



WORKING TOGETHER TO ENHANCE
AIRPORT OPERATIONAL SAFETY

Aerodrome Compatibility

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What is the first thing that comes to your mind when you see the term “**aerodrome compatibility**”?



Aerodrome Compatibility

When an aerodrome is granted a certificate, it means to aircraft operators and other organizations operating on the aerodrome that, at the time of certification, **the aerodrome meets the specifications regarding the facility and its operation**, and that it has, according to the certifying authority, the capability to maintain these specifications for the period of validity of the certificate.

Airports are certificated to accommodate aeroplanes that are within the parameters of the **physical characteristics of the aerodrome**.



Aerodrome Compatibility

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



Aerodrome Compatibility

3 basic steps

1. The airline/aircraft operator submits a request to the aerodrome operator to operate a **new type of aircraft** to the airport;
2. The aerodrome operator **evaluate** if the new aircraft type can be accommodated, including **access to the movement areas** and considers the **feasibility and economic viability** of upgrading the aerodrome infrastructure. Keep in mind that 2/3 of airports operate at a net loss!
3. The aerodrome operator and aircraft **operator discuss the** aerodrome operator's assessment, and whether operations of the aeroplane type/subtype can be accommodated and, if permitted, under what conditions



Aerodrome Compatibility Study

1. Identify the airplane's physical and operational characteristics

- Fuselage length
- Fuselage width
- Door sill height
- Aeroplane nose characteristics
- Tail Height
- Wingspan
- Wing tip vertical clearance
- Cockpit view
- Distance from the pilot's eye position to the nose landing gear
- Landing gear designs
- Outer main gear design
- Wheel base
- Gear steering system
- Maximum aeroplane mass
- Landing gear geometry, tire pressure and ACN values
- Engine characteristics
- Maximum passenger and fuel-carrying capacity
- Flight performance

Aerodrome Compatibility Study



Other areas?

1. Identify the applicable regulatory requirements
2. Establish the adequacy of the aerodrome infrastructure and facilities regarding the requirements of the new aeroplane
- 3.
4. Identify the changes required to the aerodrome
5. Document the compatibility study
6. Perform the required safety assessments identified during the compatibility study

Develop:

- Gap Analysis and
- Implementation Plan

Runway end safety area (RESA)

- A RESA is primarily intended to **reduce the risk of damage to an aeroplane undershooting or overrunning the runway.**
- Consequently, a RESA will **enable an aeroplane overrunning to decelerate, and an aeroplane undershooting to continue its landing.**





Challenges

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:

- meteorological conditions;
- type of aeroplane;
- load factor;
- available landing aids;
- runway characteristics;
- overall environment,
- human factors.

When reviewing the RESA, the following aspects have to be taken into account:

- a) the nature and **location of any hazard** beyond the runway end;
- b) the **topography and obstruction** environment beyond the RESA;
- c) the **type of aeroplanes** and level of traffic at the aerodrome and actual or proposed changes to either;
- d) **overrun/undershoot causal factors**;
- e) **friction and drainage** characteristics of the runway which have an impact on runway susceptibility to surface contamination and aeroplane braking action;
- f) **navigation and visual aids** available;
- g) **type of approach**;



- h) **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;
- i) the **location of the taxiways and runways**;
- j) **aerodrome climatology**, including predominant wind speed and direction and likelihood of wind shear; and
- k) **aerodrome overrun/undershoot and veer-off history**.

Potential solutions

- a) **restricting the operations** during adverse hazardous meteorological conditions (such as thunderstorms);
- b) **defining**, in cooperation with aeroplane operators, **hazardous meteorological conditions and other factors relevant to aerodrome operating procedures** and publishing such information appropriately;
- c) **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;

d) 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;

e) **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;

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



- g) **repainting faded runway markings and replacing inoperative runway surface lighting** identified during daily runway inspections;
- h) **upgrading visual and instrument landing aids** to improve the accuracy of aeroplane delivery at the correct landing position on runways (including the provision of ILSs);
- i) **reducing declared runway distances** in order to provide the necessary RESA;



- j) installing suitably positioned and designed **arresting systems** as a supplement or as an alternative to standard RESA dimensions when necessary;
- k) **increasing the length of a RESA and/or minimizing the potential obstruction in the area beyond the RESA;** and
- l) **publishing provisions**, including the provision of an arresting system, in the AIP.



