RA 3277 - Wake Turbulence

Rationale

All Aircraft, including ►jet-lift,◄ rotary wing and tilt-rotor, ►◄ generate vortices as a consequence of producing lift. The resultant wake turbulence can create hazardous flight conditions for Aircraft operating in close proximity. ►If the prescribed wake turbulence separation minima are not conformed to, there is an increased Risk to Life in an Aviation Duty Holder's (ADH) / Accountable Manager (Military Flying)'s (AM(MF)) operation due to the increased Risk of the pilot inadvertently losing control of the Aircraft.◄ Controllers and pilots are ►therefore◄ responsible for ►ensuring that the◄ appropriate ►wake turbulence separation between Aircraft is observed to reduce the likelihood of encountering◄ wake turbulence.

Contents

Regulation 3277(1)

Wake Turbulence

3277(1) ADH, AM(MF), ADH-Facing Organizations and Heads of Establishment **shall** ensure appropriate wake turbulence separation minima are applied.

Acceptable Means of Compliance 3277(1)

Wake Turbulence

1. Wake turbulence separation minima **should** be based on the UK Civil Aviation Authority (CAA) wake turbulence categories[1], as reproduced in Tables 1 and 2.

Table 1. International Civil Aviation Organization (ICAO) and UK CAA Fixed Wing Aircraft Wake Turbulence Categories[1] (based on Maximum Certificated Take-off Mass (MCTOM))

Category	ICAO and Flight Plan (kg)	UK Departures (MCTOM kg)	UK Arrivals (MCTOM kg)
SUPER[2] (J)	≥136,000	≥136,000	≥136,000
HEAVY (H)	≥136,000	≥136,000	≥136,000
MEDIUM (M)	>7,000 and <136,000	>40,000 and <136,000[3]	N/A
UPPER MEDIUM (UM)	N/A	N/A	>104,000 and <136,000
LOWER MEDIUM (LM)	N/A	N/A	>40,000 and ≤104,000
SMALL (S)	N/A	>17,000 and ≤40,000	>17,000 and ≤40,000
LIGHT (L)	≤7,000	≤17,000	≤17,000

Table 2. ICAO and UK CAA Rotary Wing and Tilt-rotor Aircraft Wake Turbulence Categories[1] (based on MCTOM)

Category	ICAO and Flight Plan (kg)	UK Departures (MCTOM kg)	UK Arrivals (MCTOM kg)
MEDIUM (M)	>7,000 and <136,000	>40,000 and <136,000[3]	N/A
UPPER MEDIUM (UM)	N/A	N/A	>104,000 and <136,000
LOWER MEDIUM (LM)	N/A	N/A	>40,000 and ≤104,000
SMALL[4] (S)	N/A	≥7,000 and ≤40,000	≥7,000 and ≤40,000
LIGHT[4] (L)	≤7,000	<7,000	<7,000

2. **Flight Plan**. The wake turbulence category of an Aircraft **should** be indicated on the Flight Plan (ICAO Flight Plan Item 9) as J, H, M or L according to the ICAO

[1] Refer to Civil Aviation Publication (CAP) 493 – Manual of Air Traffic Services (MATS) Part 1, Annex B.
[2] The SUPER category is only assigned to specific Aircraft types; A380-800, AN-124 Ruslan and AN-225 Mriya.
[3] The MEDIUM category is not split into UPPER MEDIUM and LOWER MEDIUM for the purposes of wake turbulence separation on departure.
[4] In the UK, the CAA has stipulated that all rotary wing Aircraft and tilt-rotor Aircraft with a MCTOM greater than or equal to 7,000 kg and less than or equal to 40,000 kg are to be classified as SMALL for the purposes of providing wake turbulence separation.

Acceptable Means of Compliance 3277(1)

specifications, not the UK category. The categories UM, LM and S are UK categories only and **should not** be entered onto the Flight Plan.

3. **Radiotelephony (RTF)**[5]. Aircraft in the SUPER or HEAVY wake turbulence category **should** include the word 'Super' or 'Heavy' immediately after the Aircraft callsign in the initial call to each Air Traffic Service (ATS) Unit.

4. Wake turbulence separation **should** be based upon flight rules, not the type of ATS applied.

5. ►Wake turbulence separation **should** be applied to consecutive arrivals and to consecutive departures.

