

CHAPTER 5

SEPARATION METHODS AND MINIMA

5.1 Provision for the separation of controlled traffic

5.1.1 Vertical or horizontal separation shall be provided:

- a) between IFR flights in Class D and E airspaces except when VMC climb or descent is involved under the conditions specified in para 5.5.6;
- b) between IFR flights and special VFR flights; [and
- c) between special VFR flights

5.1.2 No clearance shall be given to execute any manoeuvre that would reduce the spacing between two aircraft to less than the separation minimum applicable in the circumstances.

5.1.3 Larger separations than the specified minima should be applied whenever exceptional circumstances such as unlawful interference or navigational difficulties call for extra precautions. This 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.

Note — Unlawful interference with an aircraft constitutes a case of exceptional circumstances which might require the application of separations larger than the specified minima, between the aircraft being subjected to unlawful interference and other aircraft.

5.1.4 Where the type of separation or minimum used to separate two aircraft cannot be maintained, another type of separation or another minimum shall be established prior to the time when the current separation minimum would be infringed.

5.1.2 Degraded aircraft performance

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 ATC unit concerned 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.

5.2 Reduction in separation minima

5.2.1 In the vicinity of aerodromes

In the vicinity of aerodromes, the 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; or
- 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; or
- 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.

5.2.2 In the event of complete failure of radar equipment

As an emergency measure, use of flight levels spaced by half the applicable vertical separation minimum may be resorted to

temporarily if standard non-radar separation cannot be provided immediately.

5.3 Loss of separation

If, for any reason, a controller is faced with a situation in which two or more aircraft are separated by less than the prescribed minima due to reason other than ACAS RA (e.g. air traffic control errors or difference in the pilot's estimated and actual times over reporting points) controller is to

- a) use every means at his / her disposal to obtain the required minimum with the least possible delay; and
- b) pass essential traffic information.

5.4 Essential traffic information

5.4.1 Essential traffic is that controlled traffic to which the provision of separation by ATC is applicable, but which, in relation to a particular controlled flight is not, or will not be, separated from other controlled traffic by the appropriate separation minimum.

5.4.2 Essential traffic information shall be given to controlled flights concerned whenever they constitute essential traffic to each other.

5.4.3 Essential traffic information shall include:

- a) direction of flight of aircraft concerned;
- b) type and wake turbulence category (if relevant) of aircraft concerned;
- c) cruising level of aircraft concerned and;
 - i) estimated time over the reporting point nearest to where the level will be crossed; or
 - ii) relative bearing of the aircraft concerned in terms of the 12-hour clock as well as distance from the conflicting traffic; or
 - iii) actual or estimated position of the aircraft concerned.

5.5 Vertical separation

5.5.1 Vertical Separation Minimum

- a) A nominal 1000 feet below FL290 and a nominal 2000 feet at or above FL290, except as provided for in b) below; and
- b) A nominal 1000 feet when both aircraft are RVSM compliant and operating within designated RVSM airspace.

5.5.2 Cruise climb

Cruise climb is not permitted in Indian FIRs.

5.5.3 Vertical Separation during climb and descent

5.5.3.1 An aircraft may be cleared to a level previously occupied by another aircraft after the latter has reported vacating it, except when:

- a) severe turbulence is known to exist; or
- b) the aircraft concerned are established at the same holding pattern; or
- c) the difference in aircraft performance is such that less than the applicable separation minimum may result;

in which case such clearance shall be withheld until the aircraft vacating the level has reported at or passing another level separated by the required minimum.

5.5.4 Pilot in direct communication with each other may, with their concurrence, be cleared to maintain a specified vertical separation between their aircraft during ascent or descent.

5.5.5 Step climb and descents

5.5.5.1 The step climb / descent procedure may be used for simultaneous climb / descent of the aircraft to vertically separated levels provided that the lower / higher aircraft is progressively assigned levels that provide vertical separation with the higher / lower aircraft.



5.5.5.2 When applying the step climb or step descent procedures, pilot must be advised that they are subject to a step climb or descent.

5.5.6 VMC climb and descent:

When so requested by an aircraft and provided it is agreed by the pilot of the other aircraft, an ATC unit may clear a controlled flight, including departing and arriving flights, operating in airspace Classes D and E in VMC during the hours of daylight to fly subject to maintaining own separation to one other aircraft and remaining in VMC. When a controlled flight is so cleared, the following shall apply:

- a) Clearances shall be for a specified portion of the flight at or below 10,000 feet, during climb and descent;
- b) Essential traffic information shall be passed; and
- c) If there is 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 in VMC cannot be maintained for the term of clearance.

5.6 Horizontal separation

The three types of horizontal separation are:

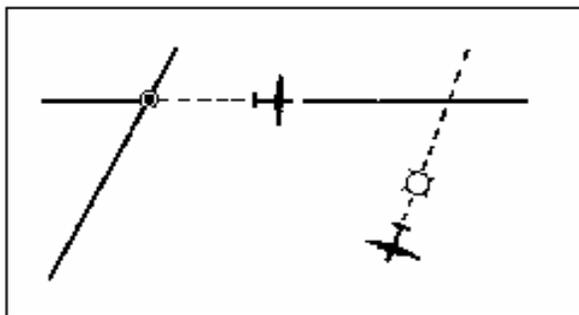
- a) Lateral separation;
- b) Longitudinal separation;
- c) Radar separation.

5.6.1 Lateral separation

Means by which lateral separation may be applied include the following:

5.6.1.1 By using the same or different geographic locations:

By position reports which positively indicate the aircraft are over different geographic locations as determined visually or by reference to a navigation aid.