Results of the BACG 777X project

- ACI Europe TOSC, Athens



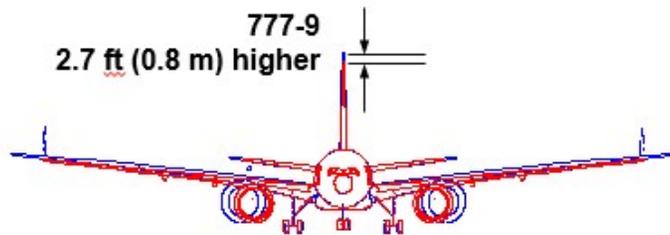
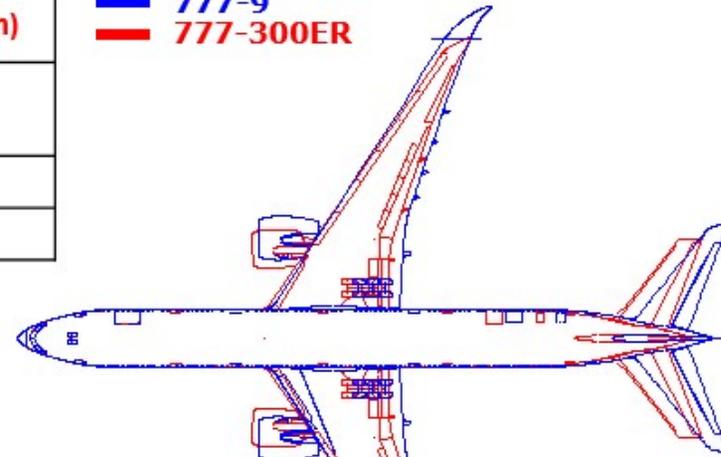
- B777-9 Aircraft characteristics
- Boeing Airport Compatibility Group (BACG 2)
- FWT Concept of operations (CONOPS)
- Proposed ICAO amendments

Aircraft Characteristics

777-9 vs 777-300R

	777-9 (ft/m)	777-300ER (ft/m)
Span	235.4/71.8 (Extended Wings) 212.8/64.8 (Folded Wings)	212.6/64.8
Length	251.8/76.7	242.3/73.9
Height	64.1/19.5	61.4/18.7

— 777-9
— 777-300ER



777-9
 11.4 ft (3.5 m) wider each
 side with extended wing tips



777-9 9.5 ft (2.8 m) longer

Aircraft Characteristics

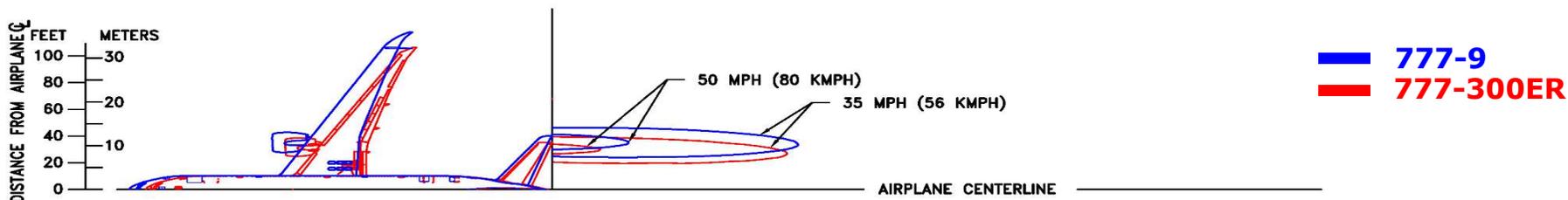
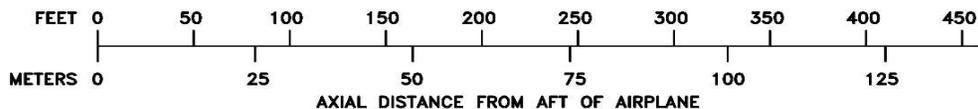
Large Aircraft Comparison

Critical model shown in red	777-9	777-300ER	747-400ER	747-8	A340-600	A380-800
Wingspan	235.4ft (71.8 m)	212.6 ft (64.8 m)	213.0 ft (64.9 m)	224.4 ft (68.4 m)	208.0 ft (63.4 m)	261.8 ft (79.8 m)
Length	251.8 ft (76.7 m)	242.4 ft (73.9 m)	231.8 ft (70.7 m)	250.2 ft (76.3 m)	247.4 ft (75.4 m)	238.7 ft (72.7 m)
Tail height (max)	64.1 ft (19.5 m)	61.4 ft (18.7 m)	64.3 ft (19.6 m)	64.0 ft (19.5 m)	58.7 ft (17.9 m)	80.2 ft (24.4 m)
Wheelbase (to turning centroid)	106.0 ft (32.3 m)	100.4 ft (30.6 m)	79.0 ft (24.1 m)	92.3 ft (28.1 m)	107.9 ft (32.9 m)	97.8 ft (29.8 m)
Cockpit-to-main gear	118.0 ft (36.0 m)	112.2 ft (34.2 m)	86.6 ft (26.4 m)	100.0 ft (30.5 m)	121.6 ft (37.1 m)	104.6 ft (31.9 m)
Main gear span (to outer tire edges)	41.8 ft (12.8 m)	42.3 ft (12.9 m)	41.4 ft (12.6 m)	41.7 ft (12.7 n)	41.3 ft (12.6 m)	46.9 ft (14.3 m)
Outer engine span (centerline to centerline)	69.8 ft (21.3 m)	63.0 ft (19.2 m)	138.0 ft (42.1 m)	138.0 ft (42.1 m)	126.3 ft (38.5 m)	168.6 ft (51.4 m)
Wingtip height (min)	27.6 ft (8.4 m)	23.6 ft (7.2 m)	16.8 ft (5.1 m)	18.6 ft (5.7 m)	19.4 ft (5.9 m)	17.1 ft (5.2 m)
Max taxi weight	777,000 lb (352,442 kg)	777,000 lb (352,442 kg)	913,000 lb (414,130 kg)	990,000 lb (449,056 kg)	840,400 lb (381,200 kg)	1,258,000 lb (571,000 kg)

