6	135	
CRJ700ER	34 019	3B	1 724	23.3	5	15	14.4	29.7	32.3	7.6	135	
CRJ700R****	34 927	4B	1 851	23.3	5	15	14.4	29.7	32.3	7.6	136	
CRJ900	36 514	3B	1 778	23.3	5	17.3	16.8	33.5	36.2	7.4	136	
CRJ900ER	37 421	4C	1 862	24.9	5	17.3	16.8	33.5	36.2	7.4	136	
CRJ900R	38 329	4C	1 954	24.9	5	17.3	16.8	33.5	36.2	7.4	137	
CRJ1000****	40 823	4C	1 996	26.2	5.1	18.8	18.3	36.2	39.1	7.5	138	
CRJ1000ER****	41 640	4C	2 079	26.2	5.1	18.8	18.3	36.2	39.1	7.5	138	
DHC-8-100	15 650	2C	890	25.9	7.9	8	6.1	20.8	22.3	7.5	101	
DHC-8-200	16 465	2C	1 020	25.9	8.5	8	6.1	20.8	22.3	7.5	102	
DHC-8-300	18 643	2C	1 063	27.4	8.5	10	8.2	24.2	25.7	7.5	107	
DHC-8-400	27 987	3C	1 288	28.4	8.8	14	12.2	31	32.8	8.3	125	
EMBRAER												
ERJ 170-100 STD	35 990	3C	1 439	26	6.2	10.6	11.5	29.9	29.9	9.7	124	
ERJ 170-100 LR,	37 200	3C	1 532	26	6.2	10.6	11.5	29.9	29.9	9.7	124	
ERJ 170-100	38 600	3C	1 644	26	6.2	10.6	11.5	29.9	29.9	9.7	125	
SB 170-00-0016	38 600	3C	1 644	26	6.2	10.6	11.5	29.9	29.9	9.7	125	
ERJ 170-200 STD	37 500	3C	1 562	26	6.2	11.4	12.3	31.7	31.7	9.7	126	
ER 170-200 LR	38 790	3C	1 667	26	6.2	11.4	12.3	31.7	31.7	9.7	126	
SU	38 790	3C	1 667	26	6.2	11.4	12.3	31.7	31.7	9.7	126	
ERJ 170-200	40 370	4C	2 244	26	6.2	11.4	12.3	31.7	31.7	9.7	126	
SB 170-00-0016	40 370	4C	2 244	26	6.2	11.4	12.3	31.7	31.7	9.7	126	
ERJ 190-100 STD	47 790	3C	1 476	28.7	7.1	13.8	14.8	36.3	36.3	10.6	124	
ERJ 190-100 LR	50 300	3C	1 616	28.7	7.1	13.8	14.8	36.3	36.3	10.6	124	
ERJ 190-100 IGW	51 800	3C	1 704	28.7	7.1	13.8	14.8	36.3	36.3	10.6	125	
ERJ 190-200 STD	48 790	3C	1 597	28.7	7.1	14.6	15.6	38.7	38.7	10.5	126	
ERJ 190-200 LR	50 790	3C	1 721	28.7	7.1	14.6	15.6	38.7	38.7	10.5	126	
ERJ 190-200 IGW	52 290	4C	1 818	28.7	7.1	14.6	15.6	38.7	38.7	10.5	128	

THE ASTERISKS IN THE TABLE ABOVE MEAN:

* Reference field length reflects the model/engine combination that provides the shortest field length and the standard conditions (maximum weight, sea level, standard day, A/C off, runway dry with no slope).
** Span includes optional wiinglets.
*** Preliminary data.
**** Preliminary data — aircraft not yet certified.
***** Longest deployed slide lengths, including upper deck slides, referenced from aircraft centre line as measured horizontally. Data are based primarily on aircraft rescue and firefighting charts.

9) **Evacuation Slide length.** Aircraft evacuation slides may be considered a determining factor when doing the compatibility study. Due to the variety of slides and slide manufacturers only the longest slides and average lengths are indicated in the table below. Deployed lengths referenced are from the aircraft center line as measured horizontally. Data are based primarily on aircraft rescue and firefighting charts.