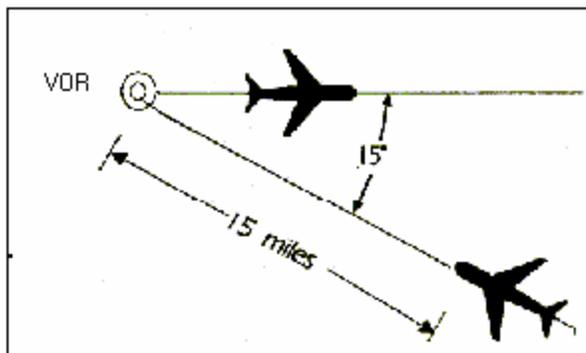


5.6.1.2 By using the same navigation aid or method

By requiring to fly on specified tracks which are separated by a minimum amount appropriate to the navigational aid or method employed. Lateral separation between two aircraft exists when:

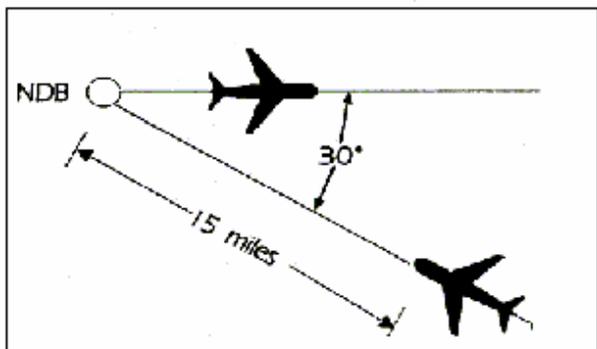
a) VOR

Both aircraft are established on radials diverging by at least 15 degrees and at least one aircraft is 15 NM or more from the facility.



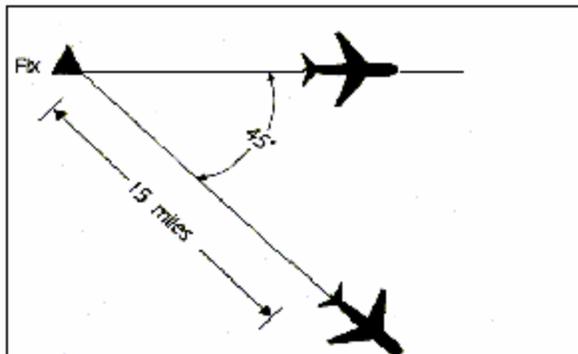
b) NDB

Both aircraft are established on tracks to or from the NDB, which are diverging by at least 30 degrees and at least one aircraft is 15 NM or more from the facility.



c) DR (dead reckoning)

Both aircraft are established on tracks diverging by at least 45 degrees and at least one aircraft is 15 NM or more from the point of intersection of the tracks, this point being determined either visually or by reference to a navigational aid and both aircraft are established outbound from the intersection.



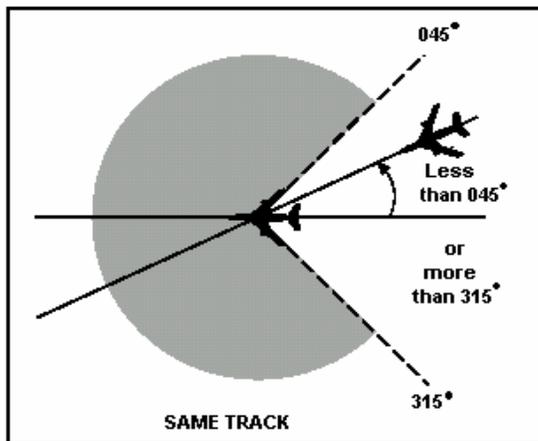
5.6.2 Longitudinal separation

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.

5.6.2.1 For the purpose of application of longitudinal separation, the terms same track, reciprocal tracks and crossing tracks shall have the following meanings:

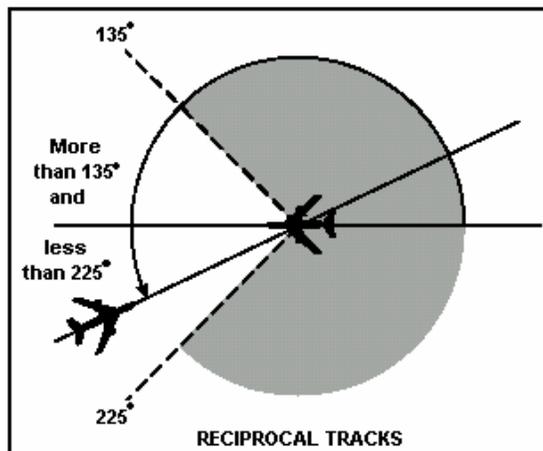
- a) **Same track:** same direction tracks and intersecting tracks or portions thereof, the angular difference of which is less

than 45 degrees or more than 315 degrees, and whose protection areas overlap.



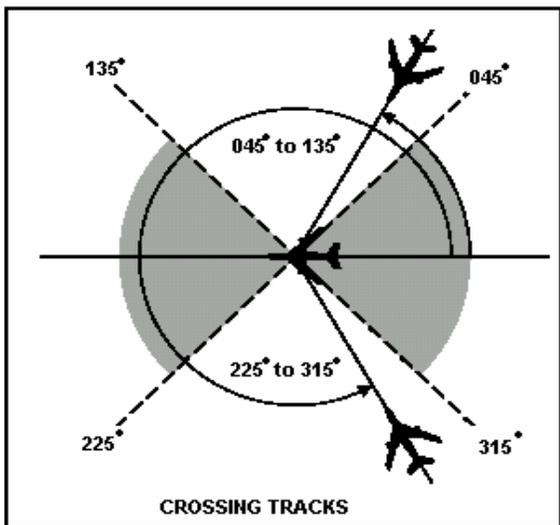
b) Reciprocal tracks

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 protection areas overlap.



c) Crossing Tracks

Intersecting tracks or portions thereof other than those specified in a) and b) above.



