

## **Section 6                      Separation Methods and Minima**

### **Chapter 1                      General**

#### **1                      Introduction**

1.1      This chapter contains procedures and procedural separation minima for use in the separation of aircraft in the en route phase as well as aircraft in the arrival and departure phases of flight.

#### **2                      Provision of Standard Separation**

Standard vertical or horizontal separation shall be provided, unless otherwise specified, between:

- a)      All flights in Class A and B airspace;
- b)      IFR flights in Class C, D and E airspace;
- c)      IFR flights and VFR flights in Class C airspace;
- d)      IFR flights and special VFR flights in Class C airspace;
- e)      Special VFR flights in Class C airspace;
- f)      IFR flights in Class F as far as Practical ;
- g)      IFR flights in Class A and C airspace and known IFR flights operating up to 10NM outside of the boundaries of such airspace;

#### **3                      Increased Separation**

3.1      Separation standards are minima and shall be increased when:

- a)      Requested by the pilot.
- b)      A controller considers it necessary.
- c)      Specified in the station standing instruction manual.
- d)      Aircraft is being subjected to unlawful interference.
- e)      Aircraft experiences navigational difficulties or other relevant emergencies.

### 3.1 Fuel Dumping

3.1.1 Other known traffic should be separated from the aircraft dumping fuel by:

- a) At least 10 NM horizontally, but not behind the aircraft dumping fuel;
- b) Vertical separation if behind the aircraft dumping fuel within 15 minutes flying time or a distance of 50 NM by;
- c) At least 1 000 ft if above the aircraft dumping fuel; and
- d) No aircraft are allowed to be below the aircraft dumping fuel.
- e) The horizontal boundaries of the area within which other traffic requires appropriate vertical separation extend for 10 NM either side of the track flown by the aircraft which is dumping fuel, from 10 NM ahead, to 50 NM or 15 minutes along track behind it (including turns).
- f) When possible, a specific sterile area should be assigned for fuel dumping, however, this should not take place below 3000 AGL.

3.2 Fuel dumping should be done with due regard to all relevant factors so as to avoid impeding the flow of air traffic by the application of excessive separations.

## 4 Reduced Separation

4.1 Standard separation may be reduced when authorised by the Civil Aviation Authority and published in the station standing instruction manual.

4.2 In the vicinity of aerodromes, the standard separation minima may be reduced if:

- a) Adequate separation can be provided by the aerodrome controller when each aircraft is continuously visible to this controller;
- b) Each aircraft is continuously visible to flight crews of the other aircraft concerned and the pilots thereof report that they can maintain their own separation;
- c) In the case of one aircraft following another, the flight crew of the succeeding aircraft reports that the other aircraft is in sight and separation can be maintained.

4.3 Clearances to fly maintaining own separation while in visual meteorological conditions, provided:

- a) It is requested by the pilot;
- b) The aircraft concerned are operating in VMC;
- c) Can maintain VMC during the period in which separation is reduced;
- d) It is used in controlled airspace by day only;
- e) The other aircraft agree to the reduced separation; and

f) The clearance shall be for a specified portion of the flight at or below 10 000 ft AMSL, during climb or descent.

4.3.1 When providing clearances to maintain own separations and VMC, the controllers shall use the phrase – maintain own separation and VMCII.

4.3.2 If there is a possibility that flight under VMC may become impracticable, an IFR flight shall be provided with alternative instructions to be complied with in the event that VMC cannot be maintained for the term of the clearance.

#### 4.4 **Emergencies**

4.4.1 If, during an emergency situation, it is not possible to ensure that the applicable horizontal separation can be maintained, emergency separation of half the applicable vertical separation minimum may be used, i.e. 500 ft between aircraft in airspace where a vertical separation minimum of 1 000 ft is applied, and 1 000 ft between aircraft in airspace where a 2 000 ft vertical separation minimum is applied.

4.4.2 When emergency separation is applied the flight crews concerned shall be advised that emergency separation is being applied and informed of the actual minimum used.

4.5 SAAF operations (military aircraft).

4.6 Formation flights when these have been pre-arranged by the pilots concerned.

4.7 In every case where standard separation is reduced, Essential Traffic Information shall be passed.

### 5 **Loss of Separation**

5.1 If, for any reason, a controller is faced with a situation in which two or more aircraft, or an aircraft and an obstruction, or an aircraft and terrain are separated by less the prescribed minima (for example, air traffic control errors or differences in the pilot's estimated and actual times over reporting points) he is to:

a) Use every means at his/her disposal to obtain the required minimum separation with the least possible delay, and

b) Pass essential traffic information as soon as possible,

5.2 Whenever, as a result of failure or degradation of navigation, communications, altimetry, flight control or other systems, aircraft performance is degraded below the level required for the airspace in which it is operating, the flight crew shall advise the controller without delay. Where the failure or degradation affects the separation minimum currently being employed, the controller shall take action to establish another appropriate type of separation or separation minimum.

#### 5.3 **ACAS Deviations**

5.3.1 When a pilot reports a manoeuvre induced by an ACAS resolution advisory (RA), the controller shall not attempt to modify the aircraft trajectory until the pilot reports returning to the terms of the current air traffic control instruction or clearance but shall provide traffic information as appropriate.

- 5.3.2 Once an aircraft departs from its clearance in compliance with a resolution advisory, the controller ceases to be responsible for providing separation between that aircraft and any other aircraft affected as a direct consequence of the manoeuvre induced by the resolution advisory. The controller shall resume responsibility for providing separation for all the affected aircraft when:

Separation has been re-established for all affected aircraft.

- 5.3.3 Following an RA event, or other significant ACAS event, pilots and controllers should complete an air traffic incident report.

## **6 Essential Traffic Information**

- 6.1 Essential traffic is traffic which is separated for any period by less than the specified standard separation.
- a) Direction of flight of conflicting aircraft;
  - b) Type and wake turbulence category of conflicting aircraft;
  - c) Cruising level of conflicting aircraft and ETA for the reporting point, or for aircraft passing through the level of another with less than the normal separation; the ETA for the **nearest or next** reporting point nearest to where the aircraft will cross levels;
  - d) Relative bearing of the aircraft concerned in terms of the 12-hour clock as well as the distance from the conflicting traffic;
  - e) Any alternative clearance.

## **7 Types of Separation**

- 7.1 Separation is divided into the following types:
- a) Vertical;
  - b) Horizontal;
    - I. Lateral.
    - II. Longitudinal.
    - III. ATS Surveillance System.

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### Chapter 2                    Vertical Separation

#### 1                    Vertical Separation

1.1                    Vertical separation is obtained by requiring aircraft using prescribed altimeter setting procedures to operate at levels expressed in terms of flight levels or altitude in accordance with the provisions in ATS Surveillance System and aerodrome control procedures.

#### 1.2                    Vertical Separation Minima

Vertical separation exists when the vertical distance between aircraft is never less than the prescribed minimum. The vertical separation minima are:

- a) 1,000 ft up to FL 290 between all aircraft;
- b) 1,000 ft between FL290 and FL410 between RVSM approved Aircraft only;
- c) 2,000 ft between FL 290 and FL410 between non-RVSM approved aircraft and any other aircraft;
- d) 2,000 ft between all aircraft above FL410 .

1.3                    Controllers are to assess the vertical distance between aircraft by observing the secondary ATS Surveillance System Mode C responses in accordance with the conditions for the use of Mode C specified in Chapter 5 or by obtaining level reports from pilots.

Only RVSM approved aircraft will be permitted to operate in RVSM airspace within the South African area of responsibility (FAJA, FACA and FAJO FIRs)

Only after prior coordination with the appropriate ATC centres will state aircraft (military, police and customs) that are not RVSM approved be cleared to operate within RVSM airspace within the South African area of responsibility. Two thousand feet (2000 ft) vertical separation will be applied between such aircraft and any other aircraft.

1.4                    Should it become necessary to suspend RVSM operations vertical separation and the semi-circular rule shall be applied as per the following table:

Contingency Cruising levels as per direction of flight – FL280 to FL430	
Route from 180 degrees to 359 degrees	Route from 000 degrees to 179 degrees
EVEN	ODD
FL430	(non RVSM level above RVSM airspace)
	FL410
FL380	
	FL350
FL320	
	FL290
FL280	(non RVSM level below RVSM airspace)

When RVSM has been suspended, the period of time for which RVSM have been suspended, specific flight levels and the geographic area of the suspension will be coordinated with adjacent ACCs.

Appropriate flow control procedures, as required should be instituted by the affected ACCs.

## 2 Changing Levels

- 2.1 Aircraft may be instructed to change level at a specified time, place or rate.
- 2.2 An aircraft may be cleared to a level previously occupied by another aircraft after the latter has reported vacating it, except when:
- Severe turbulence is known to exist; or
  - The higher aircraft is effecting a cruise climb; or
  - The difference in aircraft performance is such that less than the applicable separation minimum may result; or
  - The aircraft concerned are established in the same holding pattern.
- 2.3 In these cases such clearance shall be withheld until the aircraft vacating the level has reported at or passing another level separated by the required minimum.
- 2.4 Pilots in direct communication with each other may, with their concurrence, be instructed to maintain a specified separation between aircraft during climb or descent.

### **3 Vertical Speed Control Instructions**

- 3.1 In order to facilitate a safe and orderly flow of traffic, aircraft may be instructed to adjust rate of climb or rate of descent. Vertical speed control may be applied between two climbing aircraft or two descending aircraft in order to establish or maintain a specific vertical separation minimum.
- 3.2 Vertical speed control shall not be applied between aircraft entering or established in a holding pattern.
- 3.3 Vertical speed adjustments should be limited to those necessary to establish and/or maintain a desired separation minimum. Instructions involving frequent changes of climb/descent rates should be avoided.
- 3.4 The flight crew shall inform the ATC unit concerned if unable, at any time, to comply with a specified rate of climb or descent. In such cases, the controller shall apply an alternative method to achieve an appropriate separation minimum between aircraft, without delay.
- 3.5 Aircraft shall be advised when a rate of climb/descent restriction is no longer required.

#### Methods of application:

- a) An aircraft may be instructed to expedite climb or descent as appropriate to or through a specified level, or may be instructed to reduce its rate of climb or rate of descent.
  - b) Climbing aircraft may be instructed to maintain a specified rate of climb, a rate of climb equal to or greater than a specified value or a rate of climb equal to or less than a specified value.
  - c) Descending aircraft may be instructed to maintain a specified rate of descent, a rate of descent equal to or greater than a specified value or a rate of descent equal to or less than a specified value.
  - d) In applying vertical speed control, the controller should ascertain to which level(s) climbing aircraft can sustain a specified rate of climb or, in the case of descending aircraft, the specified rate of descent which can be sustained, and shall ensure that alternative methods of maintaining separation can be applied in a timely manner, if required.
3. Controllers need to be aware of aircraft performance characteristics and limitations in relation to a simultaneous application of horizontal and vertical speed limitations.

### **4 Horizontal Separation**

- 4.1 An 'exact reporting point' is a position established by a navigational facility which is:
  - a) Overhead a VOR.
  - b) Overhead an NDB.
  - b) A position which has been notified as a reporting point and which is established by the intersection of VOR radials.

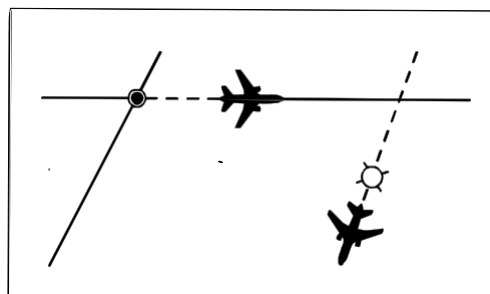
- c) A position which has been notified as a reporting point and which is established by the intersection of a VOR radial and a bearing from a NDB.
- d) A position established by a VOR radial combined with a range from a co-located DME.
- e) A recognised and published RNAV reporting point.

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### Chapter 3 Lateral Separation

#### 1 General

- 1.1 Lateral separation shall be applied so that the distance between aircraft is never less than a specified amount. It is achieved by requiring aircraft to fly on different tracks or in different geographical locations as determined by visual observations, the use of navigational aids or by the use of area navigation (RNAV) equipment.
- 1.2 Communication must be maintained with the aircraft concerned throughout the period that measured distance values are being used to achieve separation. Separation is to be checked by obtaining simultaneous DME readings from aircraft at intervals of not more than 10 minutes.
- 1.3 Where measured distance values are used, each aircraft must be using the same on track VOR/DME facility i.e. it means that the aircraft is flying either directly inbound to or directly outbound from the station.
- 1.4 VOR/DME separation criteria are based on the condition that a VOR and its associated DME station are co-located (600 metres).
- 1.5 Aircraft must be within the designated operational coverage (protected range) of a VOR or a NDB.
- 1.6 **Geographical Separation**
  - 1.6.1 This separation is only to be used in specific instances as authorised by the relevant authority and published in the appropriate documentation.
  - 1.6.2 Such a separation shall be referred to as a —deemed separation and shall be supported on merit by a safety case.

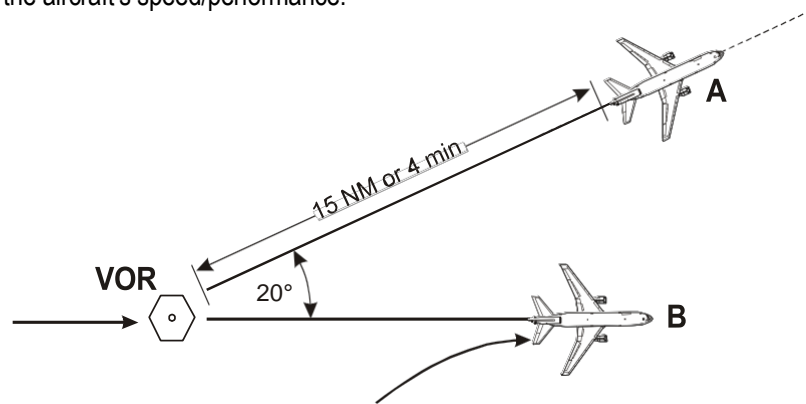




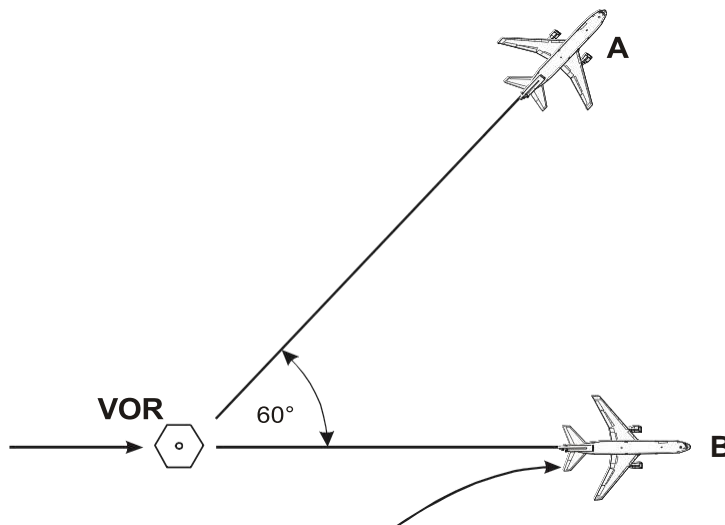
## 2 Lateral Separation on Departure or En-route; Both Aircraft Outbound Using VOR radials.

2.1 Separation is established when;

- a) Both aircraft have reported established on radials which diverge by 20 degrees or more;
- b) One aircraft is the time equivalent of 15 NM or 4 minutes (whichever is the greater) based on the speed of 225kts from the VOR; and
- c) Where only one aircraft has departed from the aerodrome where the VOR is situated, or passed overhead the VOR en-route facility, the time equivalent of 15 NM or 4 minutes (whichever is the greater) based on the speed of 225kts shall be based on the aircraft which departed from the aerodrome where the VOR is situated or passed overhead the VOR facility; and
- d) If the aircraft's speed is less than 225kts, additional time shall be added to take into account the aircraft's speed/performance.



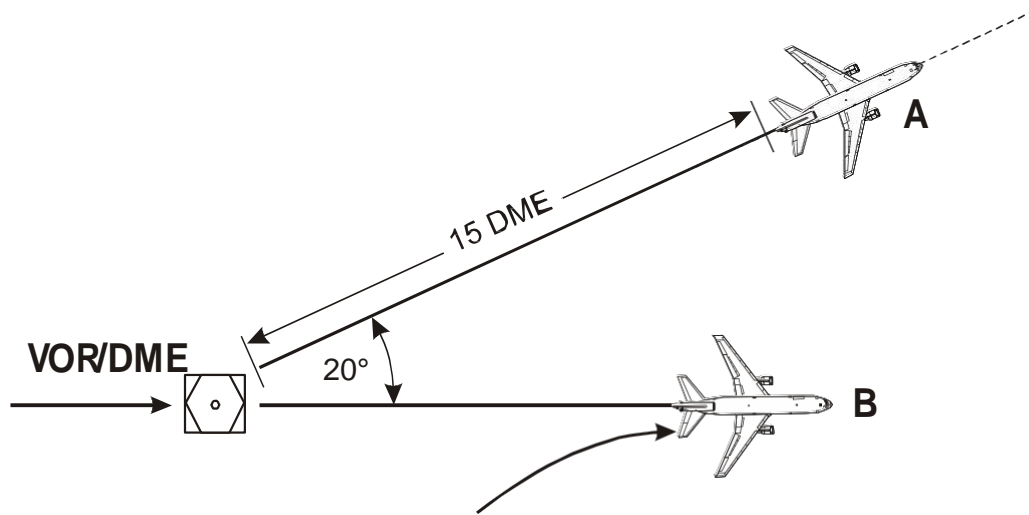
2.2 Separation is established when both aircraft have reported established on radials which diverge by 60 degrees or more.