MAXIMUM LENGTH OF EVACUATION SLIDES

MODEL	DEPLOYED LENGTH (2) (METRES)	MODEL	DEPLOYED LENGTH (2) (METRES)
737-600/-700/-800/-900	7.0	A300-600 9.0 747-100/-200 (upper deck)	11.8
747-100/-200 (lower deck)	11.5	A310	6.9
747-300/-400 (upper deck)	14.3	A318	7.2
747-300/-400 (lower deck)	11.5	A319	7.2
757-200/-300	9.3	A320	7.5
767-200/-300	8.7	A321	6.2
5 767-400	9.7	A330-200/-300	11.5
777-200/-200ER/-200LR/-200F	12	A340-200/-300	11
777-300/-300ER	12.6	A340-500	10.9
		A340-600	10.5
		A380	15.2
NOTE 1: The above is a sample. ***NOTE 2: No data available for 787 or 747-8 at this time.***			

10. RUNWAY

a. **Runway width.** Runway width may be a limiting factor, for example:

1) ***Factors affecting aircraft operations*** - For a given runway width, factors affecting aircraft operations include the characteristics, handling qualities and performance demonstrated by the aircraft. It may be advisable to consider other factors of operational significance in order to have a safety margin for factors such as wet or contaminated runway pavement, crosswind conditions, crab angle approaches to landing, aircraft controllability during aborted take-off, and engine failure procedures.

2) ***Challenges*** - The main issue associated with available runway width is the risk of aircraft damage and fatalities associated with an aircraft veering off the runway during take-off, rejected take-off or during the landing. The main causes and accident factors are:

i. for take-off/rejected take-off:

- aircraft (asymmetric spin-up and/or reverse thrust, malfunctioning of control surfaces, hydraulic system, tyres, brakes, nose-gear steering, centre of gravity and power plant (engine failure, foreign object ingestion));
- temporary surface conditions (standing water, dust, residuals (rubber), foreign object debris (FOD), damage to the pavement and runway friction coefficient);
- permanent surface conditions (horizontal and vertical slopes and runway friction characteristics);
- meteorological conditions (e.g. heavy rain, crosswind, strong/gusty winds, reduced visibility); and
- Human factors (crew, maintenance, balance, payload security).

ii. for landing:

- aircraft/airframe (malfunction of the landing gear, control surfaces, hydraulic system, brakes, tyres, nose-gear steering and power plant (reverse and thrust lever linkage);
- temporary surface conditions (standing water, snow, dust, residuals (e.g. rubber), FOD, damage to the pavement and applying runway friction coefficient);
- permanent surface conditions (horizontal and vertical slopes and runway friction characteristics);
- prevailing meteorological conditions (heavy rain, crosswind, strong/gusty winds, thunderstorms/wind shear, reduced visibility);
- Human Factors (i.e. hard landings, crew, maintenance);
- ILS localizer signal quality/interference, where auto-land procedures are used;
- any other localizer signal quality/interference of approach aid equipment;
- lack of approach path guidance such as VASIS or PAPI; and
- approach type and speed.

3) ***Runway excursion -*** The lateral runway excursion is linked to specific aircraft characteristics, performance/handling qualities, controllability in response to such events as aircraft mechanical failures, pavement contamination, winter operations and crosswind conditions. Runway width is not a required specific certification limitation. However, indirectly related is the determination of minimum control speed on the ground (Vmcg) and the maximum demonstrated crosswind. These additional factors should be considered as key factors in order to ensure that this kind of hazard is adequately addressed.

For a specific aircraft, it may be permissible to operate on a runway with a narrower width if approved by the appropriate authorities for such operations. The maximum demonstrated crosswind is included in the aircraft flight manual.

Potential solutions can be developed by applying the following measures, alone or in combination with other measures. The following list is not in any particular order and is not exhaustive:

i. paved inner shoulders of adequate bearing strength to provide an overall width of the runway and its (inner) shoulders of the recommended runway width according to the reference code;

ii. paved/unpaved outer shoulders with adequate bearing strength to provide an overall width of the runway and its shoulder according to the reference code;

iii. additional runway centre line guidance and runway edge markings; and

iv. increased full runway length FOD inspection, when required or requested.

Aerodrome operators should also take into account the possibility that certain aircraft are not able to make a 180-degree turn on narrower runways. When there is no proper taxiway at the end of the runway, providing a suitable runway turn pad is recommended.

Aerodromes which use embedded (inset) runway edge lights should take into account additional consequences, such as, more frequent cleaning intervals for the embedded lights, as dirt will affect the function more quickly if compared to elevated runway edge lights.