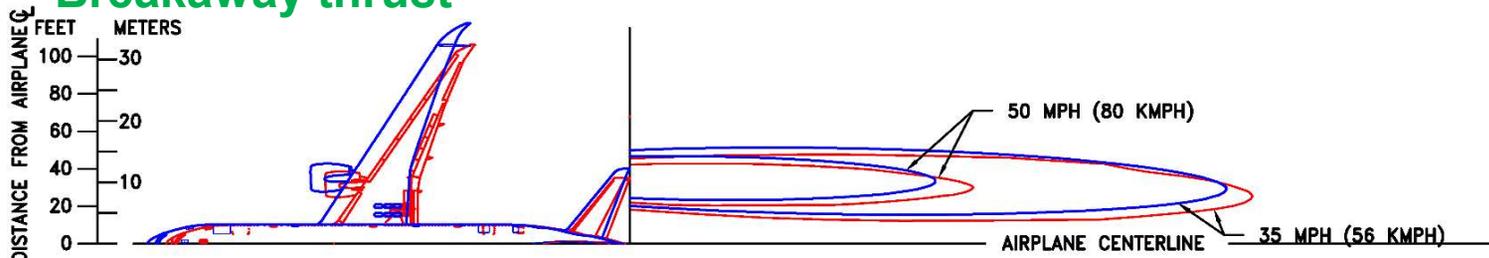
Aircraft Characteristics

Engine exhaust velocities

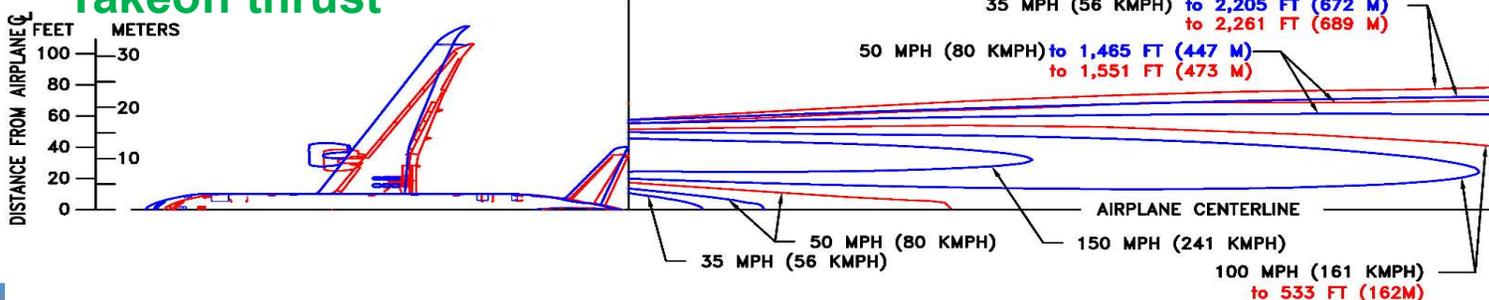
Idle thrust



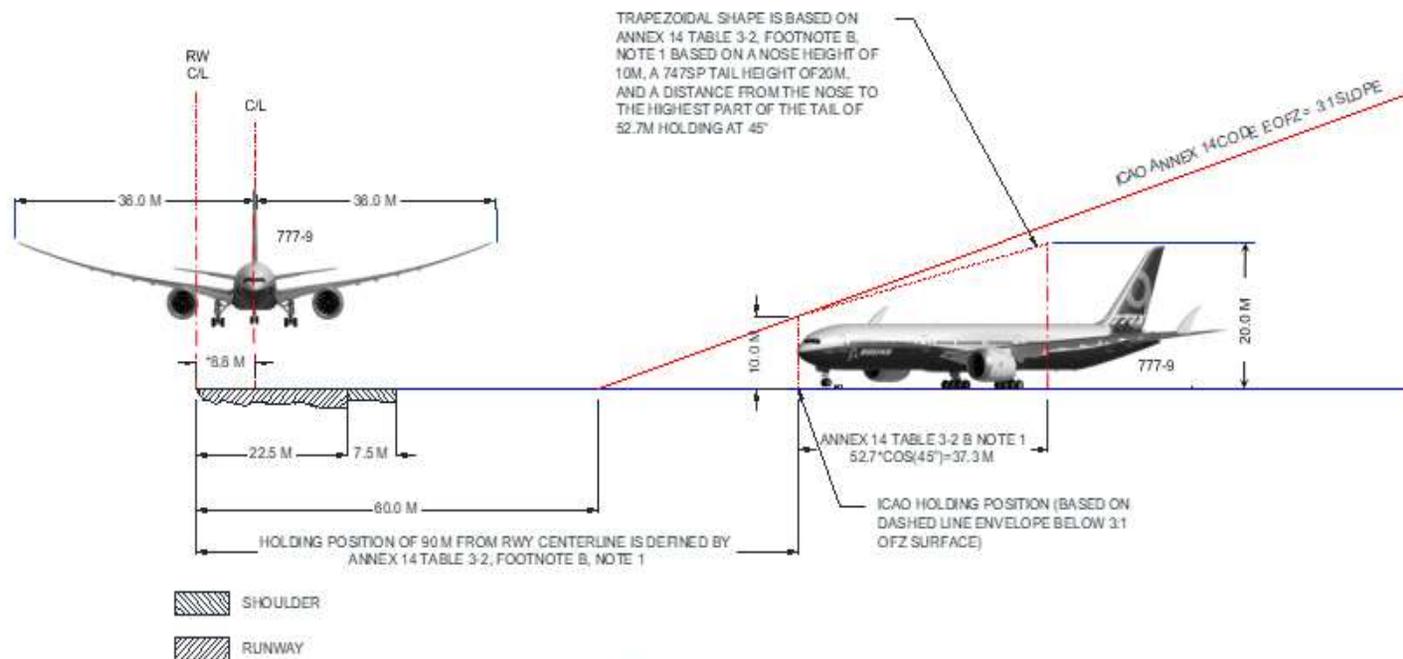
Breakaway thrust



Takeoff thrust



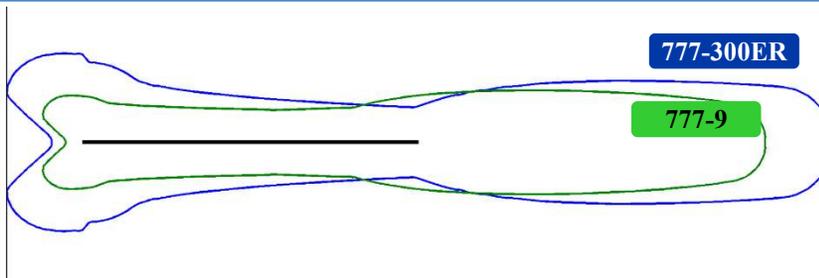