6. By providing the appropriate wake turbulence separation to an Aircraft inbound for a touch and go or low approach, the Aircraft **should** be considered as having adequate wake turbulence separation for its climbout. The wake turbulence separation minima for Aircraft conducting a touch and go or low approach immediately before or after a Runway departure is detailed in paragraphs 13 and 14 for Instrument Flight Rules (IFR) Aircraft and 18 and 19 for Visual Flight Rules (VFR) Aircraft.

7. To aid the sequencing of Aircraft, Air Traffic Control (ATC) can request an Aircraft to take off without delay[6]. If the pilot is unable to conform they **should** advise ATC immediately.

8. **Maritime Operations**. Wake turbulence separation **should not** be applied when aviation capable Ships[7] are underway.

IFR◄

9. ►◄ **General Conditions**. Aircraft requesting an IFR approach or departure **should** be subject to IFR wake turbulence separation. Where the separation minima required for IFR flights are greater than the wake turbulence separation minima, the IFR separation minima **should** be applied.

10. ►◄ **Approaches**. The wake turbulence separation minima in Table 3 **should** be applied to IFR Aircraft in the intermediate and Final Approach[8] phases of flight[9, 10] when:

a. An Aircraft is operating directly behind another Aircraft at the same Altitude or less than 1000 ft below; or

b. An Aircraft is crossing behind another Aircraft, at the same Altitude or less than 1000 ft below; or

c. Both Aircraft are using the same Runway or parallel Runways separated by less than 760 m[11].

---

[5] Refer to CAP 413 – Radiotelephony Manual, Chapter 2.
[6] ►Refer to CAP 413 – Radiotelephony Manual, Chapter 4.
[7] Aviation capable Ships are defined as those which can be categorized as Applicability Level A, B or C in Defence Standard 00-133.◄
[8] Refer to CAP 1430 – UK Air Traffic Management Vocabulary for the definition of intermediate approach segment and Final Approach.
[9] MOD wake turbulence Regulations combine the intermediate approach segment and Final Approach phases to provide one set of approach criteria.
[10] For military IFR approaches not depicted on a terminal approach chart, such as a radar straight-in approach, wake turbulence separation standards **should** be applied once the Aircraft is established on the procedure and within 10 nm of the Aerodrome.
[11] Refer to CAP 493 – MATS Part 1, Section 1, Chapter 3.

Acceptable Means of Compliance 3277(1)

Table 3. Wake Turbulence Separation Minima for the Final Approach Phase of Flight[11]

Leading Aircraft	Following Aircraft	Wake Turbulence Separation Minimum Distance (nm)[12]
SUPER	SUPER HEAVY UPPER and LOWER MEDIUM SMALL LIGHT	# 5 7 7 8
HEAVY	SUPER HEAVY UPPER and LOWER MEDIUM SMALL LIGHT	# 4 5 6 7
UPPER MEDIUM	SUPER HEAVY UPPER MEDIUM LOWER MEDIUM SMALL LIGHT	# # 3 4 4 6
LOWER MEDIUM	SUPER HEAVY UPPER MEDIUM LOWER MEDIUM SMALL LIGHT	# # # # 3 5
SMALL	SUPER HEAVY UPPER MEDIUM LOWER MEDIUM SMALL LIGHT	# # # # 3 4
LIGHT	SUPER HEAVY UPPER MEDIUM LOWER MEDIUM SMALL LIGHT	# # # # # #

11. ►◄ **Departures.** The wake turbulence separation minima in Table 4 **should** be applied[13] to Aircraft departing IFR when operating from:

a. The same Runway; or

b. Parallel Runways separated by less than 760 m; or

c. Parallel Runways separated by 760 m or more, if the projected flight path of the second Aircraft will cross the projected flight path of the first Aircraft at the same Altitude or less than 1000 ft below; or

d. Crossing Runways if the projected flight path of the second Aircraft will cross the projected flight path of the first Aircraft at the same Altitude or less than 1000 ft below[11].

12. ►If the lead Aircraft departs from an intermediate point[14] and the following Aircraft uses a greater Runway distance, the 'Departing from the Same Position' section of the table **should** be applied.

[12] # signifies that separation for wake turbulence reasons alone is not necessary.
[13] Controllers **should** apply the prescribed minima irrespective of any pilot request for reduced wake turbulence separation.
[14] An intermediate point is any position on the Runway other than the departure threshold.