Location and specifications for runway signs should be considered due to the increased size of the aircraft's wingspan (engine location) as well as the increased thrust rating from the aircraft's engines.

b. **Runway shoulders**. The shoulders of a runway should be capable of minimising any damage to an aircraft veering off the runway. In some cases, the bearing strength of the natural ground may be sufficient without additional preparation to meet the requirements for shoulders. The prevention of ingestion of objects from jet engines should always be taken into account particularly for the design and construction of the shoulders. In case of specific preparation of the shoulders, visual contrast, such as the use of runway side-stripe markings, between runway and runway shoulders, may be required.

1) ***Runway shoulder functions*** - Runway shoulders have three main functions, as follows:

i. to minimise any damage to an aircraft running off the runway;

ii. to provide jet blast protection;

iii. to prevent engine FOD ingestion; and

iv. to support ground vehicle traffic, RFF vehicles and maintenance vehicles.

2) ***Runway shoulder issues*** - Potential issues associated with runway shoulder characteristics (width, soil type, bearing strength, etc.) are:

i. aircraft damage that could occur after excursion onto the runway shoulder due to inadequate bearing capacity;

ii. shoulder erosion causing ingestion of foreign objects by jet engines due to unsealed surfaces;

iii. the impact of FOD on aircraft tyres and engines as a potentially major hazard; and

iv. difficulties for RFF services to access a damaged aircraft on the runway due to inadequate bearing strength.

v. Factors to be considered are:

- runway centre line deviations;
- powerplant characteristics (engine height, location and power); and
- soil type and bearing strength (aircraft mass, tyre pressure, gear design).

vi. Possible solutions can be developed by applying the following measures, alone or in combination with other measures. The following list is not in any particular order and is not exhaustive:

- ***Excursion onto the runway shoulder***. Provide the suitable shoulder as detailed above
- ***Jet blast***. Information about outer engine position, jet blast velocity contour and jet blast directions at take-off is needed to calculate the required width of shoulders that has to be enhanced for protection against jet blast. Lateral deviation from the runway centre line should also be taken into account;
- ***RFF vehicles***. Operational experience with aircraft currently operated on existing runways suggests that an overall width of the runway and its shoulders which is compliant with the requirements is adequate to permit intervention on aircraft by occasional RFF vehicle traffic. However, longer upper-deck escape chutes may reduce the margin between the shoulder edge and the extension of escape slides and reduce the supporting surface available to rescue vehicles; and
- ***Additional surface inspections***. It may be necessary to adapt the inspection programme for FOD detection.

c. **Runway turn pads.** Turn pads are generally provided when an exit taxiway is not available at the runway end. A turn pad allows an aircraft to turn back after landing and before take-off so that it can position itself correctly on the runway. In particular, the design of the total width of the turn pad should be such that the nose-wheel steering angle of the aircraft for which the turn pad is intended will not exceed 45 degrees.

For minimising the risk of a turn pad excursion, the turn pad should be designed sufficiently wide to permit the 170-degree turn of the most demanding aircraft that will be operated. The design of the turn pad generally assumes a maximum nose landing gear steering angle of 45 degrees, which should be used unless some other condition applies for the particular type of aircraft, and considers clearances between the gears and the turn pad edge, as for a taxiway. The main causes and accident factors of the aircraft veering off the turn pad pavement are:

1) Aircraft characteristics that are not adequate and aircraft failure (ground manoeuvring capabilities, especially long aircrafts, malfunctioning of nose-gear steering, engine, brakes);

2) adverse surface conditions (standing water, loss of control on ice-covered surfaces, friction coefficient);

3) loss of the turn pad visual guidance (markings and lights covered by snow or inadequately maintained); and

4) Human Factors, including incorrect application of the 170-degree procedure (nose-wheel steering, asymmetric thrust, differential breaking).

The ground manoeuvring capabilities available from aircraft manufacturers are one of the key factors to be considered in order to determine whether an existing turn pad is suitable for a particular aircraft. The speed of the manoeuvring aircraft is also a factor.

For a specific aircraft, it may be permissible to operate on a runway turn pad not provided in accordance with Annex 14, Volume I, specifications, after considering the following:

1) the specific ground manoeuvring capability of the specific aircraft (notably the maximum effective steering angle of the nose landing gear);

2) the provision for adequate clearances;

3) the provision for appropriate marking and lighting;

4) the provision of shoulders;

5) the protection from jet blast; and

6) if relevant, protection of the ILS.