**3 Lateral Separation on Departure or En-route; Both Aircraft Outbound Using VOR radials and a co-located DME station.**

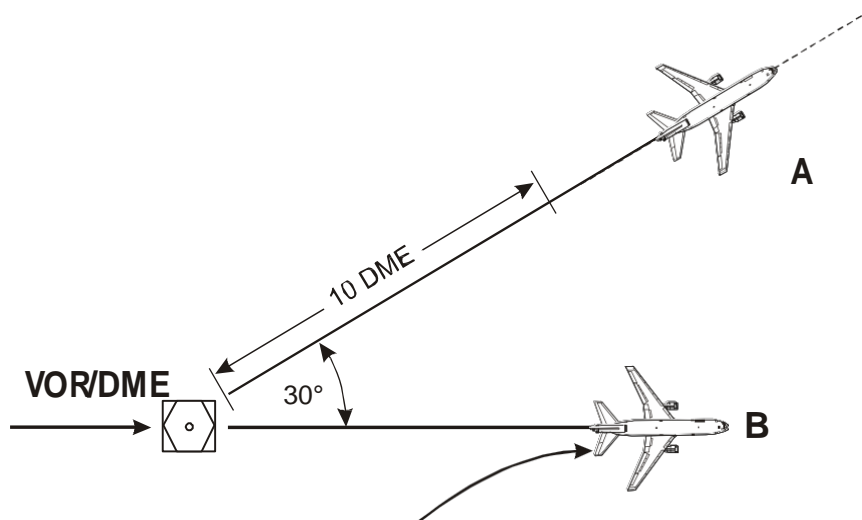
3.1 Separation is established when;

- a) Both aircraft report established on radials which diverge by 20 degrees or more; and
- b) One aircraft is at least 15 DME from the VOR station; and
- c) At least one aircraft has departed or passed overhead the VOR facility.



3.2 Separation is established when;

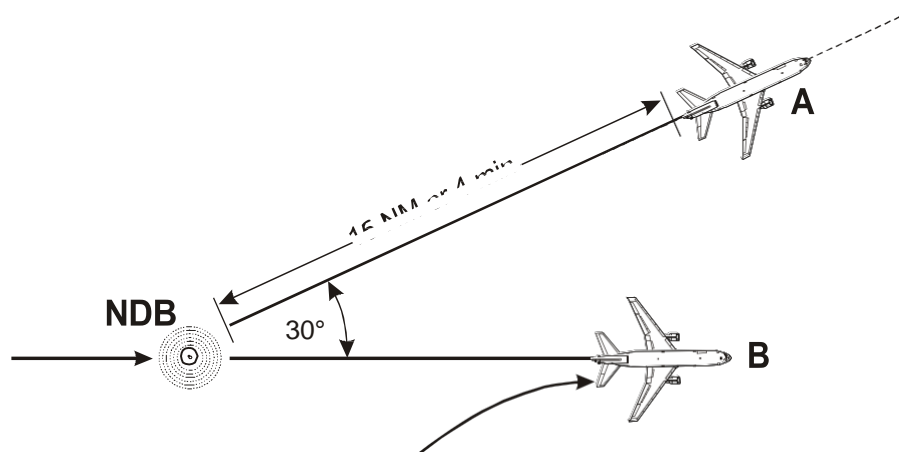
- a) Both aircraft report established on radials which diverge by 30 degrees or more; and
- b) One aircraft is 10 DME from the VOR station; and
- c) At least one aircraft has departed or passed overhead the VOR facility.



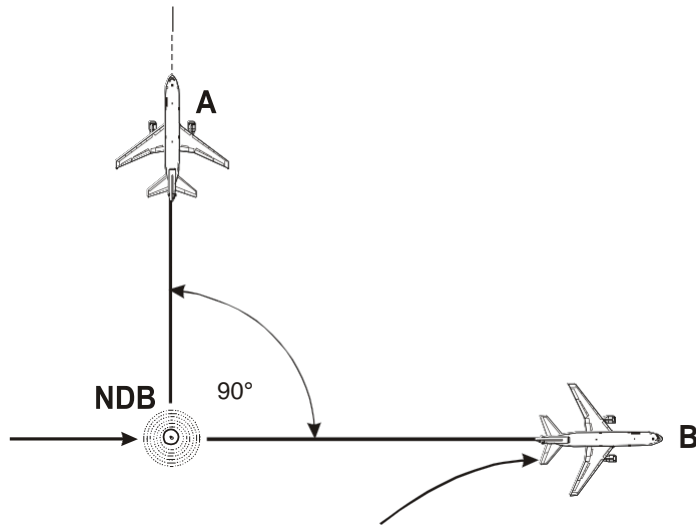
#### 4 Lateral Separation for Departure or En-route; Both Aircraft Outbound Using An NDB

4.1 Separation is established when;

- a) Both aircraft have reported established on tracks which diverge by 30 degrees or more;
- b) One aircraft is the time equivalent of 15 NM or 4 minutes based on the speed of 225kts from the NDB; and
- c) Where only one aircraft has departed from the aerodrome where the NDB is situated, or passed overhead the NDB en-route facility, the time equivalent of 15 NM or 4 minutes (whichever is the greater) based on the speed of 225kts shall be based on the aircraft which departed from the aerodrome where the NDB is situated or passed overhead the NDB facility; and
- d) If the aircraft speed is less than 225 kts, additional time shall be added to take into account the aircraft speed/performance.



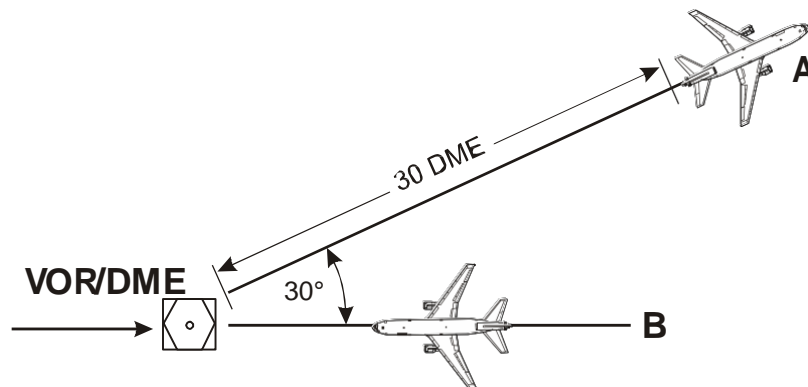
4.2 Separation is established when both aircraft report established on tracks which diverge by 90 degrees or more.



**5 Lateral Separation between Aircraft Inbound and Outbound Using VOR radials and a Co-located DME Station.**

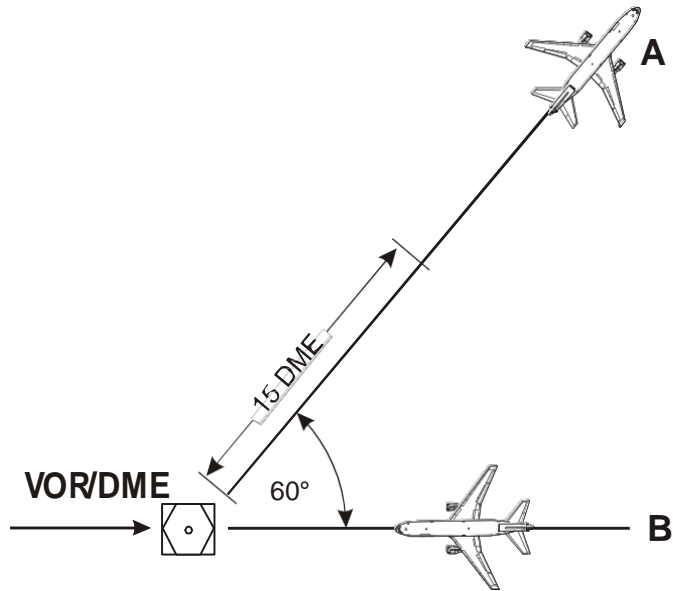
5.1 Separation is established when;

- a) Both aircraft report established on radials at least 30 degrees apart; and
- b) The outbound aircraft has reported at least 30 DME outbound from the VOR station.



5.2 Separation is established when;

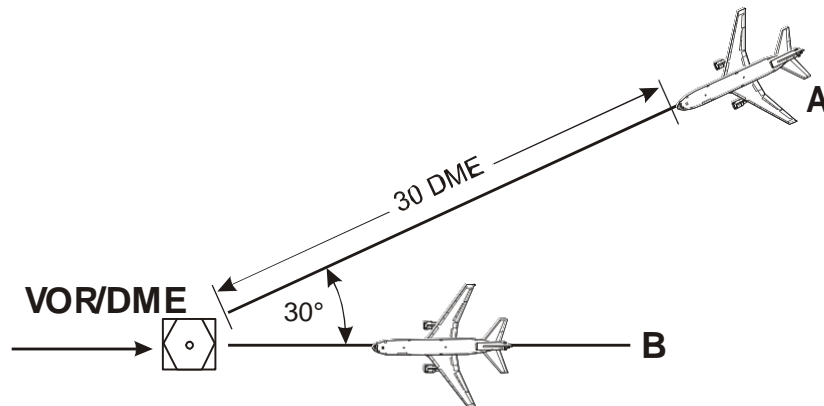
- a) Both aircraft report established on radials at least 60 degrees apart; and
- b) The outbound aircraft has reported at least 15 DME outbound from the VOR station.



**6 Lateral Separation When Both Aircraft Are Inbound Using VOR radials and a Co-located DME Station.**

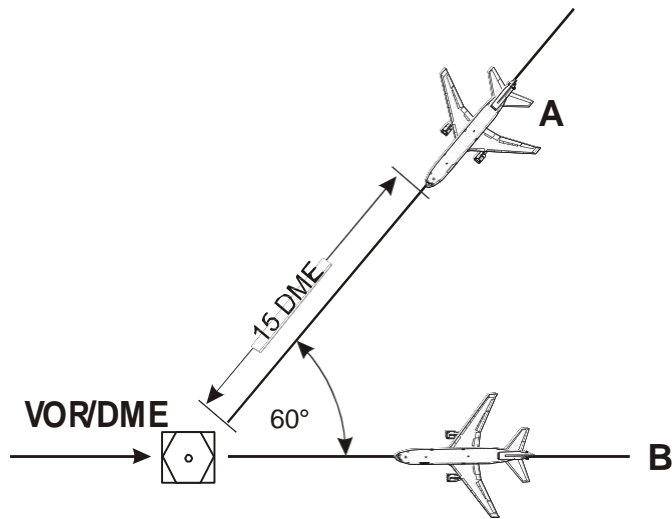
6.1 Separation is established when;

- a) Both aircraft report established on radials 30 degrees apart; and
- b) One aircraft is at least 30 DME from the VOR station.



6.2 Separation is established when;

- a) Both aircraft report established on radials 60 degrees apart; and
- b) One aircraft is at least 15 DME from the VOR station.



## 7 RNAV Operations

7.1 Separation is established when;

- a) Both aircraft are established on tracks which diverge by at least 15 degrees; and
- b) The protected airspace associated with the track of one aircraft does not overlap with the protected airspace associated with the track of the other aircraft.

7.2 This is determined by applying the angular difference between two tracks and the appropriate protected airspace value. The derived value is expressed as a distance from the intersection of the two tracks at which lateral separation exists.

### 7.3 RNAV operations where RNP is specified on parallel tracks or ATS routes

7.3.1 Within designated airspace or on designated routes, where RNP is specified, lateral separation between RNAV-equipped aircraft may be obtained by requiring aircraft to be established on the centre lines of parallel tracks or ATS routes spaced at a distance which ensures that the protected airspace of the tracks or ATS routes does not overlap.

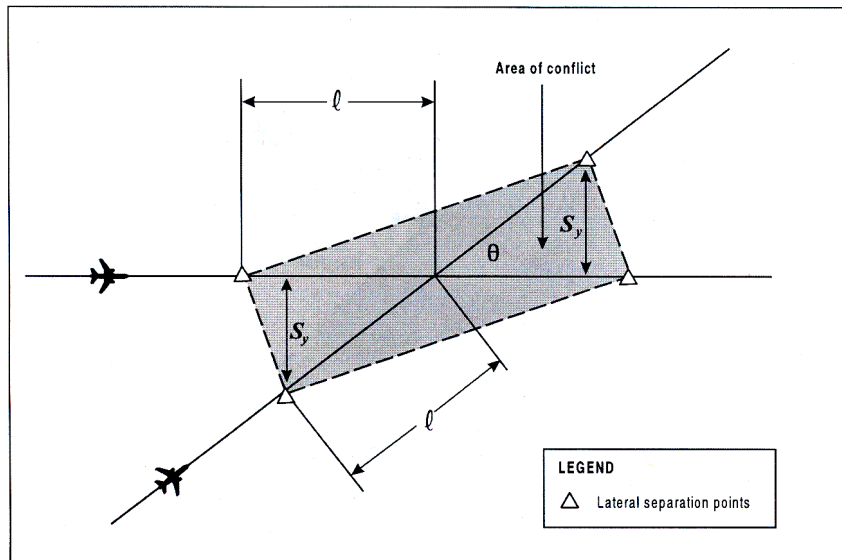
7.3.2 The spacing between parallel tracks or between parallel ATS route centre lines for which an RNP type is required will be dependent upon the relevant RNP type specified.

### 7.4 RNAV operations (where RNP is specified) on intersecting tracks or ATS routes

7.4.1 The use of this separation is limited to intersecting tracks that converge to or diverge from a common point at angles between 15 and 135 degrees.

7.4.2 For intersecting tracks, the entry points to and the exit points from the area in which lateral distance between the tracks is less than the required minimum are termed lateral separation points. The area bound by the lateral separation points is termed the area of conflict.

- 7.4.3 Lateral separation exists between two aircraft when at least one of the aircraft is outside the area of conflict.



The lateral separation points are calculated by the formula:  $l = S_y / \sin\theta$

- $S_y$  = The lateral distance between the tracks equal to the lateral separation minimum.
- $l$  = The distance of the lateral separation point from the intersection.
- $\theta$  = The angle between tracks.

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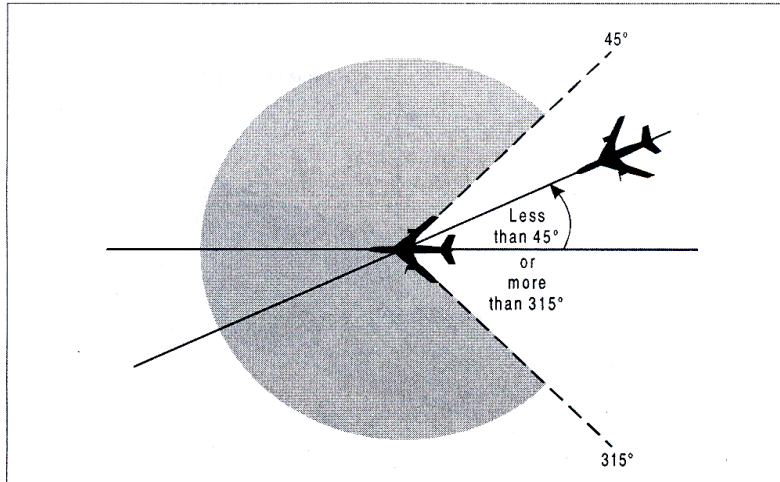
### Chapter 4 Longitudinal Separation

#### 1 General

- 1.1 Longitudinal separation shall be applied so that the spacing between the estimated positions of the aircraft being separated is never less than a prescribed minimum. Longitudinal separation between aircraft following the same or diverging tracks may be maintained by application of speed control.
- 1.2 In applying a time- or distance-based longitudinal separation minimum between aircraft following the same track, care shall be exercised to ensure that the separation minimum will not be infringed whenever the following aircraft is maintaining a higher air speed than the preceding aircraft. When aircraft are expected to reach minimum separation, speed control shall be applied to ensure that the required separation minimum is maintained.
- 1.3 Longitudinal separation may be established by requiring aircraft to depart at a specified time, to arrive over a geographical location at a specified time, or to hold over a geographical location until a specified time.
- 1.4 For the purpose of application of longitudinal separation, the terms same track, reciprocal tracks and crossing tracks shall have the following meanings:

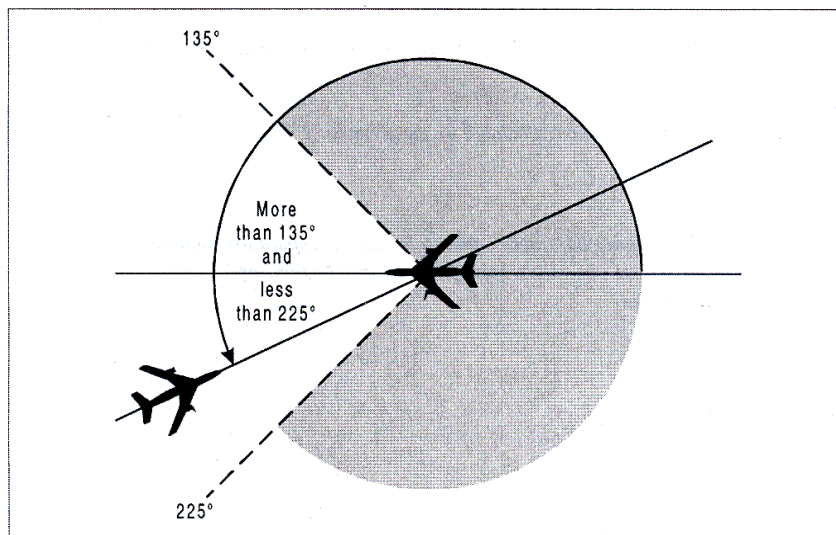
#### 2 Same Track

- 2.1 Same direction tracks and intersecting tracks or portions thereof, the angular difference of which is less than 45 degrees or more than 315 degrees, and whose protected airspaces overlap.
- 2.2 Same identical tracks are a special case of same track where the angular difference is zero degrees.