5.6.2.2 Longitudinal separation minima based on time:

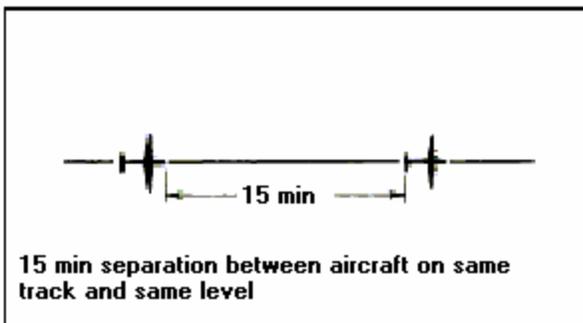
5.6.2.2.1 Cross Check Calculations

- a) Separation requirements must be cross-checked to ensure the integrity of calculations.
- b) The cross-check is to validate the initial calculation and to confirm that the calculation is consistent with the traffic disposition.

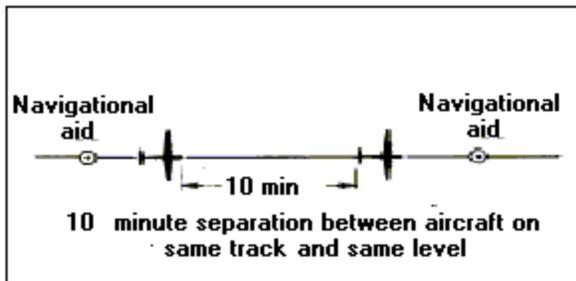
5.6.2.2.2 Aircraft at the same cruising level

5.6.2.2.2.1 Aircraft flying on the same track:

- a) 15 minutes;

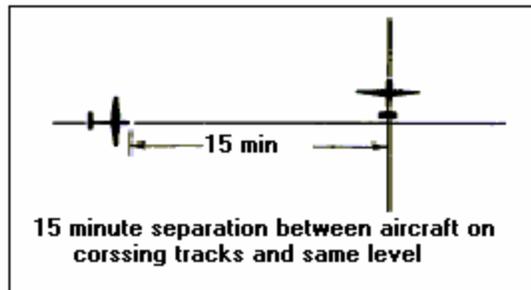


- b) 10 minutes, if navigation aids permit frequent determination of position and speed;

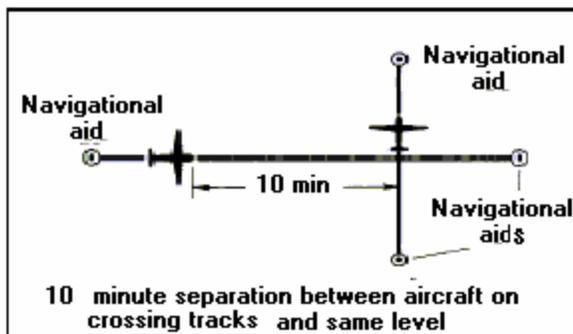


5.6.2.2.2.2 Aircraft flying on crossing tracks:

- a) 15 minutes;



- b) 10 minutes if navigation aids permit frequent determination of position and speed



5.6.2.2.3 Aircraft climbing or descending

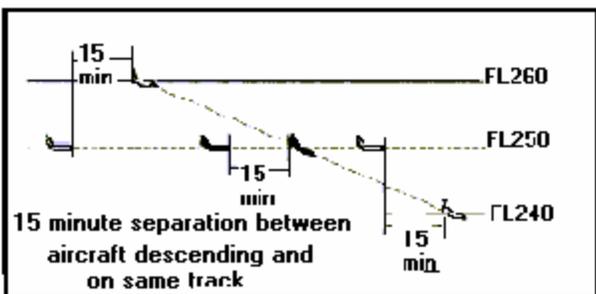
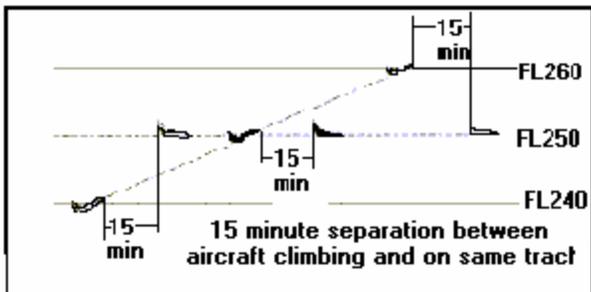
5.6.2.2.3.1 Traffic on the same track.

When an aircraft will pass through the level of another aircraft on the same track, the

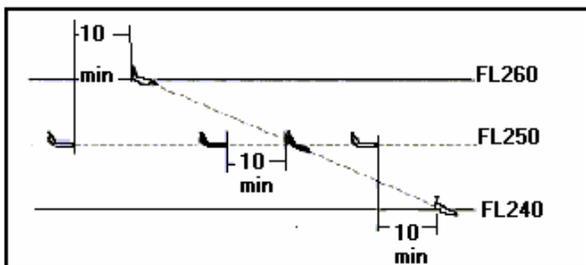
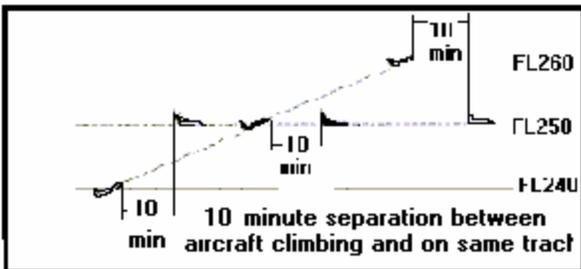


following minimum longitudinal separation shall be provided:

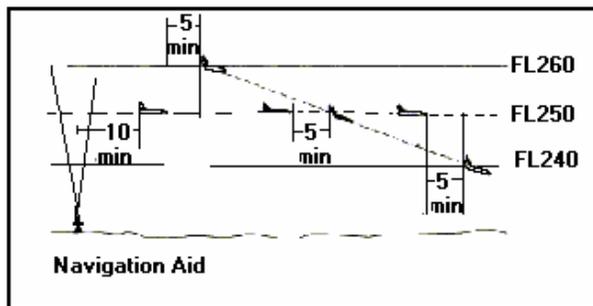
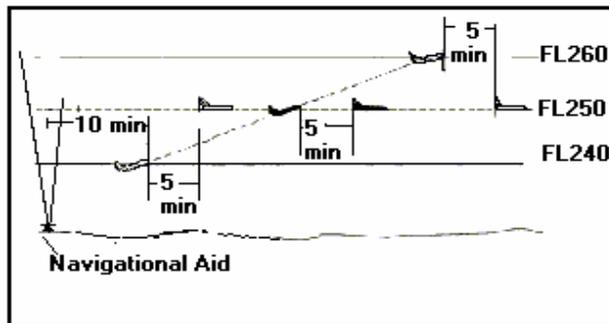
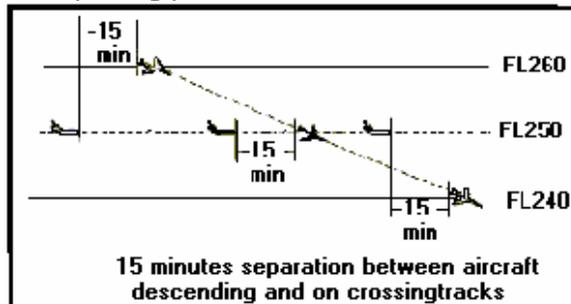
- a) 15 minutes while vertical separation does not exist



- c) 10 minutes while vertical separation does not exist, provided that such separation is authorized only where navigation aids permit frequent determination of position and speed



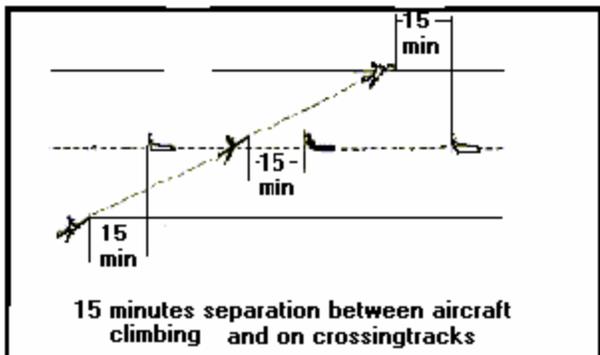
- d) 5 minutes while vertical separation does not exist, provided that the level change is commenced within 10 minutes of the time the second aircraft has reported over an exact reporting point.



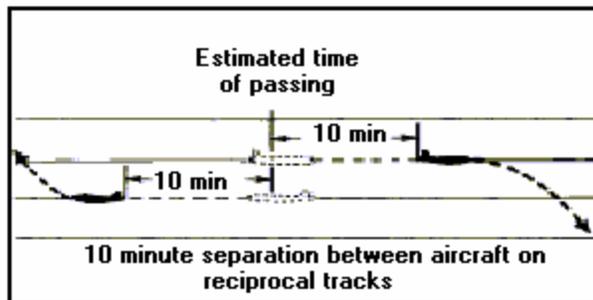
Note.— To facilitate application of the procedure where a considerable change of level is involved, a descending aircraft may be cleared to some convenient level above the lower aircraft, or a climbing aircraft to some convenient level below the higher aircraft, to permit a further check on the separation that will obtain while vertical separation does not exist.

5.6.2.2.3.2 Traffic on crossing tracks:

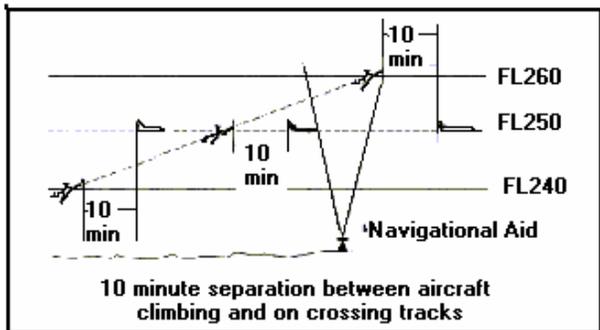
- a) 15 minutes while vertical separation does not exist



Where lateral separation is not provided, vertical separation shall be provided for at least ten minutes prior to and after the time the aircraft are estimated to pass, or are estimated to have passed.



- b) 10 minutes while vertical separation does not exist if navigation aids permit frequent determination of position and speed.



Provided that it has been determined that the aircraft have passed each other, this minimum need not apply:

5.6.2.3 Longitudinal separation minima based on distance using DME

5.6.2.3.1 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.