Acceptable Means of Compliance 3277(1)

13. **Runway departure after a Touch and Go or Low Approach.** Aircraft departing IFR after a preceding Aircraft has conducted a touch and go **should** be provided wake turbulence separation in accordance with (iaw) the top half of Table 4. Due to the wake turbulence characteristics of a low approach, Aircraft departing IFR after a preceding Aircraft that has conducted a low approach **should** be provided wake turbulence separation iaw the lower half of Table 4.

14. **Aircraft conducting a Touch and Go or Low Approach after a Runway departure.** An IFR Aircraft conducting a touch and go or low approach immediately after a Runway departure **should** be provided wake turbulence separation from the preceding Aircraft iaw Table 3.◄

Table 4. Wake Turbulence Separation Minima for the Departure Phase of Flight[11]

Leading Aircraft	Following Aircraft	Minimum Wake Turbulence Separation at the Time Aircraft are Airborne[12]	
SUPER	SUPER	Departing from the same position or From a parallel Runway separated by less than 760 m	#
	HEAVY		2 minutes
	MEDIUM[3] SMALL LIGHT		3 minutes
HEAVY	HEAVY		4 nm or time equivalent[15]
	MEDIUM SMALL LIGHT		2 minutes
MEDIUM or SMALL	LIGHT		2 minutes
►Leading Aircraft	**Following Aircraft**	**Minimum Wake Turbulence Separation at the Time Aircraft are Airborne[12]◄**	
SUPER (Full length take-off)	SUPER	Departing from an intermediate point[14] on the same Runway or From an intermediate point[14] of a parallel Runway separated by less than 760 m	#
	HEAVY		3 minutes
	MEDIUM SMALL LIGHT		4 minutes
HEAVY (Full length take-off)	HEAVY		4 nm or time equivalent[15]
	MEDIUM SMALL LIGHT		3 minutes
MEDIUM or SMALL (Full length take-off)	LIGHT		3 minutes

►VFR

15. **General Conditions**. When a flight is operating visually (VFR, IFR making a visual approach or IFR / Special VFR operating under reduced separation in the vicinity of Aerodromes) and is following or crossing behind another Aircraft, Responsibility for wake turbulence separation **should** rest with the pilot.◄

16. ►◄ **Approaches.** When ►a VFR◄ Aircraft ►conducts an approach to the Runway,◄ and it appears that the separation minimum distance in Table 3 is unlikely to exist ►from a preceding arrival◄, Controllers **should** advise the pilot 'Caution, wake

[15] ICAO PANS-ATM does not require time based wake turbulence separation between departing HEAVY Aircraft. However, it does require distance-based wake turbulence separation. In the UK, a time equivalent can be used if the period of time it takes for an Aircraft to reach 4 nm has been established.

Acceptable Means of Compliance 3277(1)

turbulence the recommended distance is (number) miles'[16]. ►If the Aircraft is conducting approaches from the visual circuit, the pilot **should** only be advised 'Caution wake turbulence', however units are not prevented from providing a recommended distance if deemed necessary.◄

17. ►◄ **Departures**. The wake turbulence separation minima in Table 4 **should** be applied[13] to Aircraft departing VFR when operating from:

a. The same Runway; or

b. Parallel Runways separated by less than 760 m; or

c. Parallel Runways separated by 760 m or more, if the projected flight path of the second Aircraft will cross the projected flight path of the first Aircraft at the same Altitude or less than 1000 ft below; or

d. Crossing Runways if the projected flight path of the second Aircraft will cross the projected flight path of the first Aircraft at the same Altitude or less than 1000 ft below[11].

18. ►**Runway departure after a Touch and Go or Low Approach**. Aircraft departing VFR after a preceding Aircraft has conducted a touch and go, **should** be provided wake turbulence separation iaw the top half of Table 4. Due to the wake turbulence characteristics of a low approach, Aircraft departing VFR after a preceding Aircraft that has conducted a low approach **should** be provided wake turbulence separation iaw the lower half of Table 4.

19. **Aircraft conducting a Touch and Go or Low Approach after a Runway departure.** When a VFR Aircraft is conducting a touch and go or low approach immediately after a Runway departure, and it appears that the separation minimum distance iaw Table 3 is unlikely to exist, Controllers **should** advise the pilot 'Caution, wake turbulence the recommended distance is (number) miles'. If the Aircraft is conducting a touch and go or low approach from the visual circuit, the pilot **should** only be advised 'Caution wake turbulence' however units are not prevented from providing a recommended distance if deemed necessary.