### 3 Reciprocal Tracks

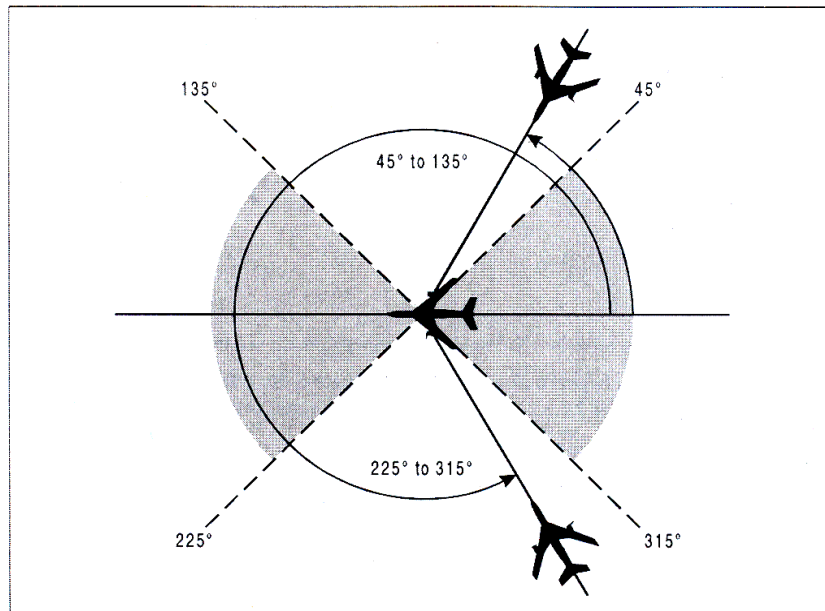
- 3.1 Opposite tracks and intersecting tracks or portions thereof, the angular difference of which is more than 135 degrees but less than 225 degrees, and whose protected airspaces overlap.
- 3.2 Reciprocal identical tracks are a special case where the angular difference is 180 degrees.



### 4 Crossing Tracks



- 4.1 Intersecting tracks or portions thereof other than those specified in paragraphs 2 and 3 of this chapter.



**Note:** The above mentioned separations are in context of RNAV where no terrestrial aids e.g. VOR's or surveillance is applicable and no RNP is specified for the route.

## 5 Longitudinal Separation Based On Time

- 5.1 Time-based separation applied may be based on position information and estimates derived from voice reports, CPDLC or ADS.

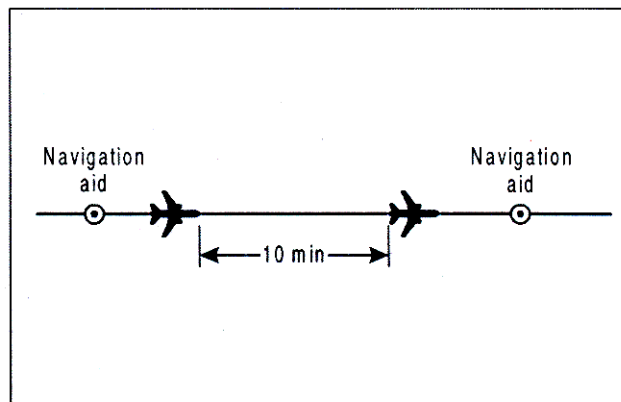
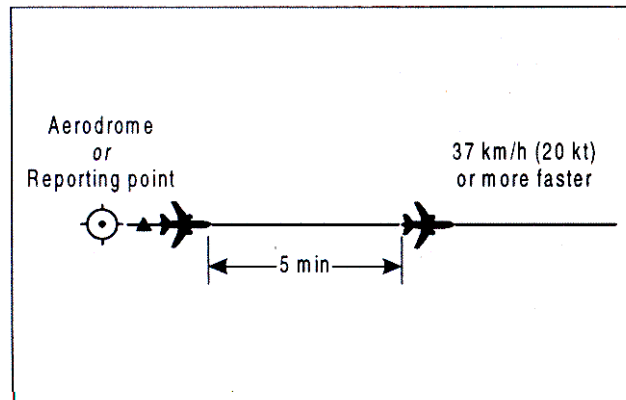
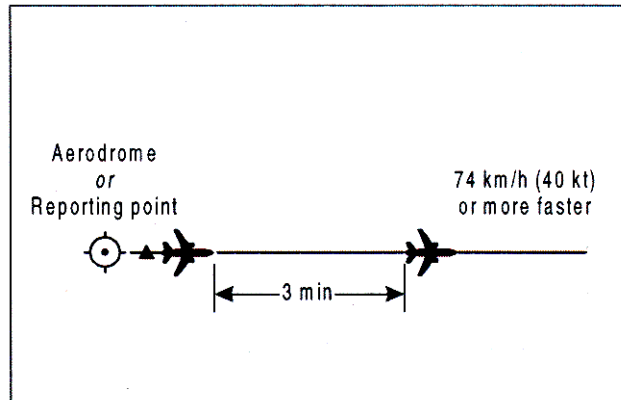
### 5.2 Same Track - Same Level

#### 5.2.1 Separation minima established between:

- a) Aircraft that have departed from the same aerodrome; or
- b) En-route aircraft that have reported over the same exact significant point; or
- c) Between departing and en-route aircraft after the en-route aircraft has reported over a fix that is so located in relation to the departure point as to ensure that five-minute separation can be established at the point the departing aircraft will join the air route;

Same Track – Same Level		
Aircraft Route	Minimum Separation	Provisions
On departure or en-route	3 minutes	Provided preceding aircraft is maintaining a true airspeed of 40kts or faster than the succeeding aircraft.
On departure or en-route	5 minutes	Provided preceding aircraft is maintaining a true airspeed of 20kts or faster than the succeeding aircraft.

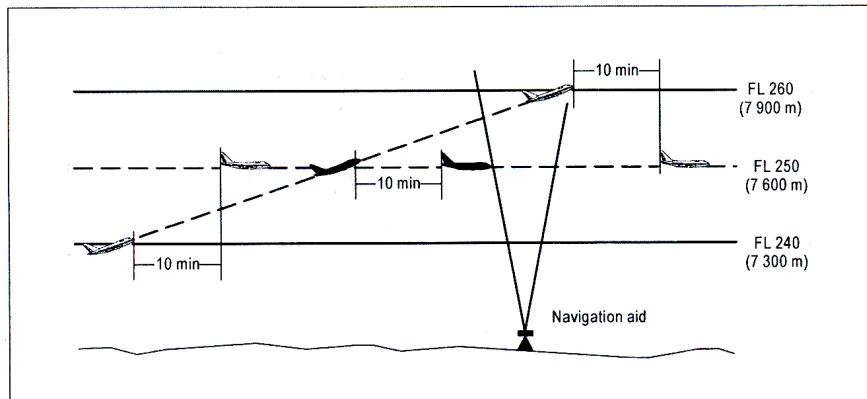
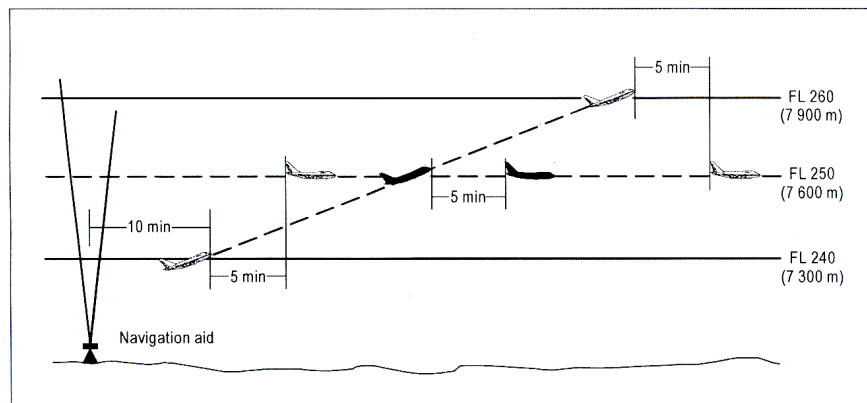
En-route	10 minutes	Same speed and the navigation infrastructure/application allows for the aircrew to regularly assess their location.
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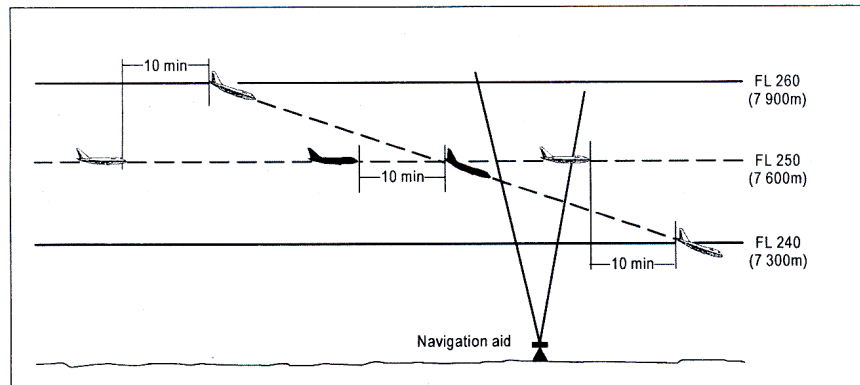
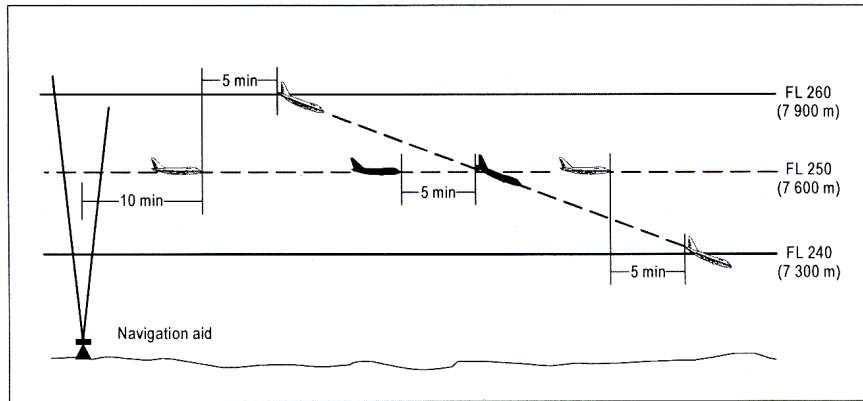


5.3 Same Track - Climbing And Descending

5.3.1 To facilitate application of the procedure where a change of level is involved, a descending aircraft may be cleared to a safe level above the lower aircraft, or a climbing aircraft to a safe level below the higher aircraft. Further descent or climb will be given once longitudinal separation has been established.

Same Track – Climbing And Descending.		
Aircraft Route	Minimum Separation	Provisions
En-route	5 minutes	While vertical separation does not exist, provided that the level change is commenced within 10 minutes of the second aircraft has reported over an exact reporting point.
En-route	10 minutes	While vertical separation does not exist.

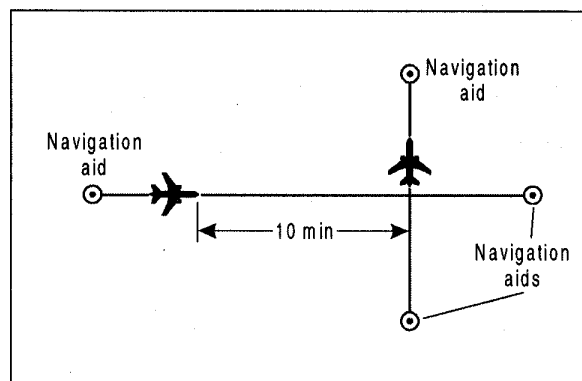




5.4 Crossing Track - Same Level Or Climbing And Descending

5.4.1 Where lateral separation is not provided, vertical separation shall be provided:

- a) For at least 10 minutes before the second aircraft estimates the crossing point; and
- b) For at least 10 minutes after the time the first aircraft past the crossing point.

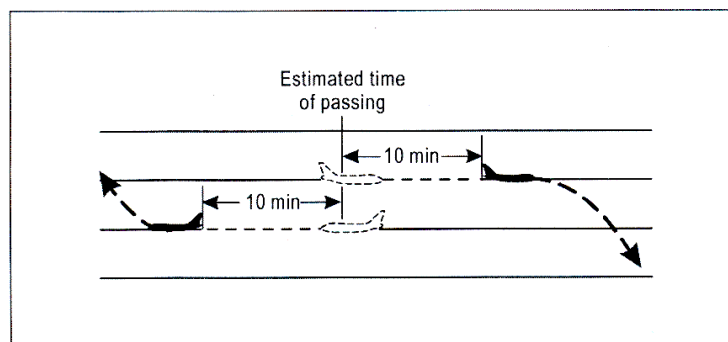


5.5 Reciprocal track

5.5.1 Where lateral separation is not provided, vertical separation shall be provided:

- a) For at least 10 minutes before the crossing time; and

- b) For at least 10 minutes after the time the aircraft are estimated to pass, or are estimated to have passed.
- 5.5.2 Provided it has been determined that the aircraft have passed each other, this minimum need not apply.
- 5.5.3 By means of the following methods it can be determined whether the aircraft have passed each other;
- a) Visual sighting;
  - b) Both aircraft have reported as having crossed the same en-route navigation facility.
- 5.5.4 ATC should give due consideration to possible navigational errors and accuracy of navigational equipment, with particular reference to the cone of silence.



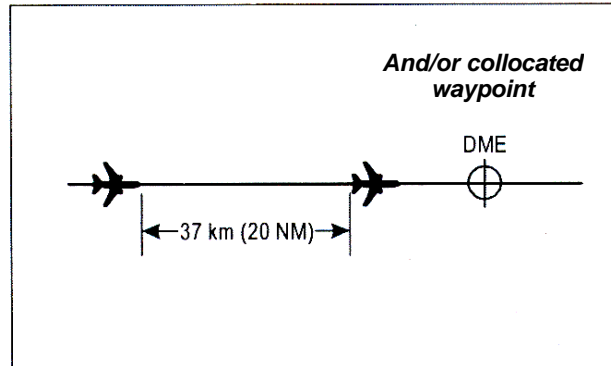
## 5.6 Longitudinal Separation Based on Distance

- 5.6.1 Separation shall be established by maintaining not less than specified distance(s) between aircraft positions as reported by reference to DME in conjunction with other appropriate navigation aids.
- 5.6.2 Direct controller-pilot communication shall be maintained while such separation is used.
- 5.6.3 Where the term —on trackII is used in the provisions relating to the application of longitudinal separation minima using DME, it means that the aircraft is flying either directly inbound to or directly outbound from the station.
- 5.6.4 Separation is to be checked by obtaining simultaneous DME readings from aircraft at frequent intervals to ensure that the minimum separation is established and will not be infringed.

## 5.7 Same Track - Same Level

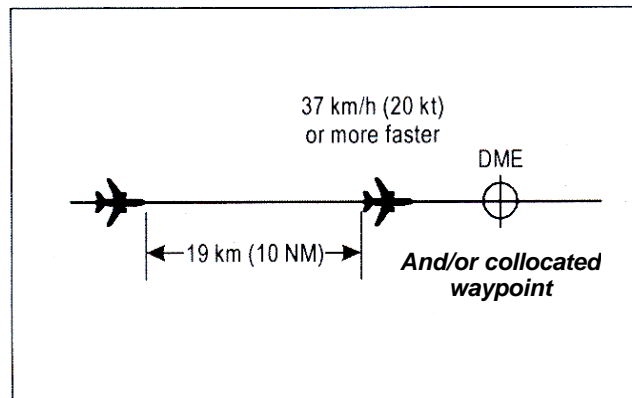
- 5.7.1 The distance between two aircraft shall be 20 NM, provided:
- a) Each aircraft utilises,
    - h)* The same —on-trackII DME stations, and when both aircraft are utilising DME; or
    - ii) An —on trackII DME station and a collocated common point when one aircraft is utilising DME and the other is utilizing GNSS, or
    - iii) The same common point when both aircraft are utilising GNSS, and

- b) Separation is checked by obtaining simultaneous DME and/ or GNSS readings from the aircraft at frequent intervals to ensure that the minimum will not be infringed.



5.7.2 The distance between two aircraft shall be 10 NM, provided:

- a) The leading aircraft maintains a true airspeed of 20kts or more faster than the succeeding aircraft; and
- b) i) Each aircraft utilises the same —on-track DME station, when both aircraft are utilising DME; or
- ii) An —on track DME station and a collocated common point when one aircraft is utilising DME and the other is utilising GNSS, or
- iii) The same common point when both aircraft are utilising GNSS, and
- c) Separation is checked by obtaining simultaneous DME and/ or GNSS readings from the aircraft at such intervals as are necessary to ensure that the minimum is established and will not be infringed.