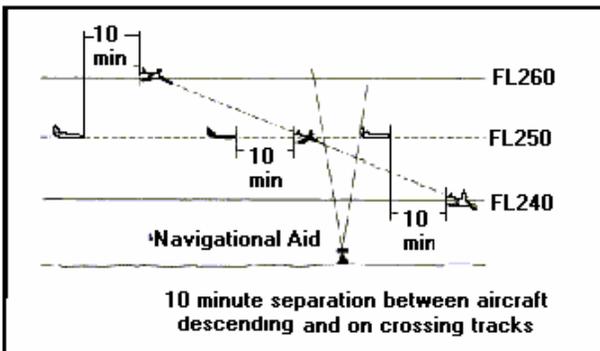
5.6.2.3.2 Direct controller-pilot communication shall be maintained while such separation is used.

5.6.2.3.3 All distance reports must be made with reference to the same DME station.

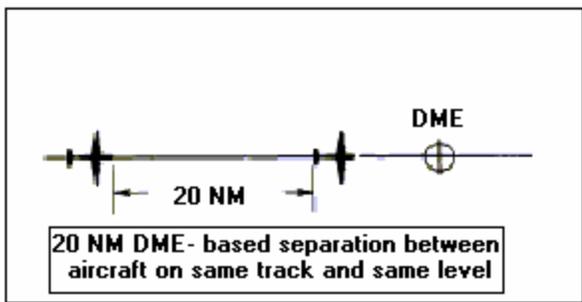
5.6.2.3.4 Aircraft at the same cruising level

5.6.2.3.4.1 Aircraft on the same track:

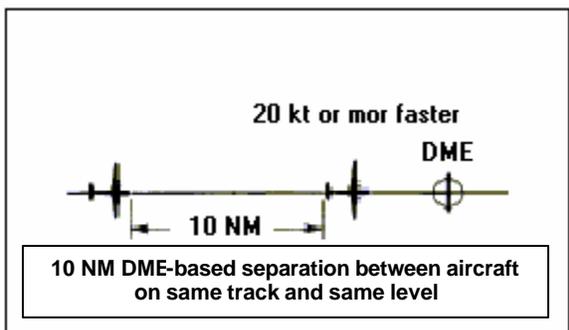
- a) 20 NM, provided:
 - i) each aircraft utilizes "on-track" DME stations; and
 - ii) separation is checked by obtaining simultaneous DME readings from the aircraft at frequent intervals to ensure that the minimum will not be infringed.



5.6.2.2.3.3 Traffic on reciprocal tracks

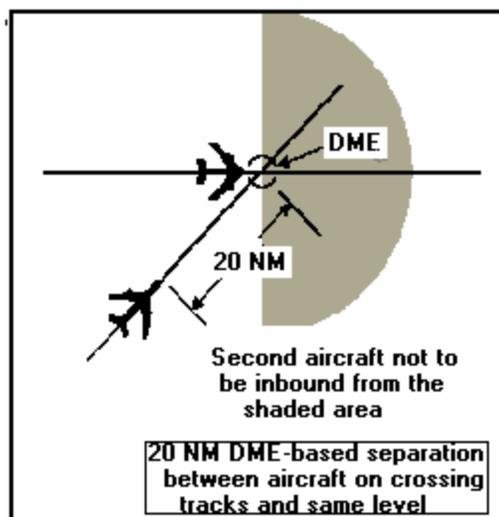


- b) 10 NM provided:
 - i) the leading aircraft maintains a true airspeed of 20 kts or more faster than the succeeding aircraft;
 - ii) each aircraft utilizes “on-track” DME stations; and
 - iii) separation is checked by obtaining simultaneous DME readings from the aircraft at such intervals as are necessary to ensure that the minimum is established and will not be infringed.

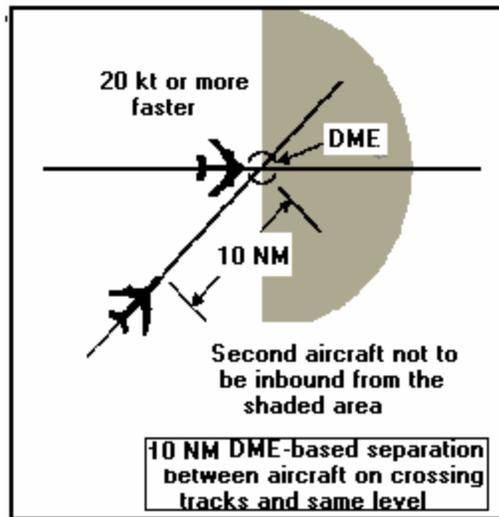


5.6.2.3.4.2 Aircraft on crossing tracks:

- a) 20 NM, provided:
 - i) each aircraft utilizes “on-track” DME stations located at the crossing point of the tracks and that the relative angle between the tracks is less than 90 degrees; and
 - ii) separation is checked by obtaining simultaneous DME readings from the aircraft at frequent intervals to ensure that the minimum will not be infringed.



- b) 10 NM provided:
 - i) the leading aircraft maintains a true airspeed of 20 kts or more faster than the succeeding aircraft;
 - ii) each aircraft utilizes “on-track” DME stations and that the relative angle between the tracks is less than 90 degrees; and
 - iii) 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.