In this case, the turn pad can have a different shape. The objective is to enable the aircraft to align on the runway while losing the least runway length as possible. The aircraft is supposed to taxi at slow speed.

d. **Runway strip dimensions.** A runway strip is an area enclosing a runway and any associated stopway. Its purpose is to:

1) reduce the risk of damage to an aircraft running off the runway by providing a cleared and graded area which meets specific longitudinal and transverse slopes, and bearing strength requirements; and

2) protect an aircraft flying over it during landing, balked landing or take-off by providing an area which is cleared of obstacles, except for permitted aids to air navigation.

The graded portion of the runway strip is provided to minimise the damage to an aircraft in the event of a veer-off during a landing or take-off operation. It is for this reason that objects should be located away from this portion of the runway strip unless they are needed for air navigation purposes and are frangible.

Where the requirements on runway strips cannot be achieved, the available distances, the nature and location of any hazard beyond the available runway strip, the type of aircraft and the level of traffic at the aerodrome should be reviewed. Operational restrictions may be applied to the type of approach and low visibility operations that fit the available ground dimensions, while also taking into account:

1) runway excursion history;

2) friction and drainage characteristics of the runway;

3) runway width, length and transverse slopes;

4) navigation and visual aids available;

5) relevance in respect of take-off or aborted take-off and landing;

6) scope for procedural mitigation measures; and

7) accident report.

An analysis of lateral runway excursion reports shows that the causal factor in aircraft accidents/incidents is not the same for take-off and for landing. Therefore, take-off and landing events may need to be considered separately.

Lateral deviation from the runway centre line during a balked landing with the use of the digital autopilot as well as manual flight with a flight director for guidance have shown that the risk associated with the deviation of specific aircrafts contained within the OFZ.

The lateral runway excursion hazard is clearly linked to specific aircraft characteristics, performance/handling qualities and controllability in response to such events as aircraft mechanical failures, pavement contamination and crosswind conditions. This type of hazard comes under the category for which risk assessment is mainly based on flight crew/aircraft performance and handling qualities. Certified limitations of the specific aircraft are one of the key factors to be considered in order to ensure that this hazard is under control.

Potential solutions can be developed by applying the following measures, alone or in combination with other measures. The following list is not in any particular order and is not exhaustive:

1) improving runway surface conditions and/or the means of recording and indicating rectification action, particularly for contaminated runways, having knowledge of runways and their condition and characteristics in precipitation;

2) ensuring that accurate and up-to-date meteorological information is available and that information on runway conditions and characteristics is passed to flight crews in a timely manner, particularly when flight crews need to make operational adjustments;

3) improving the aerodrome operator's knowledge of recording, prediction and dissemination of wind data, including wind shear, and any other relevant meteorological information, particularly when it is a significant feature of an aerodrome's climatology;

4) upgrading the visual and instrument landing aids to improve the accuracy of aircraft delivery at the correct landing position on runways; and

5) in consultation with aircraft operators, formulating any other relevant aerodrome operating procedures or restrictions and promulgating such information appropriately.

e. **Obstacles on runway strips.** An object located on a runway strip which may endanger aircrafts regarded as an obstacle, according to the definition of "obstacle" and should be removed, as far as practicable. Obstacles may be either naturally occurring or deliberately provided for the purpose of air navigation. An obstacle on the runway strip may represent either:

1) a collision risk for an aircraft in flight or for an aircraft on the ground that has laterally veered off the runway; and

2) a source of interference to navigation aids.

Mobile objects that are beyond the OFZ (inner transitional surface) but still within the runway strip, such as vehicles and holding aircraft at runway-holding positions, or wing tips of aircraft taxiing on a parallel taxiway to the runway, should be considered.