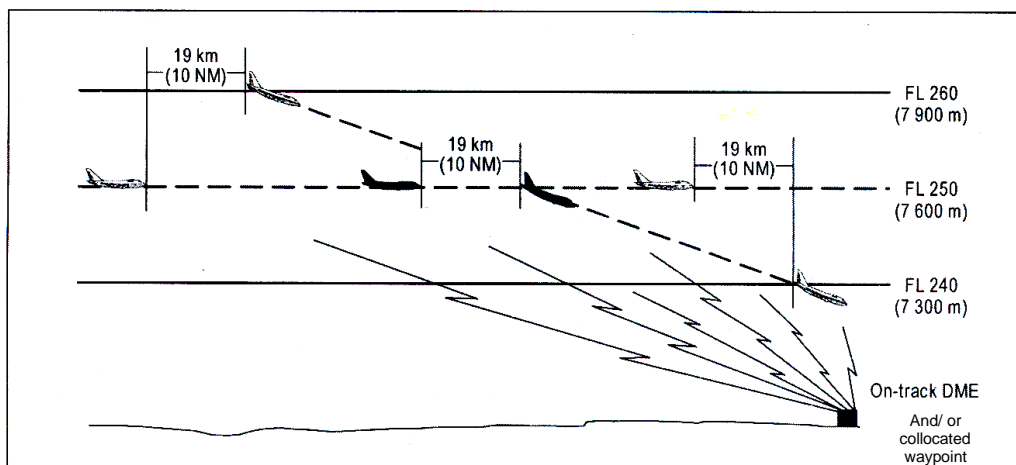
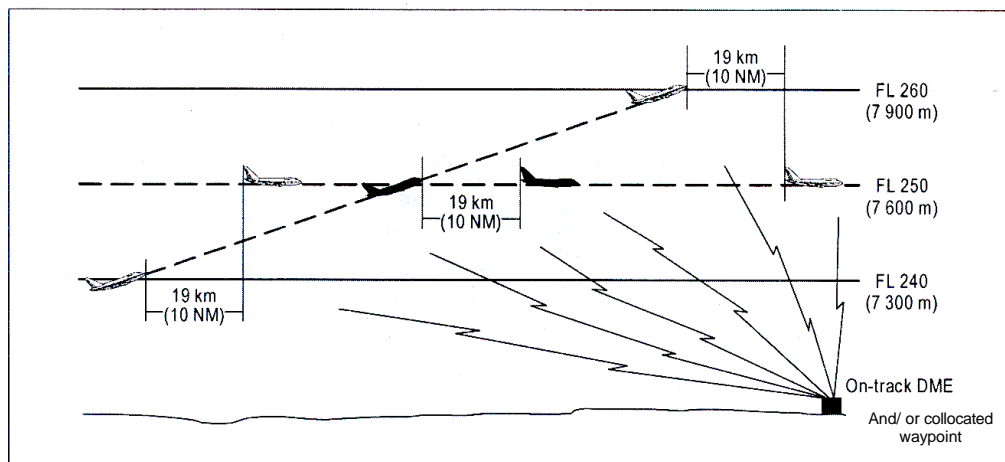


5.8 Same Track - Climbing And Descending

5.8.1 The distance between two aircraft shall be 10 NM while vertical separation does not exist, provided:

- a) Each aircraft utilises;
  - i) The same —on-track DME stations; when both aircraft are utilising DME, or
  - ii) An —on track DME station and a collocated common point when one aircraft is utilising DME and the other is utilising GNSS, or
  - iii) same common point when both aircraft are utilising GNSS, and
- b) one aircraft maintains a level while vertical separation does not exist; and
- c) Separation is established by obtaining simultaneous DME and/ or GNSS readings from the aircraft.

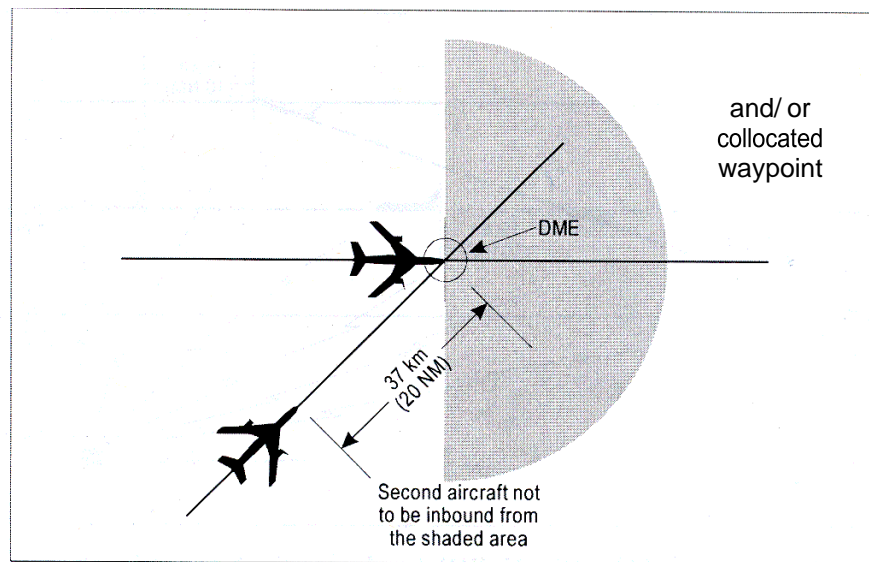
5.8.2 To facilitate application of the procedure where a change of level is involved, a descending aircraft may be cleared to a safe level above the lower aircraft, or a climbing aircraft to a safe level below the higher aircraft. Further descent or climb will be given once longitudinal separation has been established.



5.9 Crossing Track - Same Level or Climbing and Descending

5.9.1 The distance between two aircraft shall be 20 NM, provided:

- a) Each aircraft utilises:
  - i) The same —on-track DME station when both aircraft are utilising DME, or
  - ii) An —on track DME station and a collocated common point when one aircraft is utilising DME and the other is utilising GNSS, or
  - iii) same common point when both aircraft are utilising GNSS.
- b) Separation is checked by obtaining simultaneous DME readings from the aircraft at frequent intervals to ensure that the minimum will not be infringed; and
- c) Each aircraft reports the distance from the station located at the crossing point of the tracks and that the relative angle between the tracks is less than 90 degrees.

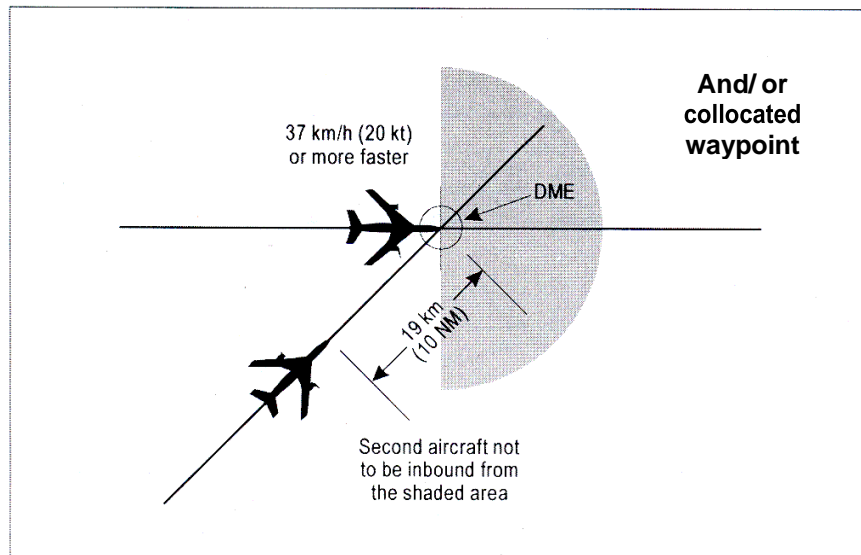


5.9.2 The distance between two aircraft shall be 10 NM, provided:

- a) The leading aircraft maintains a true airspeed of 20kts or more faster than the succeeding aircraft; and
- b) Each aircraft utilises:
  - i) The same —on-track DME station when both aircraft are utilising DME, or
  - ii) An —on track DME station and a collocated common point when one aircraft is utilising DME and the other is utilising GNSS, or
  - iii) same common point when both aircraft are utilising GNSS.



- c) Separation is checked by obtaining simultaneous DME readings from the aircraft at such intervals as are necessary to ensure that the minimum is established and will not be infringed; and
- d) Each aircraft reports distance from the station located at the crossing point of the tracks and that the relative angle between the tracks is less than 90 degrees.

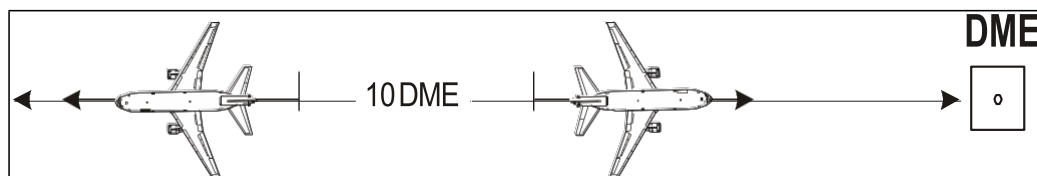


## 5.10 Reciprocal Track

5.10.1 Separation is established when;

- a) Each aircraft utilises the same on-track DME and/or collocated common point or same common point; and
- b) It has been positively established that the aircraft have passed each other; and
- c) Are at least 10 NM apart.

5.10.2 There is no longitudinal distance separation for reciprocal tracks before both aircraft have crossed.



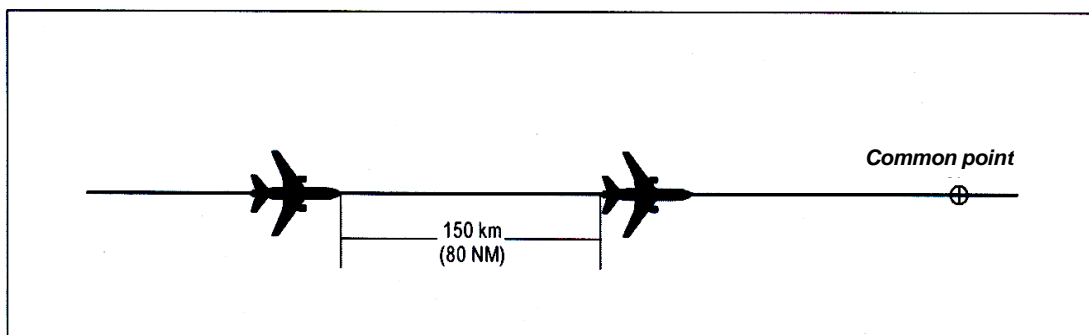
## 6 Longitudinal Separation Minima with Mach Number Technique Based On Distance Using RNAV.

*Note: See paragraph 16 with regards to the use of Mach numbers*

- 6.1 Turbojet aircraft shall adhere to the Mach number approved by ATC and shall request ATC approval before making any changes thereto. If it is essential to make an immediate temporary change in the Mach number (e.g. due to turbulence), ATC shall be notified as soon as possible that such a change has been made.
- 6.2 If it is not feasible, due to aircraft performance, to maintain the last assigned Mach number during en route climbs and descents, pilots of aircraft concerned shall advise ATC at the time of the climb/descent request.
- 6.3 RNAV distance based separation minima shall not be applied after ATC has received pilot advice indicating navigation equipment deterioration or failure.
- 6.4 Separation shall be established by maintaining not less than the specified distance between aircraft positions as reported by reference to RNAV equipment.
- 6.5 Direct controller-pilot communications should be maintained, while such separation is used. Where high frequency or general purpose extended range very high frequency air-ground communication channels are used for area control service and are worked by air-ground communicators, suitable arrangements shall be made to permit direct controller-pilot communications, or monitoring by the controller of all air-ground communications.
- 6.6 To assist pilots to readily provide the required RNAV distance information, such position reports should, wherever possible, be referenced to a common common point ahead of both aircraft.
- 6.7 RNAV distance based separation may be applied between RNAV-equipped aircraft when operating on designated RNAV routes or on ATS routes defined by VOR.

**7 Same Track - Same Level**

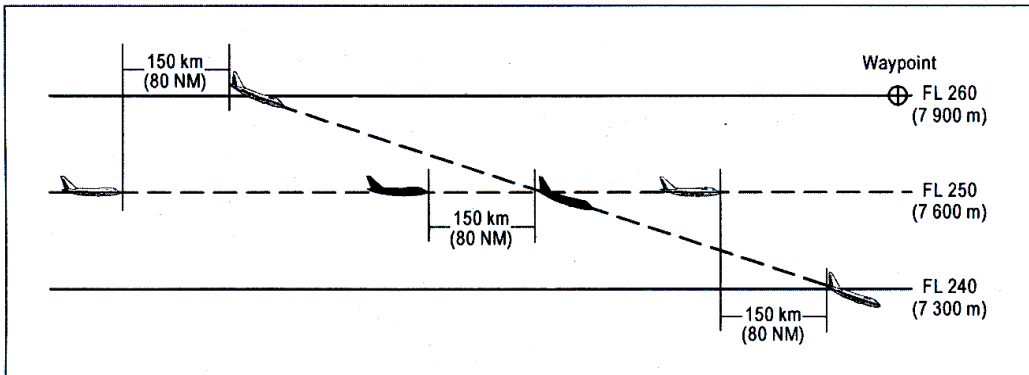
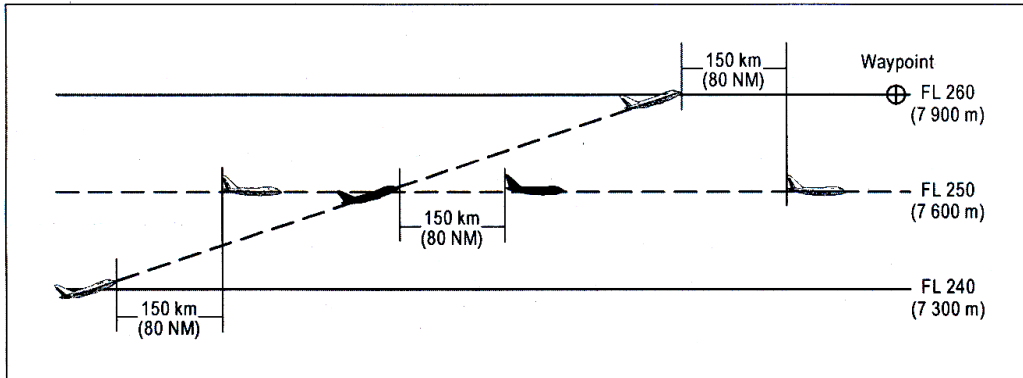
- 7.1 80 NM RNAV distance based with Mach number technique in lieu of a 10 minute longitudinal separation minimum with Mach number technique, provided:
  - a) The preceding aircraft shall maintain a Mach number equal to or greater than that maintained by the following aircraft; and
  - b) Each aircraft reports its distance to or from the same —on-track|| common point; and
  - c) Separation between aircraft at the same level is checked by obtaining simultaneous RNAV distance readings from the aircraft at frequent intervals to ensure that the minimum will not be infringed.



## 8 Same Track - Climbing and Descending

8.1 80 NM RNAV distance based with Mach number technique in lieu of a 10 minute longitudinal separation minimum with Mach number technique, provided:

- a) The preceding aircraft shall maintain a Mach number equal to or greater than that maintained by the following aircraft; and
- b) Each aircraft reports its distance to or from the same —on-track” common point; and
- c) Separation is established by obtaining simultaneous RNAV distance readings from the aircraft; and
- d) One aircraft maintains a level while vertical separation does not exist.



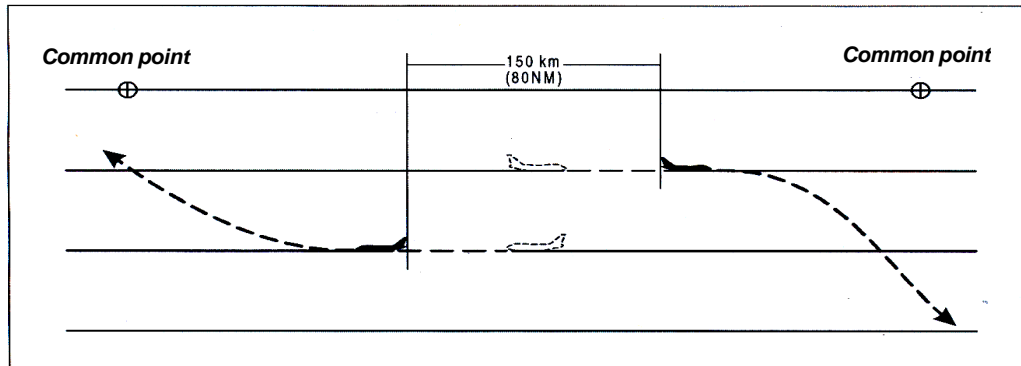
8.2 To facilitate application of the procedure where a change of level is involved, a descending aircraft may be cleared to a safe level above the lower aircraft, or a climbing aircraft to a safe level below the higher aircraft. Further descent or climb will be given once longitudinal separation has been established

## 9 Reciprocal track

9.1 Separation is established when;

- a) Each RNAV equipped aircraft utilizes the same —on-track” common point; and

- b) It has been positively established that the aircraft have passed each other by simultaneous RNAV distance readings to or from that common point; and
- c) Are at least 80 NM apart.