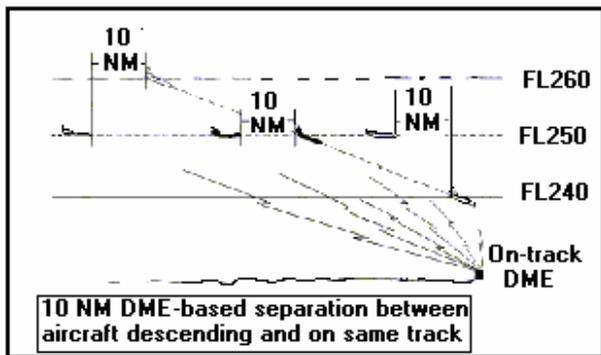
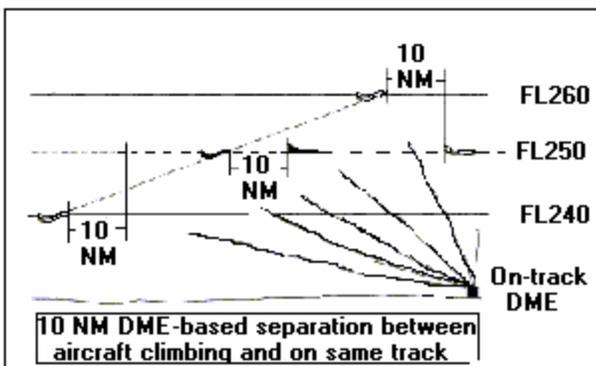


5.6.2.3.5 Aircraft climbing or descending

5.6.2.3.5.1 Aircraft on the same track

10 NM while vertical separation does not exist, provided:

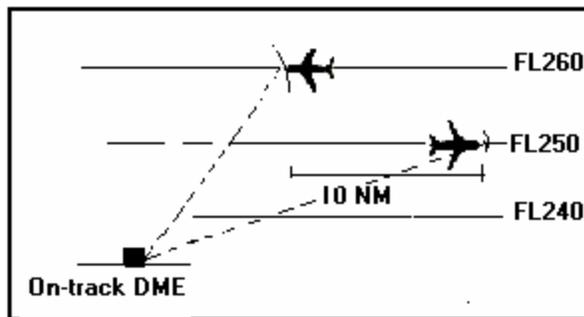
- a) each aircraft utilizes “on-track” DME stations;
- b) one aircraft maintains a level while vertical separation does not exist; and
- c) separation is established by obtaining simultaneous DME readings from the aircraft.



Note.— To facilitate application of the procedure where a considerable change of level is involved, 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, to permit a further check on the separation that will obtain while vertical separation does not exist.

5.6.2.3.5.2 Aircraft on reciprocal tracks

Aircraft utilizing on-track DME may be cleared to climb or descend to or through the levels occupied by other aircraft utilizing on-track DME, provided that it has been positively established that the aircraft have passed each other and are at least 10 NM apart.



5.6.2.4 Longitudinal separation minima with Mach number technique based on time:

5.6.2.4.1 The following conditions shall be met when the Mach number technique is being applied:

- a) **Aircraft Types:** Turbojet aircraft only.
- b) **Routes:**
 - i) 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
 - ii) If the aircraft have not reported over the same reporting point and it is possible to ensure, by radar 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.
- c) **Levels:** The aircraft concerned are in level, climbing or descending.



d) **Mach Number Assignment:** A Mach number (or, when appropriate, a range of Mach numbers) shall be issued to each aircraft.

- ↳ Assign revised Mach numbers appropriate for the estimated interval, or
- ↳ Establish vertical separation.

Note: 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.

*NOTE-*Control estimates are calculated by the controller using known wind patterns, previous aircraft transit times, pilot progress reports, and pilot estimates.

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.

d) **Relative Speeds**

The lead aircraft maintains the same or a greater Mach number than the following aircraft; or
If the following aircraft is faster than the lead aircraft, ensure that the appropriate time interval will exist until another form of separation is achieved.

e) **Separation Minima**

i) When Mach number technique is applied, minimum longitudinal separation between turbojet aircraft on the same track, whether in level, climbing or descending flight shall be 10 minutes; or the prescribed minima based on application of differential Mach number on prescribed ATS routes.

NOTE- 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 thumb” 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. This rule of thumb can be stated as follows: 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 (See Table below.)

ii) The applicable longitudinal separation minima is maintained by:

- Ensuring that the spacing between the estimated positions of the aircraft is not less than the prescribed minimum.
- Continuously monitoring aircraft position reports and updating control estimates along the aircraft's track(s). If after establishing the Mach number technique between aircraft, control information indicates that less than the applicable minima between aircraft may exist, immediately
 - ▶ Issue crossing restrictions to ensure the appropriate longitudinal minima at the next significant point, or

Application of the Mach Number Technique when the Following Aircraft is Faster					
Difference in Mach	Distance to Fly and Separation (in Minutes) Required at Entry Point				
	001-600 NM	601-1200 NM	1201-1800 NM	1801-2400 NM	2401-3000 NM
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

When preceding aircraft is maintaining a Mach number greater than the following aircraft separation minima of 9 and 5 minutes inclusive, on prescribed minima may be applied in accordance with the following table:

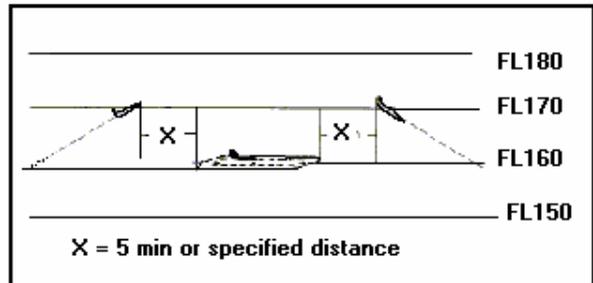
Application of the Mach Number Technique when the Preceding Aircraft is Faster	
Separation Minima in Minutes	Mach Number by which the Preceding Aircraft is Faster
09	0.02
08	0.03
07	0.04
06	0.05
05	0.06

5.6.2 Separation of aircraft holding in flight

5.6.1 Aircraft established in adjacent holding patterns shall be separated by the applicable vertical separation minimum.