Aircraft Characteristics OLS related



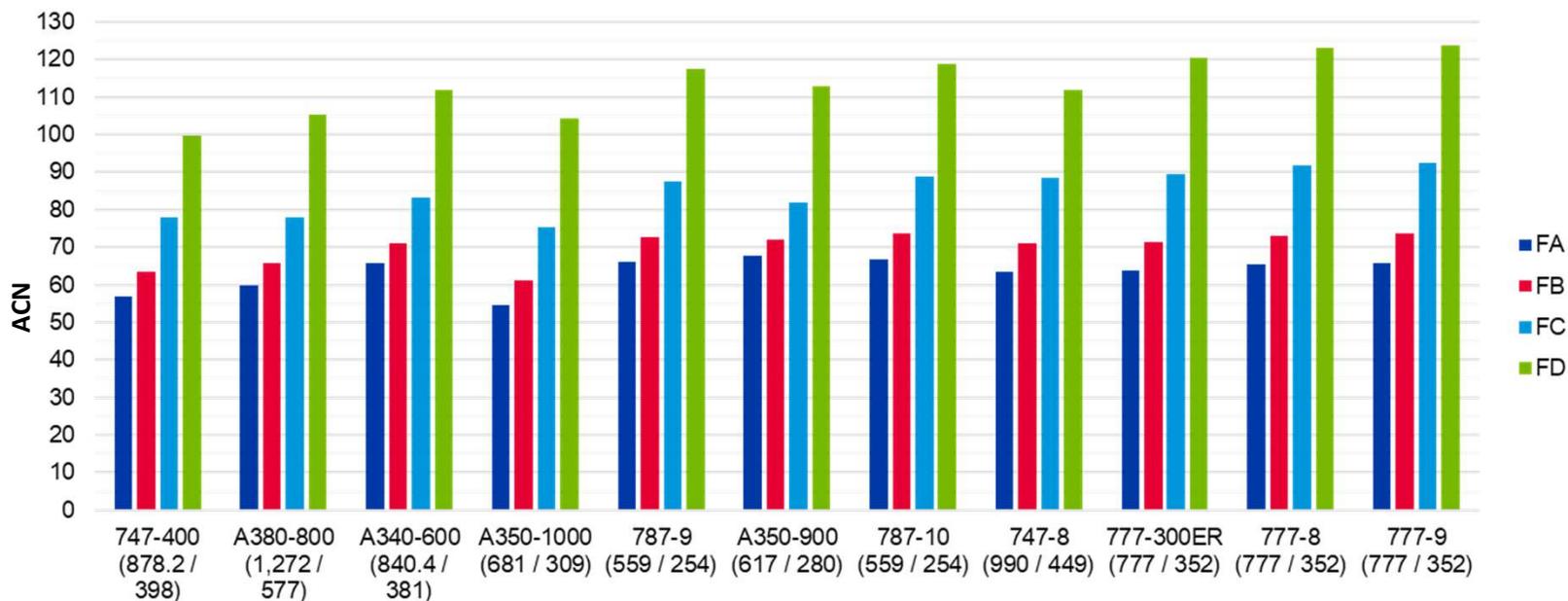
* MAXIMUM OFFSET (ON GROUND, ONE EVENT) FROM 2148 AIRCRAFT CERTIFICATION FLIGHT TESTS (LANDINGS, TAKEOFFS, TOUCH AND GOES) CONDUCTED BY BOEING, FAA, AND EASA PILOTS.