Potential solutions can be developed by applying the following measures, alone or in combination with other measures. The list below is not in any particular order and is not exhaustive:

1) Natural obstacles should be removed or reduced in size wherever possible; alternatively, grading of the area allows reduction of the severity of damage to the aircraft.
2) Other fixed obstacles should be removed unless they are necessary for air navigation, in which case they should be frangible and should be so constructed as to minimise the severity of damage to the aircraft.
3) an aircraft considered to be a moving obstacle within the runway strip should respect the requirement on the sensitive areas installed to protect the integrity of the ILS and should be subject to a separate safety assessment.
4) visual and instrument landing aids may be upgraded to improve the accuracy of aircraft delivery at the correct landing position on runways, and in consultation with aircraft operators, any other relevant aerodrome operating procedures or restrictions may be formulated and such information promulgated appropriately.

f. **Runway end safety area (RESA).** A RESA is primarily intended to reduce the risk of damage to an aircraft undershooting or overrunning the runway. Consequently, a RESA will enable an aircraft overrunning to decelerate, and an aircraft undershooting to continue its landing.

Identification of specific issues related to runway overruns and undershoots is complex. There are a number of variables that have to be taken into account, such as prevailing meteorological conditions, the type of aircraft, the load factor, the available landing aids, runway characteristics, the overall environment, as well as human factors. When reviewing the RESA, the following aspects have to be taken into account:

1) the nature and location of any hazard beyond the runway end;
2) the topography and obstruction environment beyond the RESA;
3) the type of aircraft and level of traffic at the aerodrome and actual or proposed changes to either;
4) overrun/undershoot causal factors;
5) friction and drainage characteristics of the runway which have an impact on runway susceptibility to surface contamination and aircraft braking action;
6) navigation and visual aids available;
7) type of approach;
8) runway length and slope, in particular, the general operating length required for take-off and landing versus the runway distances available, including the excess of available length over that required;
9) the location of the taxiways and runways;

10) aerodrome climatology, including predominant wind speed and direction, and likelihood of wind shear; and

11) aerodrome overrun/undershoot and veer-off history.

Potential solutions can be developed by applying the following measures, alone or in combination with other measures. The following list is not in any particular order and is not exhaustive:

1) restricting the operations during adverse hazardous meteorological conditions (such as thunderstorms);

2) defining, in cooperation with aircraft operators, hazardous meteorological conditions and other factors relevant to aerodrome operating procedures and publishing such information appropriately;

3) improving an aerodrome's database of operational data, detection of wind data, including wind shear and other relevant meteorological information, particularly when it is a significant change from an aerodrome's climatology;

4) ensuring that accurate and up-to-date meteorological information, current runway conditions and other characteristics are detected and notified to flight crews in time, particularly when flight crews need to make operational adjustments;

5) improving runway surfaces in a timely manner and/or the means of recording and indicating necessary action for runway improvement and maintenance (e.g. friction measurement and drainage system), particularly when the runway is contaminated;

6) removing rubber build-up on runways according to a scheduled time frame;

7) repainting faded runway markings and replacing inoperative runway surface lighting identified during daily runway inspections;

8) upgrading visual and instrument landing aids to improve the accuracy of aircraft delivery at the correct landing position on runways (including the provision of ILSs);

9) reducing declared runway distances in order to provide the necessary RESA;

10) installing suitably positioned and designed arresting systems as a supplement or as an alternative to standard RESA dimensions when necessary;

11) increasing the length of a RESA and/or minimizing the potential obstruction in the area beyond the RESA; and

12) publishing provisions, including the provision of an arresting system, in the AIP.

11. TAXIWAYS

11.1 Taxiway Issues

a. Taxiways are provided to permit the safe and expeditious surface movement of aircrafts.

b. A sufficiently wide taxiway permits smooth traffic flow while facilitating aircraft ground steering.

c. Particular care should be taken while manoeuvring aircraft on taxiways that have a width less than that specified in Annex 14. So as to prevent the wheels of the aircraft from leaving the pavement, while avoiding the use of large amounts of thrust that could damage taxiway lights and signs and cause erosion of the taxiway strip. Affected taxiways should be closely inspected, as appropriate, for the presence of debris that may be deposited while taxiing into position for take-off.

d. Issues arising from a lateral taxiway excursion, and the causes and accident factors may include:

   1) mechanical failure (hydraulic system, brakes, nose-gear steering);
   2) adverse surface conditions (standing water, loss of control on slippery surfaces, friction coefficient);
   3) loss of the taxiway centre line visual guidance (markings and lights covered by dust/dirt or inadequately maintained);
   4) human factors (including directional control, orientation error, pre-departure workload); and
   5) aircraft taxi speed.

e. Compatibility studies related to taxiway width and potential deviations can include:

   1) the use of taxiway deviation statistics to calculate the taxiway excursion probability of an aircraft depending on taxiway width. The impact of taxiway guidance systems and meteorological and surface conditions on taxiway excursion probability should be assessed whenever possible;
   2) view of the taxiway from the cockpit, taking into account the visual reference cockpit cut-off angle and pilot eye height; and
   3) the aircraft outer main gear wheel span.

f. Potential solutions can be developed by applying the following measures, alone or in combination with other measures. The following list is not in any particular order and is not exhaustive:

   1) the provision of taxiway centre line lights;
   2) conspicuous centre line marking;
   3) the provision of on-board taxi camera systems to assist taxi guidance;
   4) reduced taxi speed;
   5) the provision of taxi side-stripe markings;
   6) taxiway edge lights (inset or elevated);
   7) reduced wheel-to-edge clearance, using taxiway deviation data;
   8) the use of alternative taxi routes; and
   9) the use of marshal services (follow-me guidance).

g. Special attention should be given to the offset of centre line lights in relation to centre line markings, especially during adverse weather conditions when distinguishing between markings and offset lights can be difficult.

h. Location and specifications for taxiway signs should be considered due to the engine location as well as the increased thrust in the aircraft engines.

11.2 Taxiway Curves

a. Any hazard to taxiways will more likely be the result of a lateral taxiway excursion on a curved section. The main causes and factors affecting accident on taxiway curves are similar to taxiway excursions on a straight taxiway section. The use of the cockpit-over-centreline steering technique on a curved taxiway will result in track-in of the main landing gear from the centre line. The amount of track-in depends on the radius of the curved taxiway and the distance from the cockpit to the main landing gear. The consequences are the same as for lateral taxiway excursions on straight sections.

b. The required width of the curved portions of taxiways is related to the clearance between the outer main wheel and the taxiway edge on the inner curve. The hazard is related to the combination of the outer main gear wheel span and the distance between the nose gear/cockpit and the main gear. Consideration should be given to the effect on airfield signs and other objects nearby of jet blast from a turning aircraft. Certain aircraft may require wider fillets on curved sections or taxiway junctions.

c. Potential solutions can be developed by applying the following measures, alone or in combination with other measures. The following list is not in any particular order and is not exhaustive:

   1) the widening of existing fillets or the provision of new fillets;
   2) reduced taxi speed;
   3) the provision of taxiway centre line lights and taxi side-stripe markings (and inset taxiway edge lights);
   4) reduced wheel-to-edge clearance, using taxiway deviation data;
   5) pilot judgemental over steering; and
   6) publication of provisions in the appropriate aeronautical documentation.

d. Special attention should be given to the offset of centre line lights in relation to centre line markings.

e. Location and specifications for taxiway signs should be considered due to the increase in the size of aircrafts well as the increased thrust in aircraft engines.

11.3 Runway and Taxiway Minimum Separation Distances

a. A minimum distance is provided between the centre line of a runway and the centre line of the associated parallel taxiway for instrument runways and non-instrument runways.

b. The runway/taxiway separation is based on the principle that the wing tip of an aircraft taxiing on a parallel taxiway should be clear of the runway strip.

c. It is permissible to operate with lower separation distances at an existing aerodrome if a safety assessment indicates that such lower separation distances would not adversely affect the safety or significantly affect the regularity of operations of aircrafts.

d. Furthermore, attention is drawn to the need to provide adequate clearance at an existing aerodrome in order to operate an aircraft with the minimum possible risk.

e. The potential issues associated with runway/parallel taxiway separation distances are:

   1) the possible collision between an aircraft running off a taxiway and an object (fixed or mobile) on the aerodrome;

   2) the possible collision between an aircraft leaving the runway and an object (fixed or mobile) on the aerodrome or the risk of a collision of an aircraft on the taxiway that infringes on the runway strip; and

   3) possible ILS signal interference due to a taxiing or stopped aircraft.

f. Causes and accident factors can include:

   1) human factors (crew, ATS);

   2) hazardous meteorological conditions (such as thunderstorms and wind shear);

   3) aircraft mechanical failure (such as engine, hydraulic system, flight instruments, control surfaces and autopilot);

   4) surface conditions (standing water, loss of control on ice-covered surfaces, friction coefficient);

   5) lateral veer-off distance;

   6) aircraft position relative to navigation aids, especially ILS; and

   7) aircraft size and characteristics (especially wingspan).

g. Potential solutions can be developed by applying the following measures, alone or in combination with other measures. The following list is not in any particular order and is not exhaustive:

   1) place a restriction on the wingspan of aircraft using the parallel taxiway or on the runway, if continued unrestricted taxiway or runway operation is desired;

   2) consider the most demanding length of aircraft that can have an impact on runway/taxiway separation and the location of holding positions (ILS);

   3) change taxiway routing so that the required runway airspace is free of taxiing aircrafts; and

   4) employ tactical control of aerodrome movements.