20. If a unit requires to reduce RTF, caution transmissions to VFR Aircraft can be omitted between Aircraft of the same wake turbulence category but prior to implementing, the unit **should** promulgate the caution and intent to omit the transmissions in the Military Aeronautical Information Publication and Defence Aerodrome Manual.

Formations◄

21. ►◄ Aircraft employing Formation Flying techniques (close or streamed formation including radar trails) **should not** be provided with wake turbulence separation or warnings against other elements of the formation, unless requested.

►Rotary Wing and Tilt-rotor Aircraft◄

22. ►◄ When a rotary wing or tilt-rotor Aircraft[11] Air Taxies across a Runway, wake turbulence separation **should** be applied as if the crossing point was a departure from that intermediate point of the Runway.

23. To minimize the effects of wake turbulence caused by rotary wing or tilt-rotor Aircraft, Controllers:

a. **Should** instruct rotary wing or tilt-rotor Aircraft to ground taxi, when capable, rather than Air Taxi when operating in areas where Aircraft are parked or holding.

b. **Should not** allow rotary wing or tilt-rotor Aircraft to Air Taxi close to taxiways or Runways where light Aircraft operations (including light rotary wing operations) are in progress. If Air Taxiing is imperative, the Aircraft **should** be routed to:

(1) Avoid over flying parked Aircraft, vehicles or ground equipment.

[16] Refer to CAP 413 – Radiotelephony Manual, Chapter 9.

Acceptable Means of Compliance 3277(1)

(2) Follow standard taxi routes where rotary and fixed wing Aircraft share common areas on a Movement Area.

24. When a rotary wing or tilt-rotor Aircraft is Air Taxiing or hovering[17], Controllers and pilots **should** avoid taxiing light Aircraft (including light rotary wing and tilt-rotor Aircraft) within a minimum area comprising three times the rotor diameter of that rotary wing or tilt-rotor Aircraft, see Annex B. Controllers and pilots **should** consider this to be a minimum distance which will need to be increased for larger rotary wing or tilt-rotor Aircraft.

25. Controllers **should** exercise caution when an Aircraft of a lower wake turbulence category is cleared to land on a Runway immediately after a rotary wing or tilt-rotor Aircraft of higher wake turbulence category has landed or taken-off from that Runway's threshold.

Guidance Material 3277(1)

Wake Turbulence

26. **Wake Turbulence Characteristics[18]**. All Aircraft, including rotary wing and tilt-rotor Aircraft, generate vortices as a consequence of producing lift. The heavier the Aircraft and the more slowly it is flying, the stronger the vortex. Vortices are especially persistent in calm conditions. They are most hazardous to Aircraft with a small wingspan during the take-off, initial climb, final approach, and landing phases of flight.

27. A vortex Hazard may exist for about two minutes along a Runway after a large Aircraft has executed a low approach or a touch and go.

28. **Fixed Wing Aircraft**. Wake vortices begin to be generated by fixed wing Aircraft when the nose wheel lifts off the Runway on take-off and continue until the nose wheel touches down on landing.

29. **Rotary Wing Aircraft**. When rotary wing Aircraft mass is transferred from the landing gear to the rotor a strong downwash is created in all directions. When rotary wing Aircraft are in forward flight the downwash from the main rotor(s) is transformed into a pair of trailing vortices, similar to the wing tip vortices of a fixed wing Aircraft. There is some evidence that, per kilogram of gross mass, the wake turbulence generated by a rotary wing Aircraft is more intense than that of a fixed wing Aircraft.

30. **Tilt-rotor Aircraft**. Tilt-rotor Aircraft combine the characteristics of fixed wing and rotary wing Aircraft. For vertical flight, the rotors are angled so the plane of rotation is horizontal, lifting the Aircraft in the way of a rotary wing Aircraft. As the Aircraft's indicated airspeed increases, the rotors are progressively tilted forward, with the plane of rotation eventually becoming vertical, with the fixed wings providing lift and the rotors providing thrust. On final approach, as the Aircraft reduces speed, the rotors are progressively tilted backward. As such, tilt-rotor Aircraft operate as rotary wing Aircraft on final approach and departure, and as fixed wing Aircraft in the en-route and intermediate approach phases.