## 10 Longitudinal Separation Minima Based On Distance Using RNAV Where RNP Is Specified.

- 10.1 Within designated airspace, or on designated routes, separation minima in accordance with the provisions of this section may be used, subject to regional air navigation agreements.
- 10.2 Separation shall be established by maintaining not less than the specified distance between aircraft positions as reported by reference to the same —on track// common point, whenever possible ahead of both aircraft, or by means of an automated position reporting system.
- 10.3 The term —on track// means that the aircraft is flying either directly inbound to or directly outbound from the station or common point.
- 10.4 When information is received indicating navigation equipment failure or deterioration below the navigation performance requirements, ATC shall then, as required, apply alternative separation minima.
- 10.5 Direct controller-pilot communications shall be maintained while applying a distance based separation minima.
- 10.6 Direct controller-pilot communications shall be voice or CPDLC. The communication criteria necessary for CPDLC to satisfy the requirement for direct controller-pilot communications shall be established by an appropriate safety assessment.
- 10.7 Prior to and during the application of a distance-based separation minimum, the controller should determine the adequacy of the available communication link, considering the time element required to receive replies from two or more aircraft, and the overall workload/traffic volume associated with the application of such minima.
- 10.8 When aircraft are at, or are expected to reduce to, the minimum separation applicable, speed control techniques, including assigning Mach number, shall be applied to ensure that the minimum distance exists throughout the period of application of the minima.

**11 Longitudinal Distance-Based Separation Minima in an RNP RNAV Environment Not Using ADS**

11.1 Same track - same level or climbing and descending;

Same Track – Same Level or Climbing And Descending.				
<b>Separation minima</b> 50NM	<b>RNP</b> 10	<b>Communication</b> Direct controller – pilot.	<b>Surveillance</b> Procedural position reports.	<b>Distance verification</b> At least every 24 minutes.

11.2 Where a considerable change of level is involved using distance-based separation, a descending aircraft may be cleared to some convenient level above the lower aircraft, or a climbing aircraft to some convenient level below the higher aircraft 4 000 ft, or less to permit a further check on the separation that will be maintained while vertical separation does not exist.

11.3 It should be noted that the separation minimum depicted above is based on safety assessments performed specifically for a particular network of tracks or routes. As such, the assessments evaluated traffic characteristics which might be unique to the network being assessed.

11.4 The separation minimum above was developed in accordance with a collision risk analysis, which dictates conditions under which this separation can be applied.

11.5 During the application of the 50 NM separation, when an aircraft fails to report its position:

- a) The controller shall take action within 3 minutes to establish communication; or
- b) If communication has not been established within 8 minutes of the time the report should have been received, the controller shall take action to apply an alternative form of separation.

11.6 Where automated position reporting applies, a common time reference shall be used.

**12 Reciprocal Track**

12.1 Separation is established when;

- a) Each RNAV equipped aircraft utilizes the same – on-track common point; and
- b) It has been positively established that the aircraft have passed each other by simultaneous RNAV distance readings to or from that common point; and
- c) Are at least 50 NM apart.

**13 Longitudinal Distance-Based Separation Minima In An RNP RNAV Environment Using ADS**

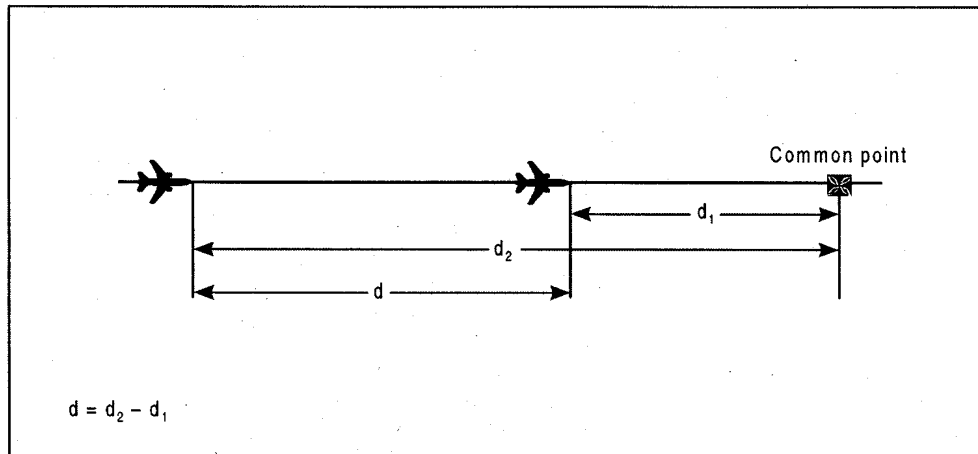
13.1 Separation based on the use of ADS shall be applied so that the distance between the calculated positions of the aircraft is never less than the prescribed minimum.

13.2 This distance shall be obtained by one of the following methods;

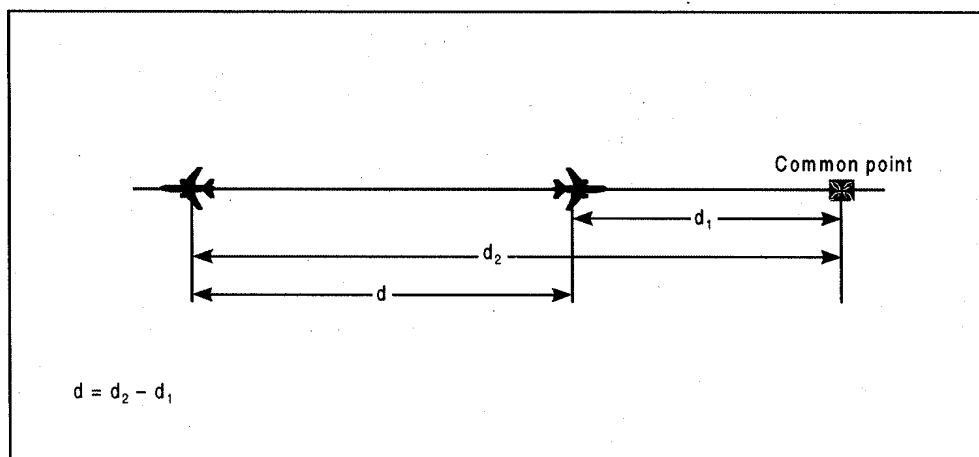
When the aircraft are on the same identical track, the distance may be measured between:

- a) The calculated positions of the aircraft; or
- b) May be calculated by measuring the distances to a common point on the track. (See Fig. 1&2).

**Note:** Same identical tracks are a special case of same track definition: where the angular difference is zero degrees; or reciprocal tracks definition: where the angular difference is 180 degrees.



Calculation of longitudinal distance between aircraft on identical track- Same Direction (Fig 1).

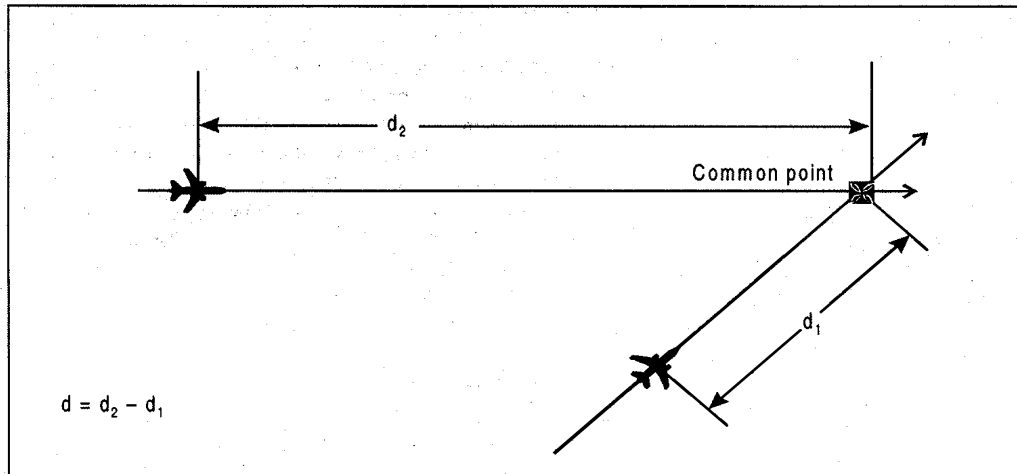


Calculation of longitudinal distance between aircraft on identical track – Opposite Direction (Fig 2).

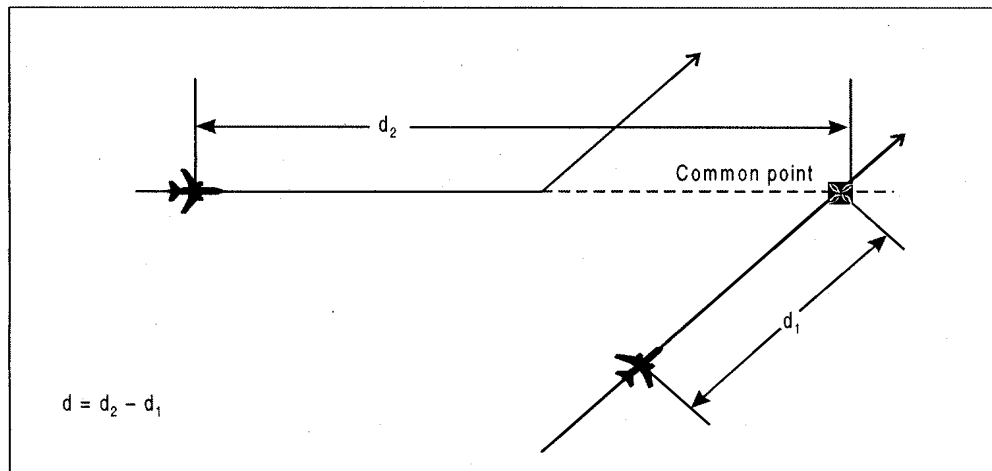
13.3 When the aircraft are on same or reciprocal non-parallel tracks other than in above, the distance shall be calculated by measuring the distances:

- a) To the common point of intersection of the tracks; or
- b) Projected track.(See Figures 3 to 5).

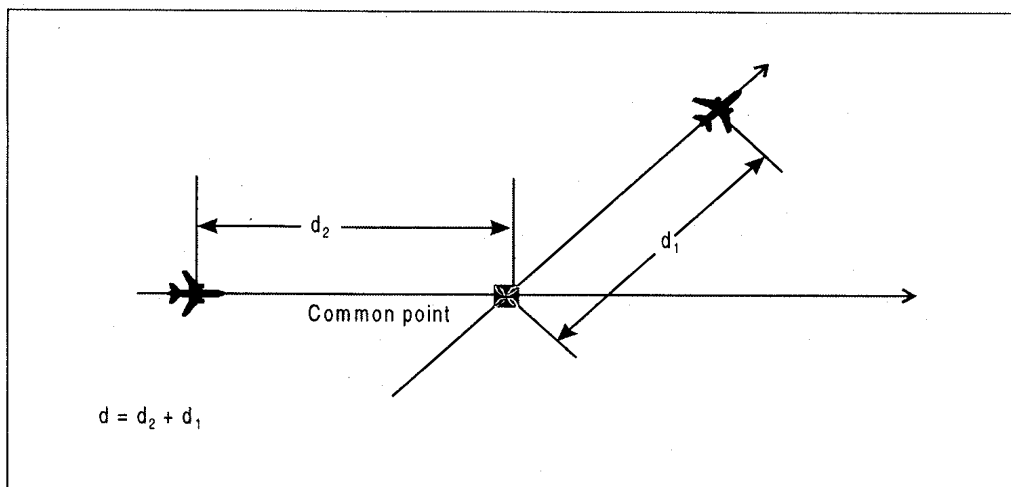
- 13.4 When the aircraft are on parallel tracks whose protection areas overlap, the distance shall be measured; along the track of one of the aircraft as in paragraph 14.32.3 using its calculated position and the point abeam the calculated position of the other aircraft. (See Figure 6).
- 13.5 When aircraft are at, or are expected to reduce to, the minimum separation applicable, speed control techniques, including assigning Mach number, shall be applied to ensure that the minimum distance exists throughout the period of application of the minima.



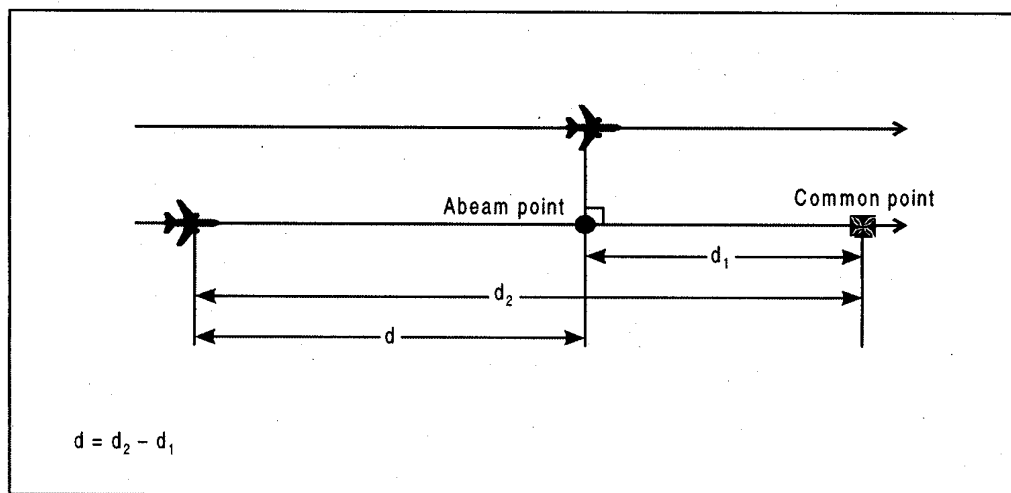
Calculation of longitudinal distance between aircraft on — Same Track — but not identical (Fig 3).



Calculation of longitudinal distance between aircraft on — Same Track — but not identical (Fig 4).



Calculation of longitudinal distance between aircraft – Opposite sides of the common point (Fig 5).



Calculation of longitudinal distance between aircraft – Parallel Tracks (Fig 6).

**14 Same Track - Same Level or Climbing and Descending**

Same Track – Same Level or Climbing and Descending		
Separation minima	RNP	Maximum ADS periodic reporting interval.
50NM	10	27 Minutes
50NM	4	32 Minutes
30NM	4	14 Minutes

14.1 The indicated periodic reporting intervals are specific to the use of ADS and are derived from performed safety assessments. As a result, these intervals may differ from those required for use with other procedural RNAV longitudinal separation minima.

14.2 The communication system provided to enable the application of these separation minima shall allow a controller:



- a) Within 4 minutes, to intervene and resolve a potential conflict by contacting an aircraft using the normal means of communication.
  - b) An alternative means shall be available to allow the controller to intervene and resolve the conflict within a total time of 10.5 minutes, should the normal means of communication fail.
- 14.3 When an ADS periodic or common point change event report is not received within 3 minutes of the time it should have been sent, the report is considered overdue and the controller shall take action to obtain the report as quickly as possible, normally by ADS or CPDLC.
- 14.4 If a report is not received within 6 minutes of the time the original report should have been sent, and there is a possibility of loss of separation with other aircraft, the controller shall take action to resolve any potential conflict(s) as soon as possible. The communication means provided shall be such that the conflict is resolved within a further 7.5 minutes.
- 14.5 Reciprocal Track

Reciprocal track – after crossing		
Separation minima	RNP	Maximum ADS periodic reporting interval.
50NM	10	27 Minutes
50NM	4	32 Minutes
30NM	4	14 Minutes

**15 Horizontal Speed Control Instructions**

- 15.1 In order to facilitate a safe and orderly flow of traffic, aircraft may, subject to conditions specified by the appropriate authority, be instructed to adjust speed in a specified manner. Flight crews should be given adequate notice of planned speed control.

*Note 1.— Application of speed control over a long period of time may affect aircraft fuel reserves.*

*Note 2.— Provisions concerning longitudinal separation using the Mach number technique are contained in Chapter 5, Separation Methods and Minima.*

- 15.2 Speed control instructions shall remain in effect unless explicitly cancelled or amended by the controller.  
*Note.— Cancellation of any speed control instruction does not relieve the flight crew of compliance with speed limitations associated with airspace classifications as specified in Annex 11 — Air Traffic Services, Appendix 4*
- 15.3 Flight crews should be given adequate notice of planned speed control, because application of speed control over a long period of time may affect aircraft fuel reserves.
- 15.4 Speed control shall not be applied to aircraft entering or established in a holding pattern.
- 15.5 Speed adjustments should be limited to those necessary to establish and/or maintain a desired separation minimum or spacing.
- 15.6 Instructions involving frequent changes of speed, including alternate speed increases and decreases, should be avoided.

- 15.6 The flight crew shall inform the ATC unit concerned if at any time they are unable to comply with a speed instruction. In such cases, the controller shall apply an alternative method to achieve the desired spacing between the aircraft concerned.
- 15.7 At levels at or above FL 250, speed adjustments should be expressed in multiples of 0.01 Mach; at levels below FL 250, speed adjustments should be expressed in multiples of 10 kts based on indicated airspeed (IAS).
- 15.8 Mach 0.01 equals approximately 6 kts IAS at higher flight levels.
- 15.9 When an aircraft is heavily loaded and at a high level, its ability to change speed may, in cases, be very limited.
- 15.10 Aircraft shall be advised when a speed control restriction is no longer required.
- 15.11 In order to maintain a desired spacing using speed control techniques, specific speeds need to be assigned to all the aircraft concerned.
- 15.12 The true airspeed (TAS) of an aircraft will decrease during descent when maintaining a constant IAS.
- 15.13 When two descending aircraft maintain the same IAS, and the leading aircraft is at the lower level, the TAS of the leading aircraft will be lower than that of the following aircraft. The distance between the two aircraft will thus be reduced, unless a sufficient speed differential is applied.
- 15.14 For the purpose of calculating a desired speed differential between two succeeding aircraft, 6 kts IAS per 1 000 ft height difference may be used as a general rule.
- 15.15 At levels below FL 80 the difference between IAS and TAS is negligible for speed control purposes.
- 15.16 Time and distance required to achieve a desired spacing will increase with higher levels, higher speeds, and when the aircraft is in a clean configuration.
- 15.17 An aircraft should, when practicable, be authorized to absorb a period of notified terminal delay by cruising at a reduced speed for the latter portion of its flight.
- 15.18 An arriving aircraft may be instructed to maintain its —maximum speed<sub>II</sub>, —minimum clean speed<sub>II</sub>, —minimum speed<sub>II</sub>, or a specified speed.
- 15.19 —Minimum clean speed<sub>II</sub> signifies the minimum speed at which an aircraft can be flown in a clean configuration, i.e. without deployment of lift-augmentation devices, speed brakes or landing gear.
- 15.20 Speed reductions to less than 250 kts IAS for turbojet aircraft during initial descent from cruising level should be applied only with the concurrence of the flight crew.
- 15.21 Instructions for an aircraft to simultaneously maintain a high rate of descent and reduce its speed should be avoided as such manoeuvres are normally not compatible. Any significant speed reduction during descent may require the aircraft to temporarily level off to reduce speed before continuing descent.
- 15.22 Arriving aircraft should be permitted to operate in a clean configuration for as long as possible.