11.4 Taxiway and Taxi Lane Minimum Separation Distances

a. **Taxiway to object separation**. The taxiway minimum separation distances provide an area clear of objects that may endanger an aircraft.

b. **Parallel taxiway separation**. The minimum separation distance is equal to the wingspan plus maximum lateral deviation plus increment. If the minimum required distance between the centre lines of two parallel taxiways is not provided, it is permissible to operate with lower separation distances at an existing aerodrome if a compatibility study, which may include a safety assessment, indicates that such lower separation distances would not adversely affect the safety or significantly affect the regularity of aircraft operations.

c. **Taxiway to object separation**. The separation distances during taxiing are intended to minimize the risk of a collision between an aircraft and an object (taxiway/object separation, taxi lane/object separation). Taxiway deviation statistics can be used to assess the risk of a collision between two aircraft or between an aircraft and an object. The causes and accident factors can include:

1) mechanical failure (hydraulic system, brakes, nose-gear steering);

2) conditions (standing water, loss of control on ice-covered surfaces, friction coefficient);

3) human factors (directional control, temporary loss of orientation resulting in aircraft being incorrectly positioned, etc.).

d. **Parallel taxiway separation**. The potential issues associated with parallel taxiway separation distances are:

1) the probable collision between an aircraft running off a taxiway and an object (aircraft on parallel taxiway); and

2) an aircraft running off the taxiway and infringing the opposite taxiway strip. Causes and accident factors can include:

   i. Human Factors (crew, ATS);

   ii. hazardous meteorological conditions (such as reduced visibility);

   iii. aircraft mechanical failure (such as engine, hydraulic system, flight instruments, control surfaces, autopilot);

   iv. surface conditions (standing water, loss of control on ice-covered surfaces, friction coefficient);

   v. lateral veer-off distance; and

   vi. aircraft size and characteristics (especially wingspan).

e. **Taxiway to object separation**. Potential solutions can be developed by applying the following measures, alone or in combination with other measures. The following list is not in any particular order and is not exhaustive:

1) the use of reduced taxiing speed;

2) the provision of taxiway centre line lights;

3) the provision of taxi side-stripe markings (and inset taxiway edge lights);

4) the provision of special taxi routing for larger aircrafts;

5) restrictions on aircraft(wingspan) allowed to use parallel taxiways during the operation of a specific aircraft;

6) restrictions on vehicles using service roads adjacent to a designated aircraft taxi route;

7) the use of "follow-me" guidance;

8) the provision of reduced spacing between taxiway centre line lights;

9) the provision of straightforward taxiway naming and ground routings with respect to the hazard of taxiway veer-offs.

f. **Parallel taxiway separation**. Potential solutions can be developed by providing the following facilities, alone or in combination with other measures. The following list is not in any particular order and is not exhaustive:

1) place a restriction on the wingspan of aircraft using the parallel taxiway if continued unrestricted taxiway operation is desired;
2) consider the most demanding length of aircraft that can have an impact on a curved taxiway section;
3) change taxiway routing; and
4) employ tactical control of aerodrome movements.
5) use of reduced taxiing speed;
6) provision of taxiway centre line lights;
7) provision of taxi side-stripe markings (and inset taxiway edge lights);
8) use of "follow-me" guidance;
9) provision of reduced spacing between taxiway centre line lights; and
10) provision of straightforward taxiway naming and ground routings with respect to the hazard of taxiway veer-offs.