31. ►**Jet-lift Aircraft**. The downwash produced by jet-lift Aircraft, such as the F-35B differs from that of other fixed wing and rotary wing Aircraft. Typically both fixed wing and rotary wing Aircraft produce a circular downwash pattern that is fairly symmetrical in shape, whereas a jet-lift Aircraft produces a more irregular shape that can produce 'spikes'. These spikes are caused by several separate flow patterns interacting with one another which causes a greater velocity than the average downwash or outwash experienced by other Aircraft types. Research on the full impact of wake vortices and downwash produced by jet-lift Aircraft is ongoing and there is currently no defined criteria for the wake turbulence separation to be applied, particularly when carrying out profiles such as slow approaches or Short Take-Off and Vertical Landing (STOVL). Therefore, local orders at relevant Aerodromes will need to stipulate the wake turbulence mitigations required against other Aircraft when a jet-lift Aircraft is arriving, departing or operating in the visual circuit.◄

32. **General**. Wake turbulence separation minima is the spacing, determined either by time or distance, to be applied so that Aircraft do not fly through the wake of a preceding Aircraft within the area of maximum vortices. Under most circumstances,

[17] Including hovering operations such as underslung loads, sloping ground etc.
[18] Refer to Aeronautical Information Circular P 083/2020 – Wake Turbulence.

Guidance Material 3277(1)

normal separation minima (Runway occupancy rules and departure releases) will provide adequate wake turbulence separation.

33. The wake turbulence categories of frequently controlled Military Aircraft can be found in Annex A. In addition, a database containing the UK wake turbulence categories of the Aircraft types most commonly provided with ATS in the UK can be found in CAP 493, Annex B[1].

34. **IFR Departures**. Wake turbulence separation minima on departure will be applied by measuring airborne times or distances between successive Aircraft, see Table 4. Take-off clearance may be issued with an allowance for the anticipated take-off run on the Runway; however, the airborne time interval will reflect a difference of at least the required time separation.

35. ►◄

Civil Equivalence

36. This Regulation is in line with CAP 493 – MATS Part 1.

ANNEX A

UK Wake Turbulence Categories for Common Military Aircraft Types

HEAVY Fixed Wing Aircraft **MCTOM ≥136,000 kg**	**UPPER MEDIUM Fixed Wing Aircraft** **MCTOM >104,000 kg and <136,000 kg**
Atlas A400M C5 Galaxy C17 Globemaster Rivet Joint Voyager	Nil
LOWER MEDIUM Fixed Wing Aircraft **MCTOM >40,000 kg and ≤104,000 kg**	**SMALL Fixed Wing Aircraft** **MCTOM >17,000 kg and ≤40,000 kg**
C130J Hercules P-8 Poseidon E-7 Wedgetail	Envoy Typhoon F-35 Lightning II F15E Lancaster
LIGHT Fixed Wing Aircraft **MCTOM ≤17,000 kg**	
Hawk Shadow Avenger Tutor Reaper Protector Watchkeeper Dakota Spitfire	Hurricane Chipmunk Phenom Prefect Texan Vigilant
SMALL Rotary Wing Aircraft[19] **MCTOM ≥7,000 kg and ≤40,000 kg**	**LIGHT Rotary Wing Aircraft** **MCTOM <7,000 kg**
Apache Chinook CH53 CV-22B MV-22B Merlin Puma	AW109SP Griffin Bell 212 Wildcat Gazelle Juno Jupiter Dauphin

[19] **Note:** Rotary wing Aircraft such as Puma or larger are classified as SMALL due to their wake turbulence characteristics, rather than LIGHT iaw their MCTOM.

ANNEX B

Rotor Diameters for Common Military Rotary Wing Aircraft Types

SMALL Rotary Wing Aircraft[19]	Rotor Diameter (rounded up)
Apache	50 ft
Chinook	60 ft
CH53	80 ft
CV-22B	85 ft
MV-22B	85 ft
Merlin	65 ft
Puma	55 ft
LIGHT Rotary Wing Aircraft	**Rotor Diameter (rounded up)**
AW109SP	40 ft
Griffin	50 ft
Bell 212	50 ft
Wildcat	45 ft
Gazelle	35 ft
Juno	35 ft
Jupiter	40 ft
Dauphin	40 ft

Intentionally Blank for Print Pagination