BALKED LANDING STUDY RESULTS SHOW CODE F AIRCRAFT WITH MODERN DIGITAL AUTOPILOT WITH TRACK HOLD GUIDANCE (777-9 IS SO EQUIPPED) USED FOR APPROACH IS CONTAINED WITHIN CODE E OFZ. ICAO CIRCULAR 301 (NEW LARGER AIRPLANES - INFRINGEMENT OF OBSTACLE FREE ZONE: OPERATIONAL MEASURES AND AERONAUTICAL STUDY)

777-9 Quieter compared to 777-300ER



777-9 ACN



MTW (1,000lb / Ton)

Boeing Compatibility Group

- Informal group consisting of Aviation Authorities, Airport, and Industry representatives.
- Formed to agree and promote a common position among the group members, with respect to operation of the 777-8/9 at existing airports that currently do not meet ICAO Code Letter F specifications.
- Agree and promote that any deviation from these ICAO specifications should be supported by appropriate safety assessment studies and relevant risk analysis.
- Report its work and findings to ICAO for the development of future provisions.
- Seek to influence the application of the agreed specifications for the operation of the 777-8/9 aircraft within national regulatory frameworks.
- Co-operate with other international organizations and working groups dealing with NLA operations.
- Enable the work of the BACG to be disseminated Globally.

Aircraft Folding Wing Operations

New and larger than ever

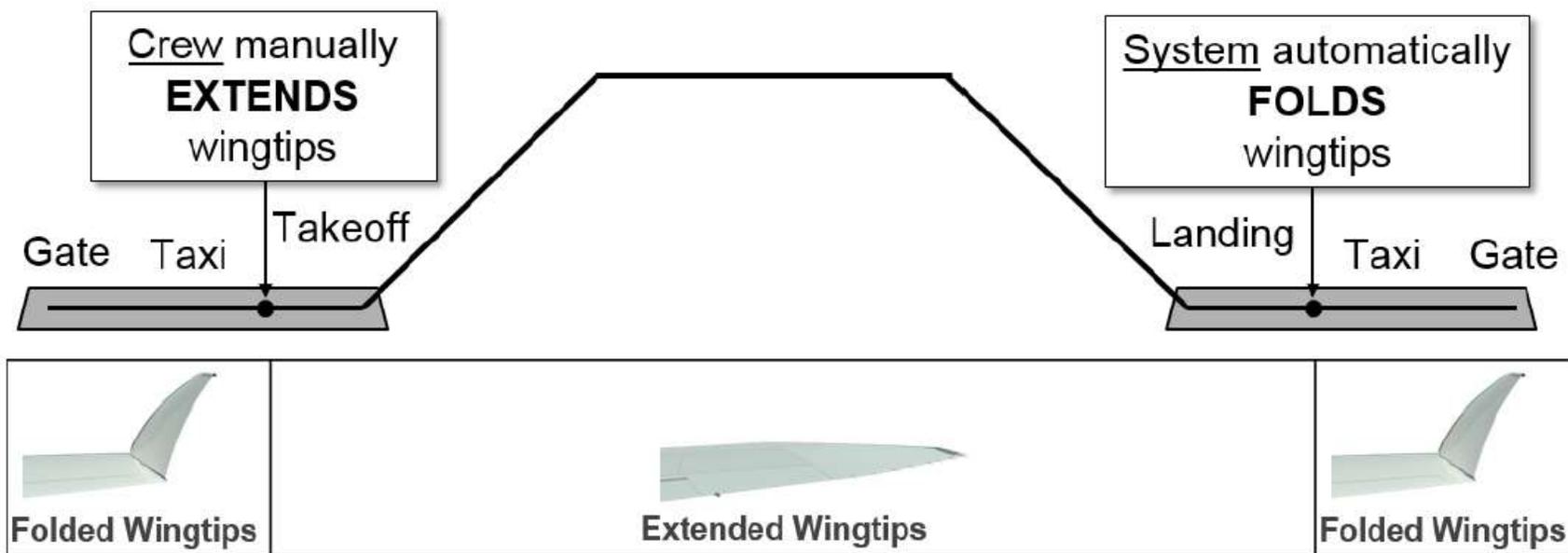
The 777X's swept-back composite wings — the key structural difference from the 777 — will fold at the tip after landing so the plane can fit at conventional airport gates. The 11-foot wing tips are made in St. Louis, while the 110-foot wings are built in a large new building on the Everett site.