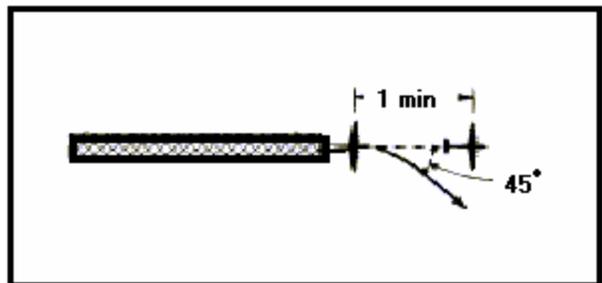
5.6.2 Except when lateral separation exists, vertical separation shall be applied between aircraft holding in flight and other aircraft,

whether arriving, departing or en route, whenever the other aircraft concerned are within five minutes flying time of the holding area or within a distance prescribed by the appropriate authority.



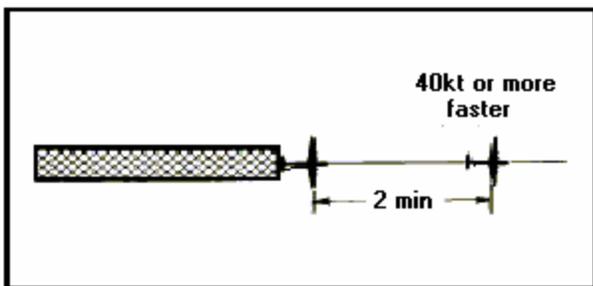
5.7 Minimum separation between departing aircraft

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



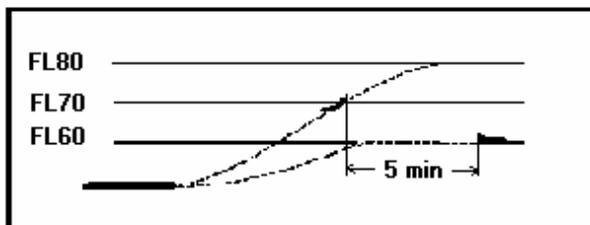
Note 1.— Wake turbulence categorization of aircraft and longitudinal separation minima are contained in Para 5.9

5.7.2 Two minutes between take-offs when the preceding aircraft is 40 kt or more faster than the following aircraft and both aircraft propose to follow the same track.



Note: Calculations, based on TAS, of speed differentials of aircraft during climb may not be sufficiently accurate in all circumstances for determining if the procedures in 5.8.2 can be applied, in which case calculations based on IAS may be more suitable.

5.7.3 Five-minute separation 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. Action must be taken to ensure that the five-minute separation will be maintained or increased while vertical separation does not exist.



5.8 Separation of departing aircraft from arriving aircraft

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

5.8.1 If an arriving aircraft is making a complete instrument approach, a departing aircraft may take off:

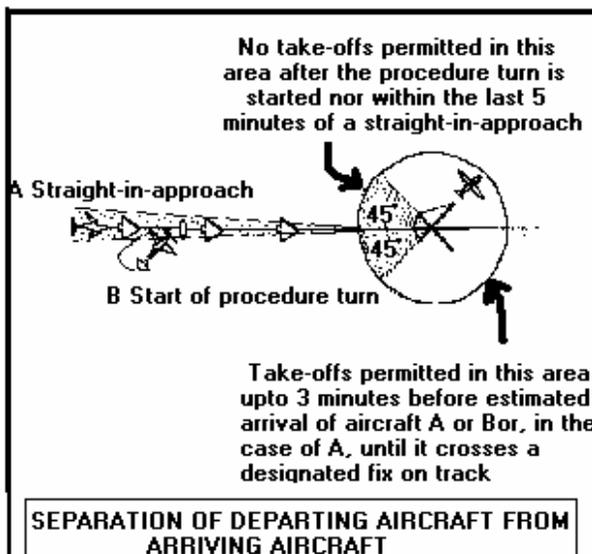
- a) in any direction until an arriving aircraft has started its procedure turn or base turn leading to final approach;
- b) in a direction which is different by at least 45 degrees from the reciprocal

of the direction of approach after the arriving aircraft has started procedure turn or base turn leading to final approach, provided that the take-off will be made at least three minutes before the arriving aircraft is estimated to be over the beginning of the instrument runway.

5.8.2 If an arriving aircraft is making a straight-in approach, a departing aircraft may take off:

- a) in any direction until five minutes before the arriving aircraft is estimated to be over the instrument runway;
- b) in a direction which is different by at least 45 degrees from the reciprocal of the direction of approach of the arriving aircraft:
 - i) until three minutes before the arriving aircraft is estimated to be over the beginning of the instrument runway, or

Note: Lateral separation is considered to exist between an arriving aircraft that subsequently commenced final approach and the departing aircraft that has established on a course diverging by at least 45 degrees from the reciprocal of the final approach course.



Note: Use of runway other than runway-in-use for the purpose of application of



separation vide para 5.8.1.a and 5.8.2.a is not authorized.

5.9 Non-radar wake turbulence longitudinal separation minima

5.9.1 Categorization of aircraft: Wake turbulence separation minima should be based on a grouping of aircraft types into three categories according to the maximum certificated take-off mass.

Category	Maximum Certified take off mass
Heavy	1,36,000 kg or more
Medium	Less than 1.36,000 kg but more than 7000 kg
Light	7000 kg or less

5.9.2 The ATC unit concerned shall not be required to apply wake turbulence separation:

- a) for arriving VFR flights landing on the same runway as a preceding landing HEAVY or MEDIUM aircraft; and
- b) between arriving IFR flights executing visual approach when the aircraft has reported the preceding aircraft in sight and has been instructed to follow and maintain own separation from that aircraft.

5.9.3 The ATC unit shall, in respect of the flights specified in 5.10.2 a) and b) as well as when otherwise deemed necessary, issue a caution of possible wake turbulence.