Below FL 150, speed reductions for turbojet or fanjet aircraft should not be less than 210 kts IAS, which will normally be very close to the minimum speed of turbojet aircraft in a clean configuration, may be used.

- 15.23 Only minor speed reductions not exceeding plus/minus 20 kts IAS should be used for aircraft on intermediate and final approach.
- 15.24 Speed control should not be applied to aircraft after passing a point 4 NM from the threshold. (Final approach.)
- 15.25 In order to establish a desired spacing between two or more successive aircraft, the controller should first:
  - a) Either reduce the speed of the last aircraft, or
  - b) Increase the speed of the lead aircraft; and then
  - c) Adjust the speed(s) of the other aircraft in order.

## **16 The Mach Number Technique**

16.1 The term —Mach number technique is used to describe the technique of clearing turbo-jet aircraft operating along the same route to maintain specified true Mach numbers in order to maintain adequate longitudinal separation between successive aircraft at, or climbing or descending to, the same level.

### **16.2 Objectives of the Use of the Mach The Number Technique**

16.2.1 The principal objectives of use of the Mach the number technique are:

- a) To ensure continued longitudinal separation between successive aircraft on long route segments with a minimum of Air Traffic Control (ATC) intervention;
- b) To obtain improved utilisation of such routes, thus contributing to the economy of flight operations of traffic concerned.

16.2.2 To achieve these objectives the speeds of aircraft operating along the same track at the same level or climbing or descending to operate at the same level are stabilized. This stability permits reasonably accurate projections of the expected longitudinal separation between aircraft to points well beyond the point where separation is first confirmed, which reduces the need for frequent ATC intervention.

16.2.3 Practical experience in the North Atlantic (NAT) region has confirmed the assumptions made above. It has been found that successive aircraft operating along the same track at the same level and aircraft climbing or descending to operate at the same level as another aircraft and maintaining the same Mach number also maintain a reasonably constant time interval between each other, when checked by position reports over the same point. This is due to the fact that the aircraft concerned are normally subject to approximately the same wind and temperature conditions. Minor variations in speed, which might temporarily increase or decrease the spacing between aircraft, tend to be neutralized over prolonged periods of flight.

### **16.3 Prerequisites**

16.3.1 The application of the Mach number technique is particularly suitable for areas where the environment is such that position reporting and ATC intervention with individual flights can, at times, be subject to delay. In addition, the following represent typical characteristics of the route structure and environment which make the use of a given area suitable for the application of the Mach number technique:

- a) Aircraft in the area generally follow the same or diverging tracks until they are provided with other forms of separation;
  - I. Operations conducted in the area comprise a significantly large phase of stable flight (e.g. not less than one hour) and the aircraft concerned have normally reached an operationally suitable level when entering the area.
  - II. The effect of seasonal jet stream phenomena should be examined closely before introduction of the Mach number technique on a regular basis.
- b) Aircraft instrumentation. The use of the Mach number technique in a given area is based on the assumption that the relevant instruments used by aircraft to which this technique is applied have been calibrated in accordance with applicable airworthiness practices. Therefore, both States of Registry and operators concerned should take the necessary measures to ensure continued compliance with this prerequisite.
- c) Flight progress information for ATC. ATC units using the Mach number technique must have at their disposal the latest forecast upper wind information, or position information obtained from previous aircraft. Such information is necessary in order to permit ATC to prepare (either manually or by means of a computer) flight progress strips showing calculated estimated times over significant points up to and including the exit point from the area wherein the technique is applied in order to confirm that the required longitudinal separation will exist at the exit point.
- d) Adherence to assigned Mach number. Unless otherwise advised by the pilot concerned, ATC will assume that the last assigned Mach number will be maintained both in cruise and in any cleared step-climbs or step-descents made in the course of the flight.

#### 16.4 **General Procedures**

16.4.1 Application of the Mach number technique should always be based on the true Mach number.

16.4.2 The ATC clearance must include the assigned Mach number that is to be maintained. It is therefore necessary that information on the desired Mach number be included in the flight plans by pilots intending to operate along routes in the area concerned.

16.4.3 ATC has a requirement to calculate estimated times at which aircraft will pass significant points along their track. These calculations are necessary both for;

- a) The provision of longitudinal separation between aircraft on crossing tracks, and
- b) For co-ordination with adjacent ATC units. Therefore ATC must be provided with necessary data to do this.

- 16.4.4 It is very important that the estimates for the entry point to the area provided by pilots are as accurate as possible since they form the basis for the advance planning of longitudinal separation between aircraft.
- 16.4.5 The prescribed longitudinal separation between successive aircraft flying at the same level must be provided over the entry point and on a particular track or tracks, or exist when climb or descent to the level of another aircraft is accomplished into the area concerned.
- 16.4.6 Thereafter, provided that aircraft maintain their last assigned Mach numbers, intervention by ATC for the portion of flight where the Mach number technique is used, should normally only be necessary if an aircraft, for some reason, is obliged to change its number or if there is conflicting traffic on crossing tracks or a flight level change is intended.
- 16.4.7 The Mach number technique requires that pilots strictly adhere to the following procedures:
- a) Aircraft must strictly adhere to the last assigned Mach number;
  - b) If essential to make an immediate temporary change in Mach number (e.g. due to turbulence), the appropriate ATC unit should be notified as soon as possible of that change;
  - c) When required by the appropriate ATC unit, the current true Mach number should be included in routine position reports.
- 16.4.8 Due account must be taken of problems which may be caused at entry and exit points if the longitudinal separation minima used in adjacent airspace differ from those used in the area where the Mach number technique is used.

## 16.5 Specific Procedures

- 16.5.1 The following specific procedures related to the use of the Mach number technique are based on experience gained in its use in the NAT region. They are especially useful in areas of high traffic density where position reporting and ATC intervention with individual flights may, at times, be subject to delay.
- 16.5.2 En-route step-climbs and step-descents
- 16.5.3 The Mach number technique may be used as a means of applying longitudinal separation between aircraft carrying out step-climbs or step-descents and other en-route traffic on the same track provided;
- a) That the prescribed minimum longitudinal separation between the climbing/ descending aircraft and other affected en-route traffic exists at the time a climb/descent clearance is issued; and
  - b) Will exist during climb/descent, as well as at each further significant point along track and at the exit point.
- 16.5.4 Application of this procedure is based on the assumption that the last assigned true Mach number will be maintained during step-climbs and step-descents, and that in the event it is not feasible, ATS is advised at the time of the climb/descent request.

## 16.6 Separation at Entry Point When the Following Aircraft Is the Faster

- 16.6.1 The NAT/SPG developed a table to be used in connection with the application of the Mach number technique at the entry point in situations where the following aircraft is maintaining a true Mach number greater than the preceding aircraft.

This table shows in terms of distance to be flown (in still air) the separation required in minutes at entry point;

Difference in Mach	Distance To Fly And Separation(In Minutes) Required At Entry Point.				
	0001-600NM	601-1200NM	1201-1800NM	1801NM-2400NM	2401-3000NM
0.01	11	12	13	14	15
0.02	12	14	16	18	20
0.03	13	16	19	22	25
0.04	14	18	22	26	30
0.05	15	20	25	30	35
0.06	16	22	28	34	40
0.07	17	24	31	38	45
0.08	18	26	34	42	50
0.09	19	28	37	46	55
0.10	20	30	40	50	60

- 16.6.2 If two aircraft intend to operate along the same track and at the same flight level, with the second aircraft operating at a higher true Mach number than the preceding aircraft, the longitudinal spacing between the aircraft over the entry point should be increased by an additional time interval.
- 16.6.3 To ensure that minimum longitudinal separation will exist over that point the increase must take into account:
- The relative ground speeds; and
  - The track distance to the common exit point.
- 16.6.4 The calculation of ground speeds and estimated times over significant points is a time-consuming process which, in dense traffic situations, could result in unacceptable delays in issuance of clearances. A –rule of thumbll may be applied which allows clearances to be issued in a timely manner, provided the expected minimum longitudinal separation over the exit point is subsequently confirmed when the calculated flight progress strip data become available.
- 16.6.5 The rule of thumb.

For each 600 NM in distance between the entry and exit points of the area where the Mach number technique is used, add one minute for each 0.01 difference in Mach number for the two aircraft concerned to compensate for the fact that the second aircraft is overtaking the first aircraft

Track Distance.	Required Multiplier.	Differences In Mach Number.	Required Minutes To Be Added.
1800NM	3	0.01	3
2400NM	4	0.02	8
3000NM	5	0.01	5

An aircraft operating at Mach 0.82 is followed by another aircraft operating at Mach 0.84. The longitudinal separation minimum at the exit point is 15 min. Track distance is 1 800 NM.

<p>Calculation:</p> <p>Add 3min x 2 (Required multiplier) = 6 min:</p> <p>15 min + 6 min = 21 min. longitudinal separation at entry point.</p>
--

An aircraft operating at Mach 0.78 is followed by another aircraft operating at Mach 0.84. The longitudinal separation minimum at the exit point is 15 min. Track distance is 2 400 NM.

<p>Calculation:</p> <p>Add 4 min x 6 (Required multiplier) = 24 min:</p> <p>15 min + 24 min = 39 min. longitudinal separation at entry point.</p>
---

**16.7 Longitudinal Separation Minima with Mach Number Technique Based On Time**

- 16.7.1 Turbojet aircraft shall adhere to the Mach number approved by ATC and shall request ATC approval before making any changes thereto. If it is essential to make an immediate temporary change in the Mach number (e.g. due to turbulence), ATC shall be notified as soon as possible that such a change has been made.
- 16.7.2 If it is not feasible, due to aircraft performance, to maintain the last assigned Mach number during en-route climbs and descents, pilots of aircraft concerned shall advise ATC at the time of the climb/descent request.

**16.8 Same Track – Same Level or Climbing and Descending**

- 16.8.1 Separation is established when the turbojet aircraft are adhering to Mach number specified and required time interval is established; and
  - a) The aircraft concerned have reported over the same reporting point and follow the same track or continuously diverging tracks until some other form of separation is provided; or
  - b) If the aircraft have not reported over the same reporting point and it is possible to ensure, by **ATS Surveillance System** or other means, that the appropriate time interval will exist at the common point from which they either follow the same track or continuously diverging tracks;

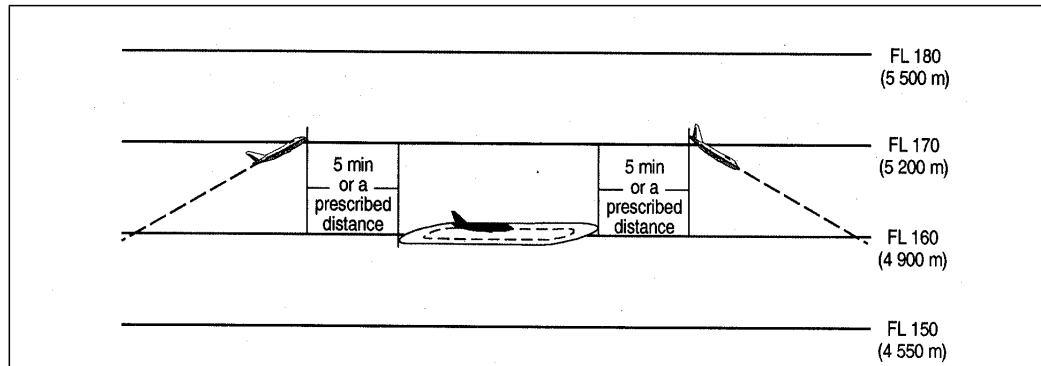
<b>Same Track – Same Level Or Climbing And Descending.</b>	
Time interval at same or common reporting point.	Provided the preceding aircraft is maintaining this Mach number greater than the succeeding aircraft. Equal to or greater.
10	
9	0.02
8	0.03
7	0.04
6	0.05

## 17 Holding Aircraft

17.1 When aircraft are being held in flight the following separation standards shall apply:

- a) *Aircraft leaving a holding stack:* Vertical separation shall be maintained until the aircraft is at least 5 minutes flying time away from the holding aircraft's flight path.
- b) *En-route aircraft approaching to join a holding stack:* Vertical separation shall be established at least 10 minutes before the joining aircraft is estimated to reach the holding aircraft's flight path.

17.2 Aircraft established in adjacent holding patterns shall, except when lateral separation between the holding areas exists, be separated by the applicable vertical separation minimum, unless the applicable holding patterns are published as deemed to be separated.



17.3 Except where lateral separation exists, vertical separation shall be applied between aircraft holding in flight and other aircraft, whether arriving, departing or en-route, whenever the other aircraft concerned are within 5 minutes flying time of the holding area.

## 18. Arrival/Departure Separation

18.1 The following separation is applicable to a departing flight in relation to an arriving flight and it does not prejudices the IFR separation as previously discussed.

18.2 The separation shall be applied when take-off clearance is based on the position of an arriving aircraft.

18.3 This separation shall only apply to aircraft departing from runways, the QDM of which is 45 degrees or more away from the reciprocal of the approach path of the arriving aircraft and no subsequent manoeuvre by the departing aircraft shall take it into the prescribed 45 degrees sectors.

18.4 An arriving aircraft shall be considered as:

18.4.1 An aircraft doing a procedure turn approach:

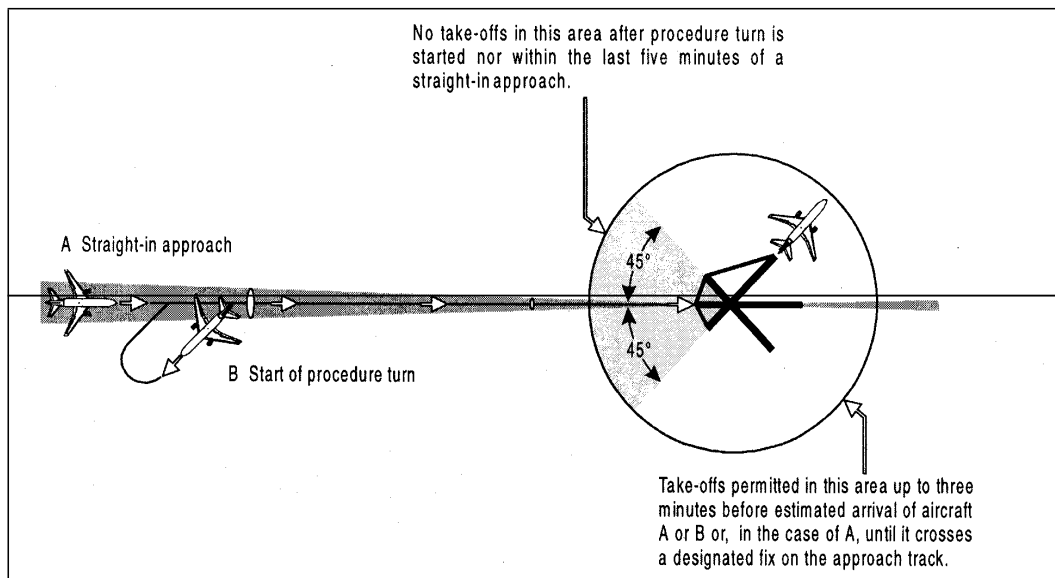
- a) that has been cleared for the procedure turn approach as No. 1; and
- b) has crossed the facility.

18.4.2 An aircraft in the associated let-down pattern;

- a) that has been cleared for an instrument approach as No. 1; and
- b) has crossed the facility for the last time.



- 18.4.3 An aircraft doing a straight in approach:**
- that has been cleared for a straight-in approach to the runway and is No. 1 to land,
  - is not more than 10 minutes or 20 NM, whichever is first, from touch-down; and
  - is established on the ILS localizer or extended centre - line of the runway.
- 18.5 Departing aircraft may be permitted to take-off in any direction from any runway, other than in the 45 degrees stated in section 18.3, until;**
- the arriving aircraft is established on final approach at a point which is at least 3 minutes from the beginning of the instrument runway; or is established on the ILS glide-slope, whichever is earlier.
- 18.6 After this point in time no departure shall be permitted from any runway under IMC conditions.**
- 18.7 This separation can be used when there is no ILS at the station using NDB/VOR approaches.**
- 18.8 Any deviation from these requirements shall be accompanied by SACAA approved Safety risk assessment. 19.**



**19. Sector Separation between Arriving and Departing Aircraft (SA- CAA Approved).**

**19.1 The following sector separation may only be used between:**

- a) Aircraft departing from an aerodrome and aircraft inbound to the same aerodrome; or
- b) Aircraft holding in a standard holding pattern associated with the landing facility at that aerodrome.