Source: Boeing

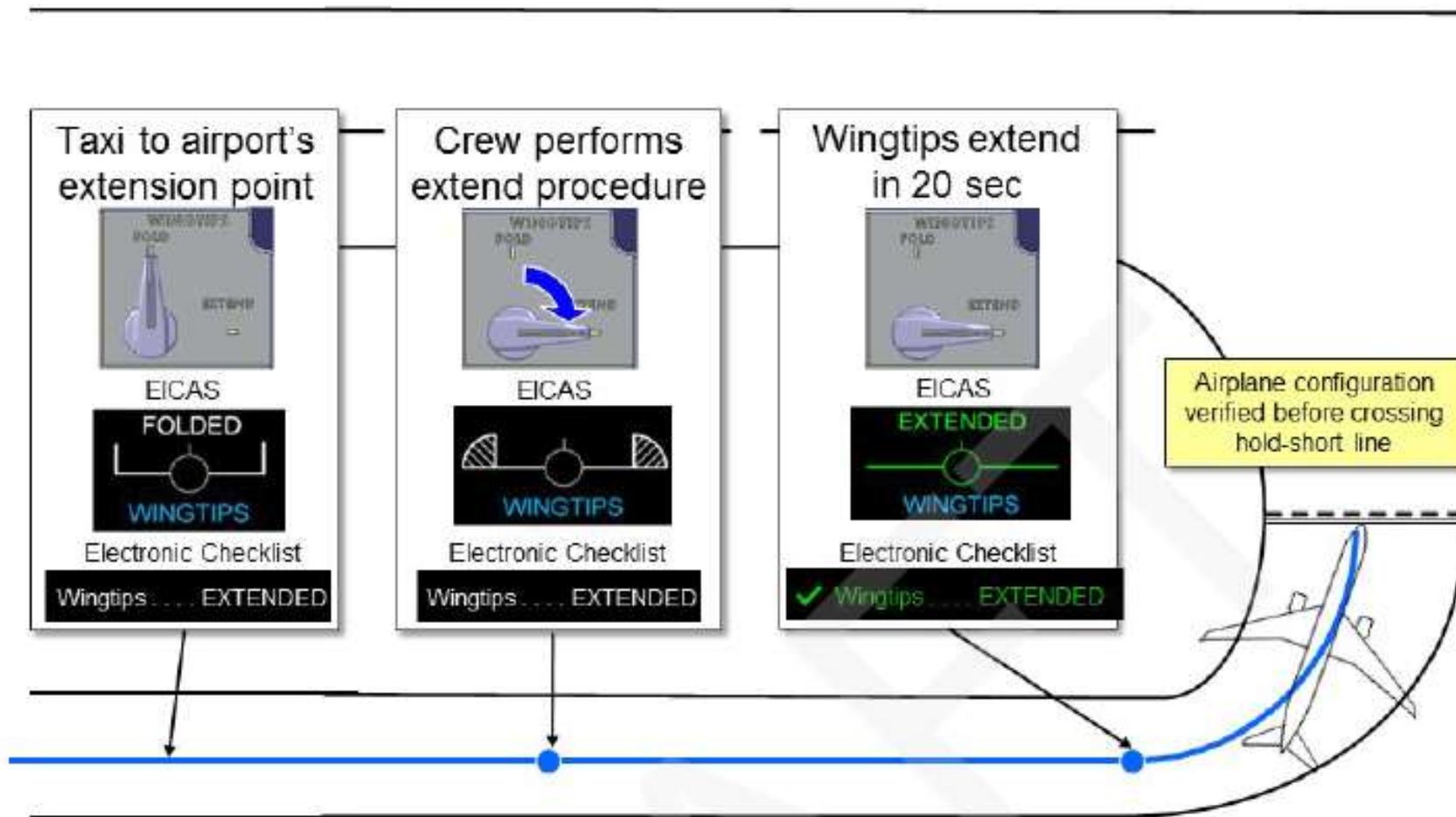
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Aircraft Folding Wing Operations