11.5 Taxiway Shoulders

a. Taxiway shoulders are intended to protect an aircraft operating on the taxiway from FOD ingestion and to reduce the risk of damage to an aircraft running off the taxiway.

b. The taxiway shoulder dimensions are based on current information regarding the width of the outer engine exhaust plume for breakaway thrust. Furthermore, the surface of taxiway shoulders is prepared so as to resist erosion and ingestion of the surface material by aircraft engines.

c. The factors leading to reported issues are:

1) powerplant characteristics (engine height, location and power);
2) taxiway shoulder width, the nature of the surface and its treatment;
3) taxiway centreline deviation factors, both from the expected minor wander from tracking error and the effect of main gear track-in in the turn area while using the cockpit-over-centre line-steering technique.

d. Potential solutions can be developed by applying the following measures, alone or in combination with other measures. The following list is not in any particular order and is not exhaustive:

1) ***Excursion on the taxiway shoulder***. The thickness and composition of shoulder pavements should be such as to withstand the occasional passage of the aircraft operating at the aerodrome that has the most demanding impact on pavement loading, as well as the full load of the most demanding aerodrome emergency vehicle. The impact of an aircraft on pavements should be assessed and, if required, existing taxiway shoulders (if allowed to be used by these heavier aircrafts) may need to be strengthened by providing a suitable overlay.

2) ***Jet blast***. Information on engine position and jet blast velocity contour at breakaway thrust mode is used to assess jet blast protection requirements during taxiing operations. A lateral deviation from the taxiway centre line should be taken into account, particularly in the case of a curved taxiway and the use of the cockpit-over-centre-line steering technique. The effect of jet blast can also be managed by the use of thrust management of the engines (in particular for four-engine aircraft).

Note - Further information concerning aircraft characteristics including the margins between the outer engine axis and the edge of the shoulder, and the distance from the outer engine to the ground can be found in the manufacturer's "Aircraft Characteristics for Airport Planning" manuals.

e. RFF vehicles. Operational experience with current aircraft on existing taxiways suggests that a compliant overall width of the taxiway and its shoulders permits the intervention of aircraft by occasional RFF vehicle traffic.

12. CLEARANCE DISTANCE ON AIRCRAFT STANDS

a. ICAO Annex 14 stipulates the minimum distance between an aircraft using the stand and an obstacle.

b. The possible reasons for collision between an aircraft and an obstacle on the apron or holding bay can be listed as:

1) mechanical failure (e.g. hydraulic system, brakes, nose-gear steering);

2) surface conditions (e.g. standing water, ice-covered surfaces, friction coefficient);

3) loss of the visual taxi guidance system (docking system out of service); and

4) human factors (directional control, orientation error).

c. The probability of a collision during taxiing depends more on human factors than on aircraft performance. Unless technical failure occurs, aircraft will respond reliably to directional inputs from the pilot when taxiing at the usual ground speed. Nevertheless, caution should be exercised with regard to the impact of aircraft with larger wingspans.

d. Potential solutions can be developed by applying the following measures, alone or in combination with other measures. The following list is not in any particular order and is not exhaustive:

1) appropriate condition of marking and signage;

2) apron stand lead-in lights;

3) azimuth guidance as a visual docking system;

4) appropriate training of operating and ground personnel should be ensured by an aerodrome operator;

5) operational restrictions (e.g. adequate clearances before and behind parked or holding aircraft due to the increased length of aircrafts);

6) temporarily downgraded adjacent aircraft stands;

7) towing the aircraft on/from the stand;

8) use of remote/cargo stands or "roll-through" parking positions for handling the aircraft;

9) publication of procedures in the appropriate aeronautical documentation (i.e. closing or rerouting of taxi lanes behind parked aircrafts);

10) advanced visual guidance system;

11) marshal guidance;

12) enhancing apron lighting levels in low visibility conditions; and

13) use of the vertical clearances provided by high wings.

13. PAVEMENT DESIGN

a. To facilitate flight planning, various aerodrome data are required to be published, such as data concerning the strength of pavements, which is one of the factors required to assess whether the aerodrome can be used by an aircraft of a specific all-up mass.

b. The aircraft classification number/pavement classification number (ACN/PCN) method is used for reporting pavement strength.

c. The increased mass and/or gear load of the aircraft may require additional pavement support. Existing pavements and their maintenance will need to be evaluated for adequacy due to differences in wheel loading, tyre pressure, and undercarriage design. Bridge, tunnel and culvert load-bearing capacities are a limiting factor, requiring some operational procedures.

d. Potential solutions can be developed by applying the following measures, alone or in combination with other measures. The following list is not in any particular order and is not exhaustive:

1) restrictions on aircraft with higher ACNs on specific taxiways, runway bridges or aprons; or

2) adoption of adequate pavement maintenance programmes.

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