**19.2 The sectors so prescribed must be clearly laid down in the Station Standing Instructions at the ATSU.**

**19.3 The holding facility shall:**

- a) Be situated in the arrival sector;
- b) Be at least 3.5 NM from the departure runway
- c) Threshold Be positioned on the extended centre-line of such runway.

**19.4 The arrival sector shall be defined as 60 degree arcs on either side of the approach path to the instrument runway.**

*Note: The 60 degree arcs shall be measured from the holding facility.*

**19.5 Departure sector shall be defined as 60 degree arcs on either side of the extended centre-line of the instrument runway.**

*Note: The 60 degree arcs shall be measured from:*

- a) A point which is 4 NM from the up-wind end and on the extended centre-line of the instrument runway.
- b) Where there is a facility situated not less than 3,5 NM from the up-wind end and on the extended centre-line of the instrument runway, the arcs may be measured from this point.

**19.6 The inbound track of the holding pattern must be in line with the runway centre line.**

**19.7 Inbound traffic to the holding facility must be;**

- a) On tracks for the facility which are contained within the prescribed arrival sector; and
- b) Shall under no circumstances be cleared beyond the facility.

**19.8 Departing traffic must be departing from runways that will permit them to proceed on tracks directly into the prescribed departure sector.**

**19.9 VOR/DME may be used to establish an aircraft in a particular sector.**

- 19.9.1 Where an aircraft's original track is not within the required sector the aircraft may be cleared to alter heading to intercept a track within the sector provided that the aircraft is equipped with functioning VOR/DME facility.

The procedure, as given above, may not be used for aircraft equipped with ADF or VOR only.

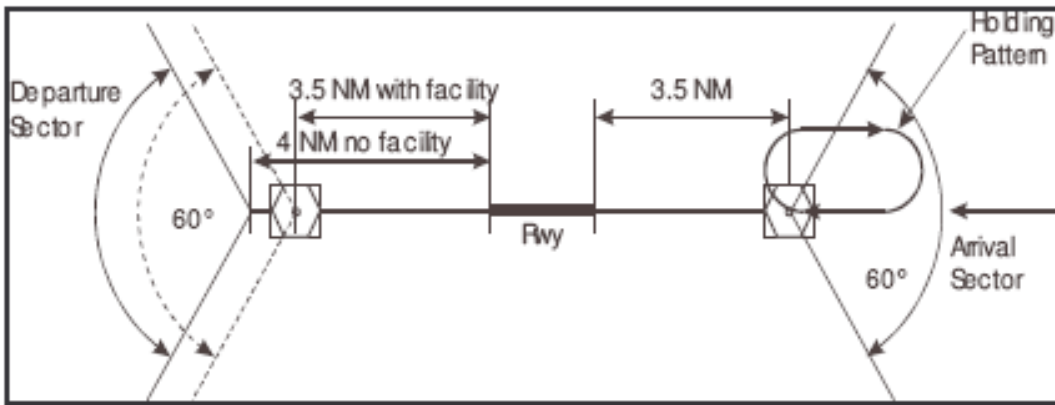
19.9.2 Aircraft in the arrival sector (including that part of the hold protruding into the in-between area) are deemed separated from departing aircraft in the departing sector.

19.10 Aircraft in the in-between area are not separated from either sector.

19.10.1 Until departing traffic has entered the departure sector it shall be vertically separated from holding or inbound traffic.

19.11 In circumstances where sector separation cannot be applied standard separation shall be used.

19.11.1 The sector separation, as given above, in no way prejudices the arrival/departure separation as given in this chapter.

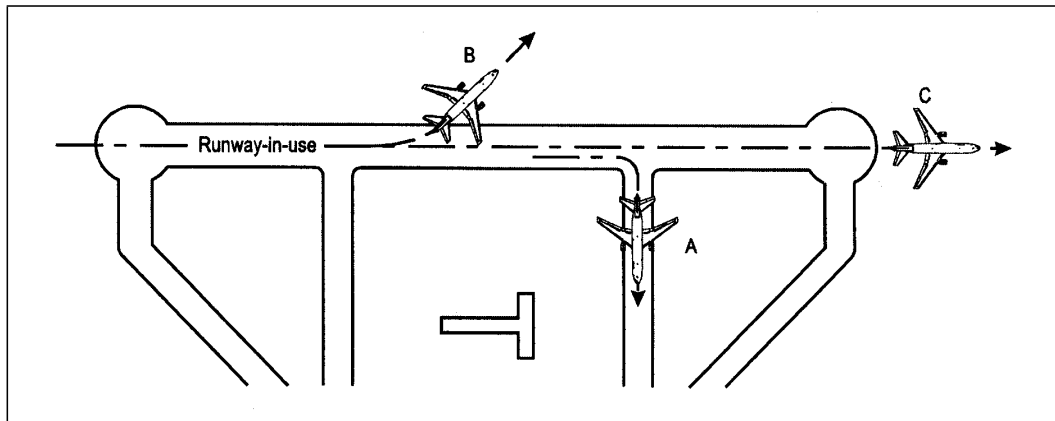


## Section 6 Separation Methods and Minima

### Chapter 5 Aerodrome Traffic Separation

#### 1 Departure

1.1 A departing aircraft will not be permitted to commence take-off until the preceding departing aircraft has crossed the end of the runway-in-use, or has started a turn and all preceding landing aircraft are clear of the runway-in-use.



*Separation between departing and arriving aircraft – Position limits to be reached by an aircraft (A) that has landed or a departing aircraft (B or C) before an arriving aircraft may be cleared to cross the threshold of the runway-in-use or a departing aircraft may be cleared for take-off.*

- 1.2 An aircraft will be permitted to begin take-off when the preceding departing aircraft is seen to be safely airborne. The minimum distance, however, shall never be less than half the available take-off run.
- 1.3 The above separations may be reduced during daylight hours when VMC prevails. However, cognisance must be made with due respect to wake turbulence criteria and longitudinal separation minima.
- 1.4 Before the reduction of separation minima can be used, the following factors must be taken into consideration:
  - a) Runway length;
  - b) Aerodrome layout; and
  - c) Types of aircraft involved.
- 1.5 The reduction of the above separation minima will not apply:
  - a) Between a departing aircraft and a preceding landing aircraft;
  - b) Between sunset and sunrise;
  - c) When braking action may be adversely effected by runway contaminants;
  - d) In weather conditions preventing the pilot from making an early assessment of traffic conditions on the runway.

## **2 Separation of Landing Aircraft and Preceding Landing and Departing Aircraft Using the Same Runway.**

- 2.1 A landing aircraft will not be permitted to cross the beginning of the runway on its final approach until the preceding departing aircraft has crossed the end of the runway-in-use, or has started a turn and all preceding landing aircraft are clear of the runway-in-use. To reduce the potential for misunderstanding, the landing clearance shall include the designator of the landing runway;
  - 2.1.1 However, during daylight hours and when VMC conditions prevail, a landing aircraft may be permitted to cross the beginning of the runway on its final approach when the preceding departing aircraft is seen to be safely airborne.
- 2.2 A landing aircraft may not be permitted to touch down before the preceding landing aircraft, which has landed is clear of the runway.
  - 2.2.1 However, during daylight hours and when VMC conditions prevail, this separation may be reduced as follows:
    - a) A landing aircraft may be cleared to land when there is reasonable assurance that the separation in Sec 6 Chap 5 para 1.1 and indicated in paragraphs 1.4,1.5 and 2.2 will exist

when the aircraft crosses the runway threshold, provided that a clearance to land shall not be issued until a preceding landing aircraft has crossed the runway threshold.

b) Before this reduction of separation minima can be used the factors contained in Sec 6 Chap 5 para 1.1 and indicated in paragraphs 1.4 and 5 shall be taken into consideration.

c) Phraseology to be used when using the above reduced separation shall be "Land After Beech 90 Ahead".

2.3 A landing aircraft may be permitted to touch down before the preceding landing aircraft, which has landed, is clear of the runway.

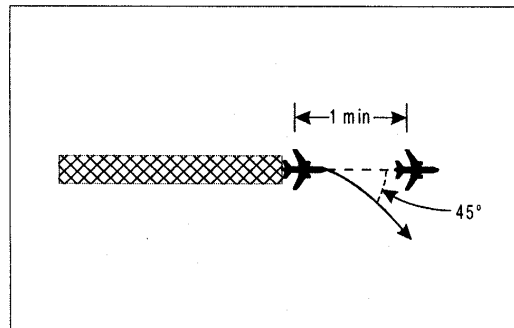
2.4 Before this reduction can be used the following factors shall be taken into account:-

- a) The runway is long enough to allow safe separation between the two aircraft and there is no evidence to indicate that braking action may be adversely affected;
- b) The Controller is satisfied that the landing aircraft will be able to see the preceding aircraft, which has landed, clearly and continuously, until it is clear of the runway;
- c) The aircraft involved shall be of a similar approach and landing performance; and
- d) The pilot of the following aircraft is warned and reports the preceding aircraft in sight.

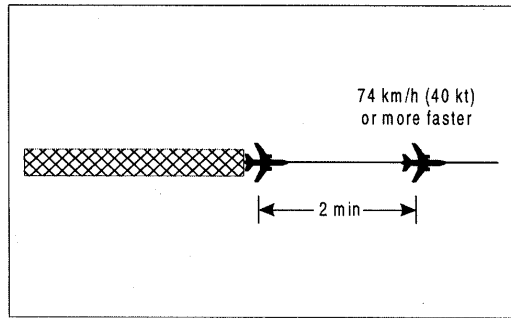
*Note: The responsibility for ensuring adequate separation rests with the pilot of the following aircraft.*

### 3 Minimum Separation between Departing Aircraft

3.1 One-minute separation is required if aircraft are to fly on tracks diverging by at least 45 degrees immediately after take-off so that lateral separation is provided.

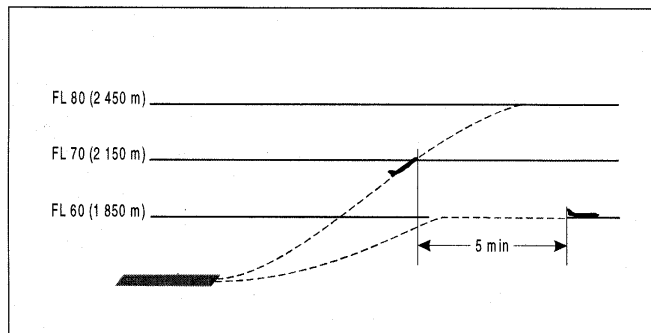


3.2 Two minutes are required between take-offs when the preceding aircraft is 40 kts or faster than the following aircraft, both aircraft will follow the same track and neither aircraft is cleared to execute any manoeuvre that would decrease the 2 minute separation between them.



3.3 Five-minute separation shall be required while vertical separation does not exist if a departing aircraft will be flown through the level of a preceding departing aircraft and both aircraft propose to follow the same track, thereafter the aircraft will subsequently be separated either:

- a) Vertically.
- b) By tracks that diverge by 30° or more, or
- c) By an ATS Surveillance System .



#### 4 Wake Turbulence Separation

- 4.1 The spacing between aircraft, determined either by time or distance, is to be applied so that aircraft of a lower weight category do not fly through the wake of an aircraft of a higher category within the area of maximum vortices.
- 4.2 Wake turbulence separation must be considered when aircraft of different weight categories are operating into and out of an aerodrome during light wind conditions.
- 4.3 During calm or light wind conditions, vortices do not disperse easily and could remain in the runway area for an extended period of time. The vortices tend to sink to the landing/ take-off paths of following aircraft, or could drift across to a parallel runway.
- 4.4 Ground reflection causes vortices to travel horizontally over the ground away from one another.
- 4.5 All aircraft generate vortices at the wing tips as a consequence of producing lift. The heavier the aircraft and the slower it is flying, the stronger the vortex. This turbulence is the most dangerous during take-off, initial climb, final approach phase and could induce roll, impose changes in rate of climb or descent and may cause structural overloads.

- 4.6 Hazardous wake vortices begin to be generated by fixed wing aircraft from the point of rotation on departure and continues until the nose wheel touches down on landing.
- 4.7 When helicopters 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.
- 4.8 When the helicopter weight is transferred from the landing gear to the rotor a strong downwash is created in all directions, although this can be moved by the wind.

**5 En-route and Intermediate Approach**

- 5.1 No special longitudinal spacing based on time are required. When a Medium, Small or Light aircraft is positioned by ATS Surveillance System to cross behind or follow the same track as a Heavy aircraft, the minimum spacing shall be 5 miles.

**6 ATS Surveillance System Wake Turbulence Separation Minima**

The distance minima will apply when an aircraft follows or crosses behind, at the same altitude or less than 1000 feet below, the wake generating aircraft in the arrival and departure phase.

Leading Aircraft	Following Aircraft	Minimum Distance
Super Heavy	Super Heavy	Not required (see note)
Super Heavy	Heavy	6 NM
Super Heavy	Medium	7 NM
Super Heavy	Light	8 NM
Heavy	Heavy	4 NM (see note)
Heavy	Medium	5NM
Heavy	Light	6NM
Medium	Heavy	5NM
Medium	Medium	5NM
Medium	Light	5NM
Light	Heavy	5NM
Light	Medium	5NM
Light	Light	5NM

**Note:** Where standard ATS Surveillance System separation minima and ATS Surveillance System wake turbulence separation minima, when applied together present different minima values, the larger of the two minima's shall be applied.

**7 Arriving Aircraft – Time-Based Wake Turbulence Longitudinal Separation Minima**

- 7.1 The aerodrome or approach unit shall not be required to apply wake turbulence separation but shall issue a caution for possible wake turbulence for:
  - a) Arriving VFR flights landing on the same runway as a preceding landing heavy or medium aircraft;

- b) Between arriving IFR flights executing visual approaches when the aircraft has reported the preceding aircraft in sight and has been instructed to follow and maintain own separation from that aircraft.

7.2 The pilot-in-command of the aircraft concerned shall be responsible for ensuring that the spacing from a preceding aircraft of a heavier wake turbulence category is acceptable. If it is determined that additional spacing is required, the flight crew shall inform the ATSU accordingly, stating their requirements.

7.3 The following minima shall be applied to aircraft landing behind a Super, Heavy or a Medium aircraft:

Leading Aircraft	Following Aircraft	Minimum Spacing - Time
Heavy	Medium	2 minutes
Heavy or Medium	Light	3 minutes
A380-800 (Super)	Medium	3 minutes
A380-800 (Super)	Light	4 minutes

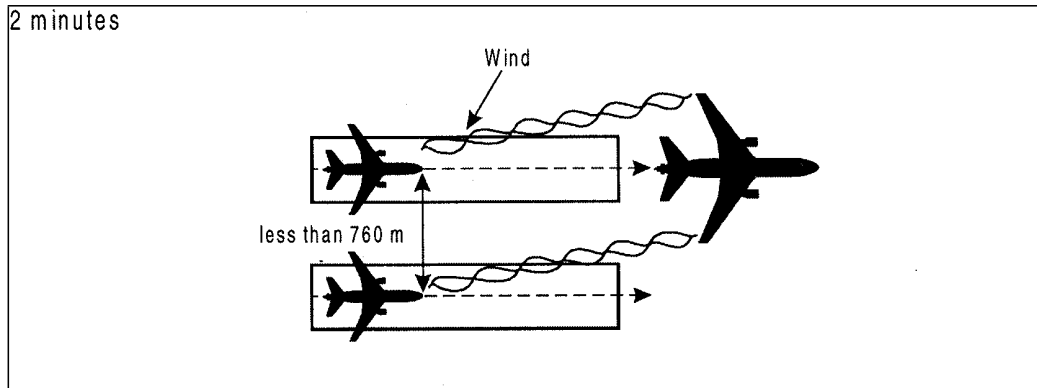
## 8 Departing Aircraft – Time-Based Wake Turbulence Longitudinal Separation Minima

8.1 The minimum spacing listed below is to be applied between successive aircraft, both IFR and VFR flights:

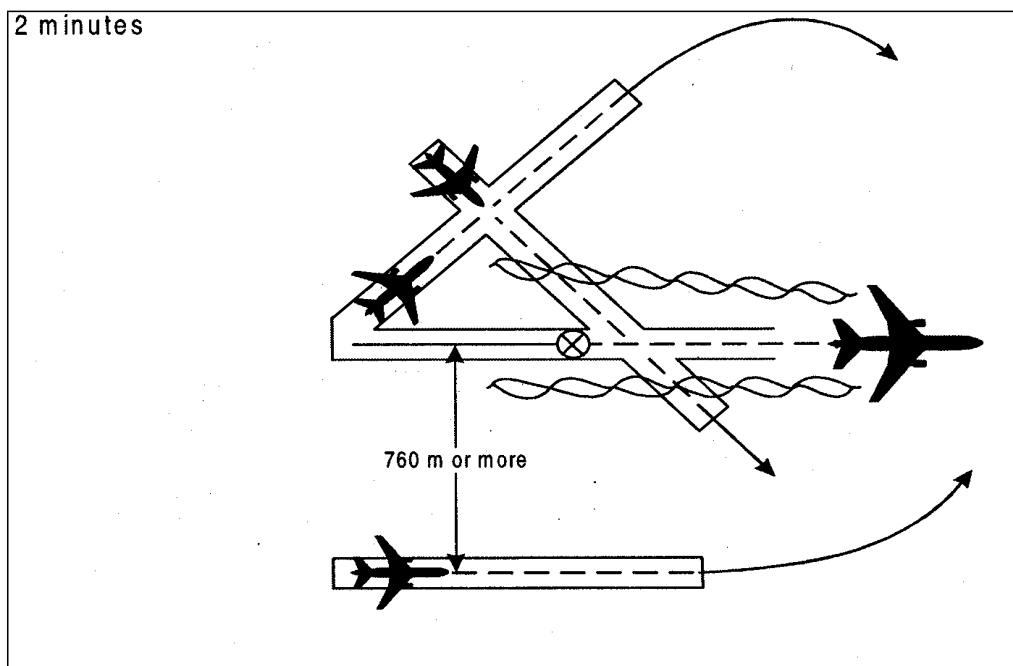
- a) Aircraft departing from the same runway;
- b) Parallel runways separated by less than 760 m;
- c) Crossing runways if the projected flight path of the first aircraft is at the same altitude or less than 1000 feet below;
- d) Parallel runways separated by 760 m or more, if the projected flight path of the second aircraft will cross the projected flight path of the first aircraft at the same altitude or less than 1000 feet below.