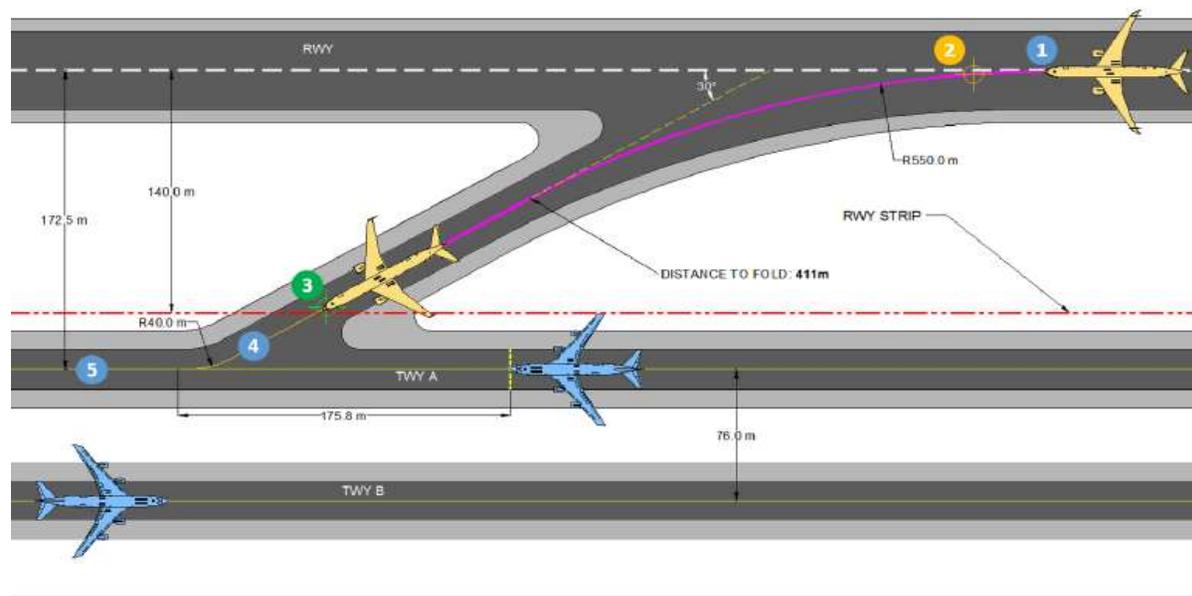


Aircraft Folding Wing Operations



Aircraft Folding Wing Operations

- **Rapid exit taxiway (RET) considered in FWT operational procedure development**
 - Boeing performed studies to confirm that the timing as part of the design will ensure that the FWT will be folded prior to entering the parallel taxiway.
 - These studies considered high speed exits to rapid-exit taxiways designed to both ICAO and FAA separation standards
 - Simulation of the 777-8/9 taking an ICAO rapid-exit taxiway (RET) to ICAO Annex 14 and Aerodrome Design Manual parameters conducted (below)
 - Simulation confirms wing tips folded prior to entering parallel taxiway



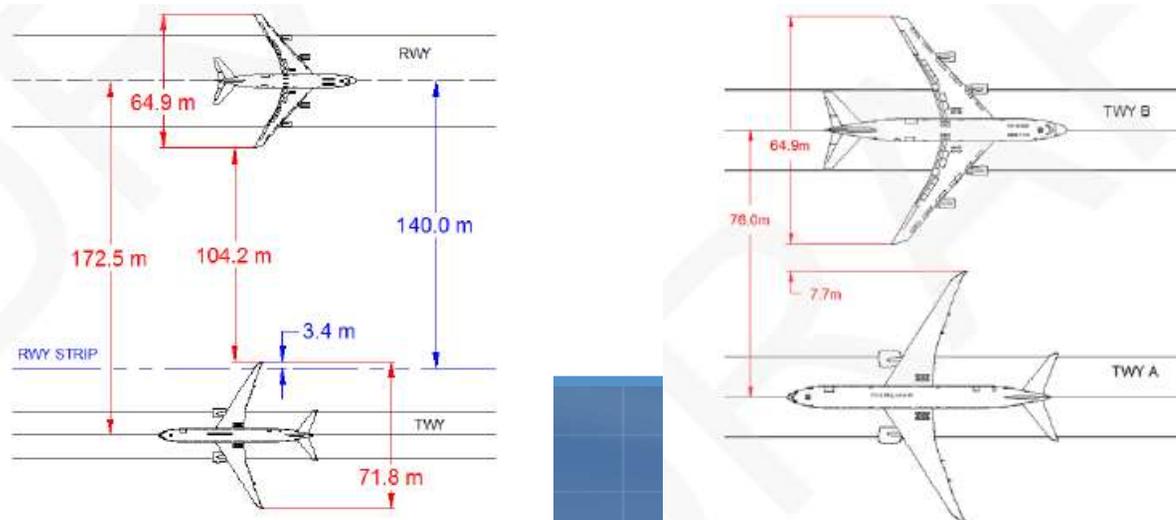
1. Initial point where aircraft enters the RET
2. Transition of FWT to fold begins at 50 kt ground speed.
3. FWT are folded prior to entering the parallel taxiway—777-8/9 is Code E.
4. FWT are folded, 777-8/9 reaches 14 kt ground speed and maintains it throughout the remainder of the RET
5. FWT are folded.