5.9.4 Arriving aircraft

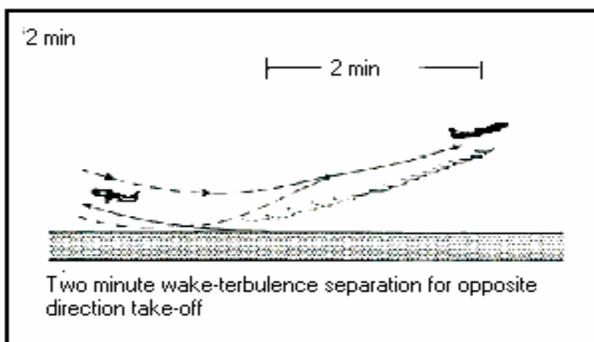
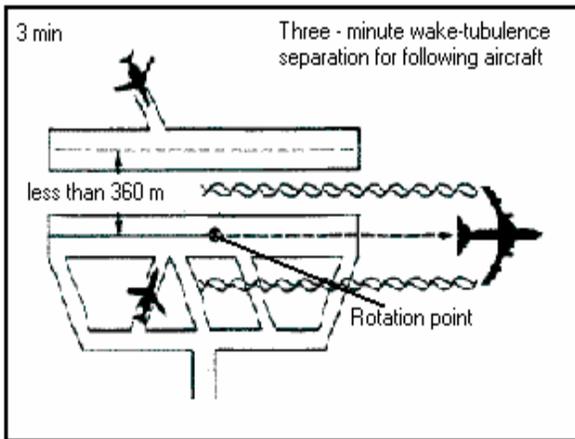
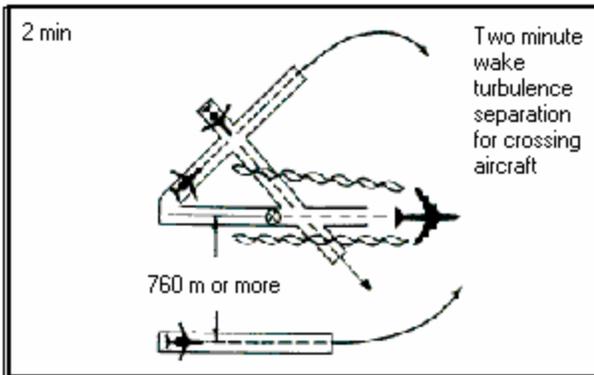
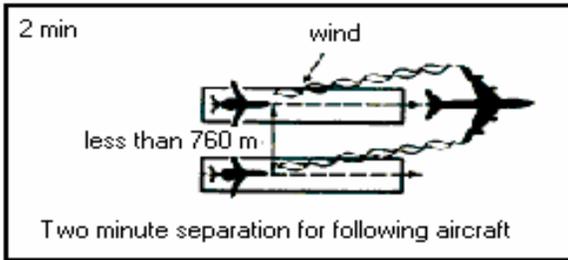
Except as provided in 5.10.2 a) and b), the following minima shall be applied to aircraft landing behind a HEAVY or a MEDIUM aircraft:

Leading Aircraft	Following Aircraft	Separation Minima
HEAVY	MEDIUM	2 min
HEAVY or MEDIUM	LIGHT	3 min

HEAVY	MEDIUM	2 min
HEAVY or MEDIUM	LIGHT	3 min

5.9.5 Departing aircraft

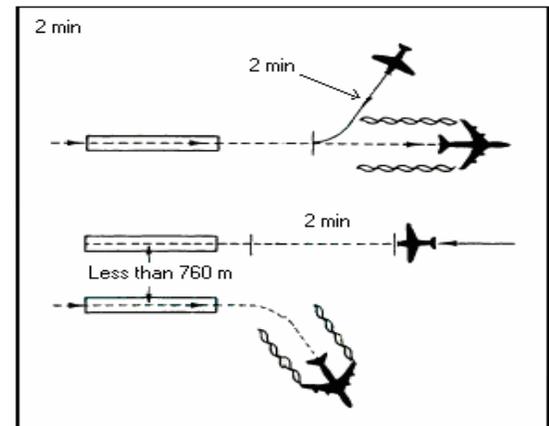
Leading Aircraft	Following Aircraft	Separation Minima	
HEAVY	MEDIUM or LIGHT	Departing from a) the same runway b) parallel runway separated by less than 760 m c) crossing runways if the projected flight path of the second aircraft will cross the projected flight path of the first aircraft at the same altitude or less than 1 000 ft below;	2 min
MEDIUM	LIGHT	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 1 000 ft below.	
HEAVY (Full length take-off)	MEDIUM or LIGHT	Departing from a) an intermediate part of the same runway;	3 min
MEDIUM (Full length take-off)	LIGHT	b) an intermediate part of a parallel runway;	



5.9.6 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 lighter aircraft is:

- a) utilizing an opposite-direction runway for take-off;
- or
- b) landing on the same runway in the opposite direction, or on a parallel opposite-direction runway separated by less than 760 m.



5.9.7 Displaced landing threshold

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 operating on a runway with a displaced landing threshold when:

- a) a departing LIGHT or MEDIUM aircraft follows a HEAVY aircraft arrival and a departing LIGHT aircraft follows a MEDIUM aircraft arrival; or
- c) an arriving LIGHT or MEDIUM aircraft follows a HEAVY aircraft departure and

an arriving LIGHT aircraft follows a MEDIUM aircraft departure if the projected flight paths are expected to cross.

Note: Wake Vortex generation begins when the nose wheel lifts off the runway on take-off and continues until the nose wheel touches down on landing.