Leading Aircraft	Following aircraft	Minimum spacing at the time aircraft are airborne
Super	Medium or Light	Departing from the same take-off position. 3 minutes
Heavy	Super, Medium or Light	Departing from the same take-off position. 2 minutes
Medium	Light	Departing from the same take-off position 2 minutes





Two minute separation for following aircraft (Refer to paragraph 8.1 a & b)



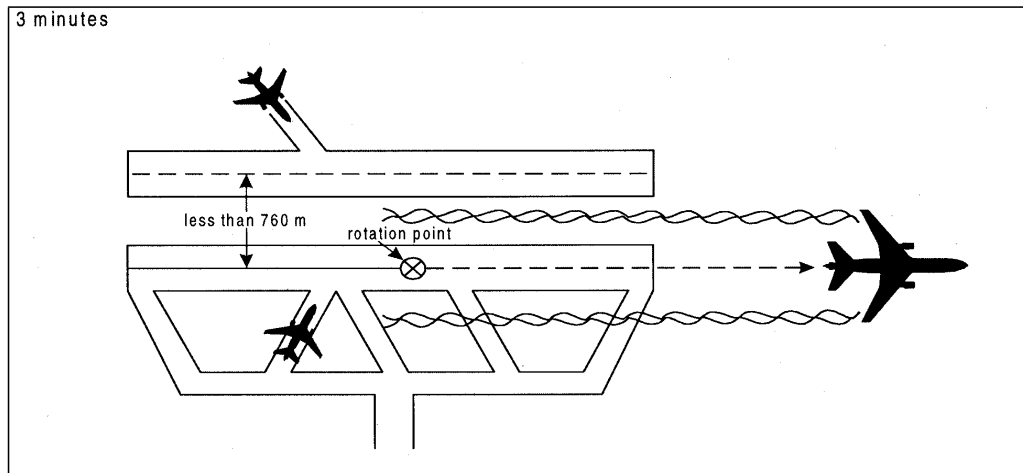
Two minute wake turbulence separation for crossing aircraft (Refer to paragraph 8.1 c & d)

8.2 A separation minimum of three minutes shall be applied as per the table below in respect of aircraft departing from:

- a) An intermediate part of the runway; or
- b) An intermediate part of a parallel runway separated by less than 760 m.

Leading Aircraft	Following aircraft
Super	Medium or Light Departing from an intermediate take-off point.
Heavy Full length take-off	Medium or Light Departing from an intermediate take-off point.

Medium	Light	Departing from an intermediate take-off point.	3 minutes
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*Three minute wake turbulence separation for following aircraft (Refer to paragraph 14.20.2)*

## 9 Displaced Landing Threshold

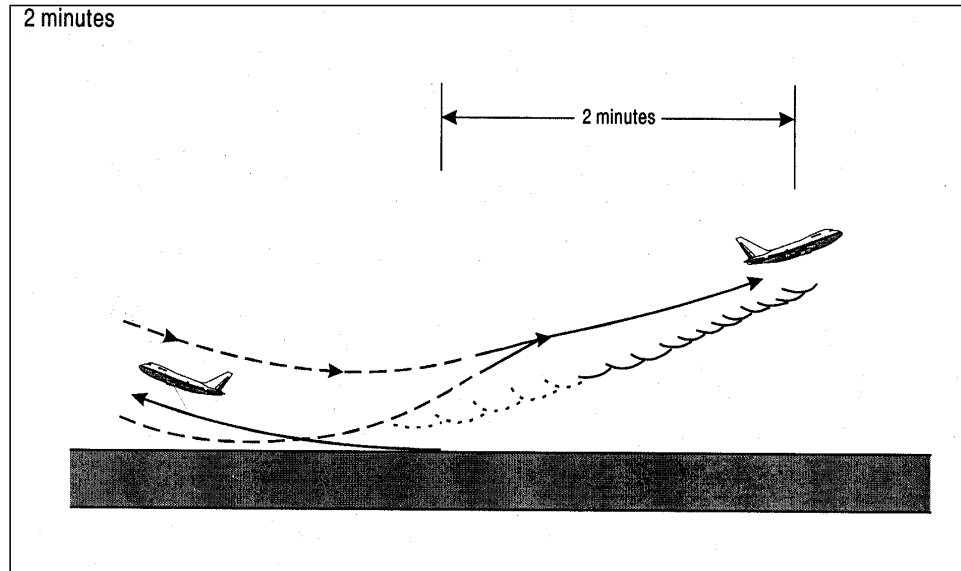
Leading Aircraft	Following aircraft		Minimum spacing at the time aircraft are airborne
Super Arrival	Medium or Light	Departure	3 minutes
Heavy Arrival		Departure	2 minutes
Heavy Departure	Medium or Light	Arrival	2 minutes
Super Departure	Medium or Light	Arrival	3 minutes
Medium Arrival	Light	Departure	2 minutes
Medium Departure	Light	Arrival	2 minutes

## 10 Opposite Direction

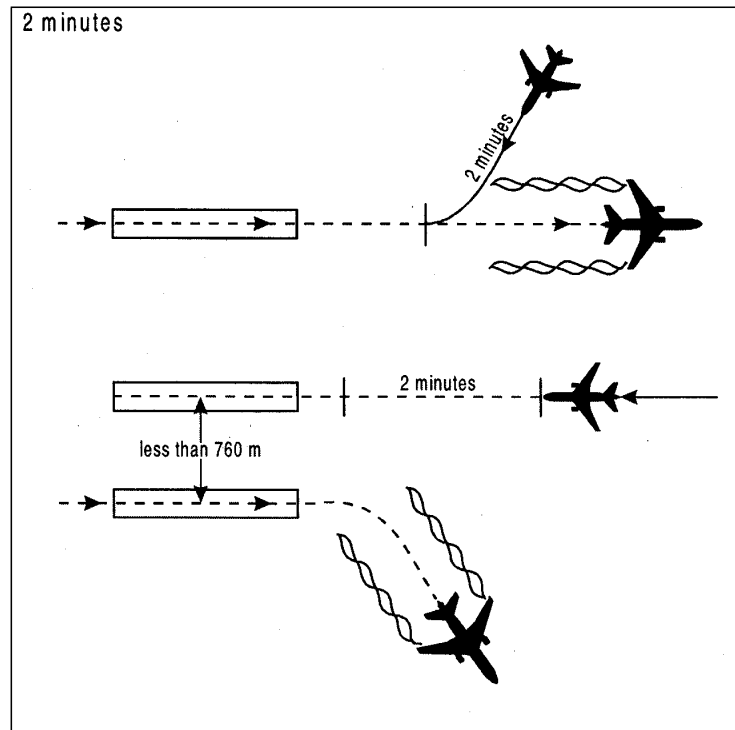
A separation minimum of 2 minutes shall be applied between a Light or Medium aircraft and a Heavy aircraft; and between a Light aircraft and a Medium aircraft when the heavier aircraft is making a low or missed approach and the light aircraft is:

- a) Utilising an opposite-direction runway for departure; or
- b) Landing on the same runway in the opposite direction, or on a parallel opposite-direction runway separated by less than 760m.

**Note:** A separation minima of 3 minutes shall be applied between a LIGHT or MEDIUM aircraft and an A380-800 aircraft when the A380-800 aircraft is making a low or missed approach.



Two minute wake turbulence separation for opposite direction take-off. (Refer to paragraph 10a)



Two minute wake turbulence separation for opposite direction landing (Refer to paragraph 10 b).

## 11 Timing of Separation

Accurate Timing of wake turbulence separation is essential to ensure safety while achieving expeditiousness and efficiency. Either of the following two methodologies may be used when timing wake turbulence separation for consecutive departing aircraft.

a) timing the required wake separation time from the time the preceding aircraft is observed to commence the take-off roll until the following aircraft is allowed to commence the take-off roll ;

b) timing the required wake separation time from the time the preceding aircraft is observed to rotate until the time that the following aircraft rotates. (This technique requires the controller to anticipate the duration of the take-off roll of the following aircraft.) When the required wake separation time, minus the anticipated time for the following aircraft's take-off roll has passed, the following aircraft may be cleared to commence the take off roll).

Note: Units should develop a process of accurately anticipating the duration of the take-off roll for each type of aircraft correlated to the route flown by monitoring and recording the average duration of operations at the particular aerodrome. This information should be published in the local information manuals

## 12 Aircraft Initiating a Touch and Go

12.1 When an aircraft requests a clearance for a touch and go, the aircraft must be considered as making a departure from an intersection for vortex wake purposes. Therefore, a minimum of 3 minutes vortex spacing must be applied between the aircraft requesting the touch and go and any previous departing aircraft of a higher vortex wake category.

## 13 Helicopter Aerodrome Operations

13.1 When hovering or air taxiing, a helicopter directs a forceful blast of air downwards which then rolls out in all directions. To minimise this effect controllers should:

- a) Instruct helicopters to ground taxi rather than air taxi when operating in areas where aircraft are parked or holding.
- b) If air taxiing is imperative, helicopters must be routed to:
  - i) Avoid over flying parked aircraft or vehicles;
  - ii) Give the maximum possible clearance from other aircraft and loose ground equipment.

13.2 Helicopters must not be air taxied close to taxiways or runways where light aircraft operations (including light helicopter operations) are in progress. Vortex wake separation will be applied between helicopters air taxiing across runways and other aircraft, by considering the helicopter to be a departure from a crossing runway.

## 14 SEPARATION OF DEPARTING AIRCRAFT FROM ARRIVING AIRCRAFT

14.1 If an arriving aircraft is following an RNAV or RNP instrument flight procedure, a departing aircraft may take off on a departure path that is clear of the arrival protection area for the arriving aircraft (see Figure 5-41) provided:

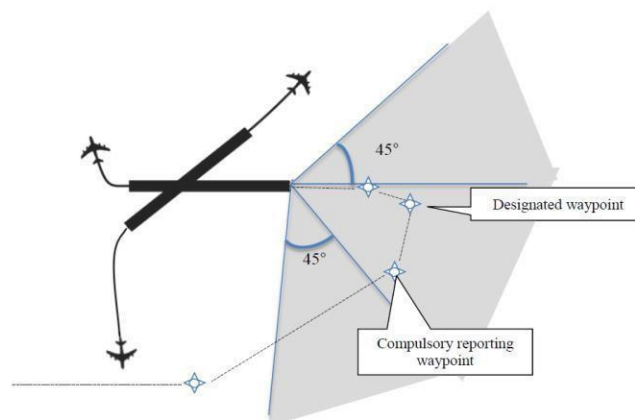
- a) vertical separation is applied until the arriving aircraft has reported passing the compulsory reporting waypoint on the instrument flight procedure, the location of such waypoint to be determined by the

appropriate ATS authority;

b) the take-off takes place before the arriving aircraft crosses a designated waypoint on the instrument flight procedure, the location of such waypoint to be determined by the appropriate ATS authority; and

c) the departing aircraft remains clear of the arrival protection area until another form of separation is established.

Note. — The arrival protection area is defined as the shaded area extending from a line 45 degrees from the extended runway centreline to a line 45 degrees from an established compulsory reporting waypoint.



#### Rationale

a) The need for appropriate separation minima for use within the performance-based navigation (PBN) concept has been recognized by the Separation and Airspace Safety Panel (SASP) and work is in progress to provide separation minima applicable to the various navigation specifications for various phases of flight.

b) One of the identified needs is to provide separation methods and minima for the separation of RNAV and RNP arriving aircraft from departing aircraft in the terminal airspace. This amendment proposal is intended to cater for this need.

c) PANS-ATM section 5.7 defines the separation of departing aircraft from arriving aircraft and the SASP identified this section as the appropriate location for the new separation method.

d) The proposed new separation minimum in 5.7.1.3 is intended for procedurally controlled terminal airspace.

e) The separation is based on a concept of establishing a 45 degrees protection area around the flight path of the arriving aircraft. This concept is already proven in the existing separation methods in PANS-ATM, section 5.7. The difference in applying this concept to a PBN arrival compared to the existing procedures in 5.7 is that the 45 degrees protection area trailing the arriving aircraft depends on which waypoint is chosen as a reference point; the protected airspace being measured from a waypoint that has been compulsorily reported by the arriving aircraft. This does not mean that the controller is required to plot a moving protection area —on the fly. It simply means that, for certain arrival/departure combinations, the ATS authority has flexibility to design the airspace in such a way that a departure route becomes separated from the arrival route once the arriving aircraft has reported passing a specified waypoint, at which point the departing aircraft can then be released for take-off (see, for example, the —southboundll departure in figure 5-41), or before the arrival aircraft has passed a designated waypoint.

## **Section 6                      Separation Methods and Minima**

### **Chapter 6                      *ATS Surveillance System Separation Minima***

#### **1                      General**

1.1        (a) The horizontal separation minimum based on ATS surveillance information shall be:

- (i) 5 NM; or
- (ii) if a higher minimum applies under Section 6, Chapter 5 (ATS Surveillance System - Wake Turbulence Separation Minima)— that higher minimum.

1.2. (b) The separation minimum in section 1.1 (a) may be reduced to not less than 3 NM if:

- (i) a higher minimum under Chapter 5 (ATS Surveillance System - Wake Turbulence Separation Minima) does not apply; and
- (ii) the relevant aircraft are in communication with, and under the control of, a terminal control unit or associated control tower; and
- (iii) an ATS surveillance system and associated display system is in use which is demonstrably suitable for using 3 NM separation.

1.3        These separations only apply between known and identified targets and between such targets and known unidentified targets. In the case of an unknown, unidentified target, the separation minima shall be 10NM. Under no circumstances are primary returns, secondary returns or symbols allowed to overlap unless vertical separation has been applied prior to the reduction below the distances as tabled.

1.4        When it is known that an aircraft is subjected to unlawful interference or a similar emergency, aircraft should be separated from normal traffic, especially traffic below. Minor off-routings may also be considered when indications are that the aircraft is subject to possible technical failures, which would result in emergency descents.

#### **2                      Separation Application**

2.1        Factors which the controller must take into account when determining the spacing to be applied in particular circumstances in order to ensure that the separation minimum is not infringed include aircraft relative headings and speeds, ATS Surveillance System technical limitations, controller workload and any difficulties caused by communication congestion. Larger separations than the prescribed minimum will also need to be applied whenever the possible effects of wake turbulence call for extra precautions, turbulence due to weather activity or, when runway vacation time by landing aircraft indicates the necessity of increased separation in the approach phase.

2.2        ATS Surveillance System separation shall be applied between identified aircraft when there is reasonable assurance that identification will be maintained.

2.3        Except when transfer of ATS Surveillance control is to be effected, procedural separation shall be established by an ATS Surveillance controller before an aircraft under ATS Surveillance control reaches the limits of the relevant area of responsibility, or before the aircraft leaves the area of ATS Surveillance System coverage.

2.4        In the event that the ATS Surveillance controller has been notified of a controlled flight entering or about to enter the airspace within which ATS Surveillance separation is applied, but has not identified the aircraft, he may continue to provide an ATS Surveillance service to identified aircraft

provided that:

- a) The unidentified controlled flight is being operated by an aircraft of a type which may be expected to give an adequate return on the ATS Surveillance System in the airspace within which an ATS Surveillance separation is applied; and
- b) An ATS Surveillance separation is maintained between the ATS Surveillance System - controlled flights and any other observed position indicator until either the unidentified controlled flight has been identified or that procedural separation has been established.

Note: The ATS Surveillance System separation procedures detailed previously must be used with extreme caution on the part of the ATS Surveillance controller, who should bear in mind the desirability of having available immediate direct-speech communication with the unidentified controlled aircraft at the latest, when it enters the area of jurisdiction of the ATS Surveillance controller.

- 2.5 ATS Surveillance separation may be applied between an aircraft taking off and a preceding departing aircraft or other ATS Surveillance controlled traffic provided there is reasonable assurance that the departing aircraft will be identified within 1NM from the end of the runway, and that, at the time, the required separation will exist.
- 2.6 ATS Surveillance separation shall not be applied between aircraft holding over the same holding point.
- 2.7 ATS Surveillance separation shall be provided between an aircraft under ATS Surveillance control and unknown aircraft within controlled airspace unless procedures detailed in Station Standing Instructions and the SA-AIP does not require this.

### 3. **SID and STAR**

The flight crew shall comply with published SID and STAR speed restrictions unless the restrictions are explicitly cancelled or amended by the controller.

*Note 1. — Some SID and STAR speed restrictions ensure containment with RNAV departure or arrival procedure (e.g. maximum speed associated with a constant radius arc to a fix (RF) leg).*

*Note 2. — See 6.3.2.4 pertaining to clearances on a SID and 6.5.2.4 pertaining to clearances on a STAR.*