Aircraft Folding Wing Non Normal Operations

- FWT (one or both) fails to extend when auctioning FWT Pilot Control Module Lever.
- Flt Crew will get WINGTIPS DRIVE message on the EICAS + Master Caution Light + Aural Beeper.
- Airport's non normal FWT operational plan will be followed.
- Taxi the aircraft to the designated parking stand or gate via the agreed taxi route.
- Wing tips manually locked in the extended position as a Code F aircraft and dispatch as per MEL.
- Flight crew will taxi the aircraft along the predetermined non-normal FWT route and takeoff.

Aircraft Folding Wing Non Normal Operations

- FWT system does not automatically issue the fold command (autofold failure)
- Flt Crew will receive WINGTIPS POSITION caution message on the EICAS + Master Caution Light + Aural Beeper.
- Flight crew will action the Folding Wing Tip Pilot Control Module lever manually
- WINGTIPS DRIVE caution message on the EICAS + master caution light + aural beeper, if failure continues.
- Flight crew informs ATC and Airport's non normal FWT operational plan is activated.



Aircraft Folding Wing Non Normal Operations

- **Annex 14**

New note in Chapter 1 Table 1-1

Note 2.— Guidance for accommodating aeroplanes with Folding Wing Tips that cause it to span two code letters is given in Doc 9981, Procedures for Air Navigation Services (PANS) – Aerodromes.

- **Annex 4**

New note in Chapter 14 para 14.6

Note: In case of aerodromes accommodating Aeroplanes with Folding Wing Tips (FWT), the locations to extend the FWT may be included on the ground movement chart.

- **Annex 15** Aeronautical Information Services

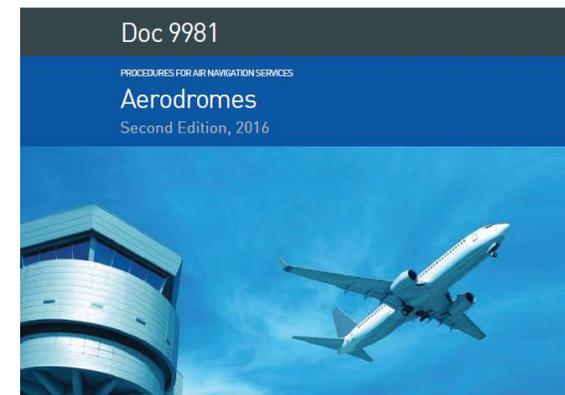
New note to Appendix 1, Contents of the Aeronautical Information Publication (AIP), AD 2.24 Charts related to an aerodrome, 3) Aerodrome Ground Movement Chart –ICAO

Note: In case of aeroplanes with folding wing tips (FWT). Include location to extend folding wing tips (FWT) on the taxiway charts.

PANS-AERODROMES (Doc 9981)

- Attachment A to Chapter 4 on AEROPLANE PHYSICAL CHARACTERISTICS
- In the case of a Folding Wing Tip (FWT), the wingspan may change ARC letters as a result of the folding/extending. Consideration should be given to the wingspan configuration and resultant operations of the aeroplane at an aerodrome.
- Note .— Further information concerning aeroplane Folding Wing Tip (FWT) physical characteristics, concept of normal and non-normal operations can be found in the manufacturer's aircraft characteristics for airport planning manual.

- 777X with Folding Wing Tips will enter into service in 2020
- Folding Wing Tips provides the aerodynamic benefit of a larger wingspan while retaining aerodrome compatibility
- Updates to regulatory guidance documents will assist Civil Aviation Authorities in the consistent application of Folding Wing Tip operations
- Updates proposed to ICAO Annex 14, PANS-Aerodromes, and Annex 15 with supporting manufacturer documents
- Manufacturer documents will include additional details on 777X Folding Wing Tip operations
- BACG2 –777X Boeing Airport Compatibility Group 2 (an ACI sponsored document)
- 25 April –Endorsement event hosted by Boeing in Everett, Washington



This edition supersedes, on 10 November 2016, all previous editions of Doc 9981.

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