



NAT DOC 008

Application of Separation Minima

North Atlantic Region

1st Edition
November 2010

Published on behalf of the North Atlantic Systems Planning Group

FOREWORD

The Application of Separation Minima – North Atlantic Region (NAT Doc 008) is published on behalf of the North Atlantic Systems Planning Group (NAT SPG) and represents the separation methods and minima that will be applied to aircraft transiting the ICAO North Atlantic (NAT) Region based on agreement by the ICAO NAT Region Air Traffic Service providers. It contains definitions, general rules pertaining to the application of separation minima, separation minima in the vertical, lateral, and longitudinal planes applicable to aircraft operating in the ICAO NAT Region, and airspace reservations.

This document is specifically designed for, and provides guidance to operational air traffic control personnel. It serves as a written and pictorial interpretation of separation rules and their application, its overall objective being a common application of separation minima throughout the ICAO North Atlantic Region.

Other ICAO documentation, such as the NAT Regional Supplementary Procedures (Doc 7030) and Procedures for Air Navigation Services-Air Traffic Management (Doc 4444) should be read in conjunction with this document.

More information can be obtained electronically on the ICAO EUR/NAT website :

<http://www.paris.icao.int/> [under “Documents” – “*NAT Docs*”]

Amendments to the NAT ASM (NAT Doc 008)

Amendments to the NAT ASM are approved by the North Atlantic Implementation Management Group (NAT IMG) on behalf of the NAT SPG. The space below is provided to keep a record of such amendments.

Amendments to the NAT ASM containing the following changes:	
Edition 2005- Version 1.0	<ul style="list-style-type: none"> • New definitions added • Table of acronyms added • ICAO Doc references updated to reflect the most current editions • Part I of the previous edition re-structured for clarity • Separation minima for supersonic aircraft have been removed • Recent changes to longitudinal separation minima <ul style="list-style-type: none"> - the removal of non-MNPS turbojet longitudinal separation minima - updates to other than turbojet longitudinal separation minima • Clarification on the application of RVSM minima between formation flights <ul style="list-style-type: none"> - formation flights of two aircraft with station-keeping equipment (only C-17s) can be provided RVSM separation - all other formation flights will not be provided RVSM minima • Airspace reservation minima has been incorporated into Chapter 3 • Part II of the previous edition concerning automation has been removed
Edition 2008 Version 2.0	<ul style="list-style-type: none"> • Definition of Mach number technique updated to refer to true Mach number • Longitudinal separation minimum applicable only to MNPS aircraft corrected • Cross reference corrected <p><i>(approved at NAT SPG/43 – June 2007)</i></p> <hr/> <p>Application of reduced longitudinal separation of 5 minutes for climb/descent between GNSS equipped aircraft: <i>Paragraph 3.4.2 G added (following NAT IMG/32 endorsement – Nov2008)</i></p>
Edition 2009 Version 3.0	<ul style="list-style-type: none"> • Paragraph 3.2.1 updated to include vertical separation minimum from supersonic aircraft in accordance with NAT SUPPs 6.2.4.2 • Paragraph 3.4.2 updated to consolidate longitudinal separation minima and ensure consistency with associated Doc 4444 and NAT SUPPs provisions. Editorial revisions for clarity. • New paragraph 4.4.4 added to clarify direction regarding conflict prediction calculations. Subsequent paragraphs renumbered. • Text in diagram accompanying (new) paragraph 4.4.6 amended for consistency with (new) 3.4.2E.2.b. • (New) paragraph 4.4.7 and the explanatory text in the accompanying diagrams corrected.

Amendments to the NAT ASM containing the following changes:	
As of November 2010, the NAT ASM is published as <i>Application of Separation Minima – North Atlantic Region</i> (NAT ASM, NAT Doc 008)	
1 st Edition November 2010	<ul style="list-style-type: none">• Definition for Same Identical Track added and definitions for Mach Number Technique, Opposite Direction Aircraft and Same Direction Aircraft updated.• Provisions for the application of longitudinal separation using Mach number technique (paragraphs 3.4.2 and 3.4.7) updated to refer to “same identical track” where appropriate.• Paragraphs 4.4.3 and 4.4.8 updated to take account of revised definitions for Same Direction aircraft and Opposite Direction aircraft respectively.

TABLE OF CONTENTS

FOREWORD	i
Amendments to the NAT ASM (NAT Doc 008)	ii
CHAPTER 1. – DEFINITIONS/ACRONYMS	1
1.1 DEFINITIONS	1
1.2 ACRONYMS	3
CHAPTER 2. - SEPARATION	4
CHAPTER 3. – SEPARATION MINIMA	5
3.1 INTRODUCTION	5
3.2 VERTICAL SEPARATION MINIMA	5
3.3 LATERAL SEPARATION MINIMA	6
3.4 LONGITUDINAL SEPARATION MINIMA	8
CHAPTER 4. -APPLICATION OF SEPARATION	11
4.1 INTRODUCTION	11
4.2 VERTICAL SEPARATION	11
Overview	11
Level changes	11
4.3 LATERAL SEPARATION	12
Overview	12
Gentle Slope Rules	13
4.4 LONGITUDINAL SEPARATION	17
Overview	17
Same Direction	17
Opposite Direction	21
4.5 MACH NUMBER TECHNIQUE	23
Application of Mach Number Technique (succeeding aircraft faster)	23
Caution in the use of Mach Number Technique (succeeding aircraft faster)	24
Application of Mach Number Technique (preceding aircraft faster)	24

CHAPTER 1. – DEFINITIONS/ACRONYMS

1.1 DEFINITIONS

AIRSPACE RESERVATION - A defined volume of airspace that, by agreement between the appropriate ATS authority and a requesting agency, is temporarily reserved for exclusive use by the requesting agency.

AIR TRAFFIC CONTROL CLEARANCE - Authorization for an aircraft to proceed under conditions specified by an air traffic control unit. For convenience, the term “air traffic control clearance” is frequently abbreviated to “clearance” when used in appropriate contexts.

COMMON POINT - A point on the surface of the earth common to the tracks of two aircraft, used as a basis for the application of separation (e.g. significant point, waypoint, navigation aid, fix).

CRUISE CLIMB - An aeroplane cruising technique resulting in a net increase in altitude as the aeroplane mass decreases.

CRUISING LEVEL - A level maintained during a significant portion of a flight.

DIVERGING TRACKS – Tracks downstream of the common point whose angular divergence is equal to or less than 90 degrees.

FLIGHT LEVEL - A surface of constant atmospheric pressure that is related to a specific pressure datum, 1013.2 hectopascals (hPa), and is separated from other such surfaces by specific pressure intervals

FORMATION FLIGHT - More than one aircraft which, by prior arrangement between the pilots, operate as a single aircraft with regard to navigation and position reporting. Separation between the aircraft within the formation remains the responsibility of the flight leader and the pilots of the other aircraft in the flight, including periods when aircraft within the formation are maneuvering to attain separation from each other to effect individual control and during join-up and break-away.

LATERAL SEPARATION - Lateral separation is the specified spacing between aircraft expressed in terms of distance or angular displacement between tracks.

LONGITUDINAL SEPARATION - Longitudinal separation is the specified interval between aircraft expressed in units of time or distance along track.

MACH NUMBER TECHNIQUE - The term used to describe the technique of clearing turbojet aircraft operating along the same identical track or continuously diverging tracks 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.

MINIMUM NAVIGATION PERFORMANCE SPECIFICATIONS AIRSPACE - A portion of the ICAO North Atlantic Region airspace between FL285 and FL420 extending between latitude 27° North in the New York FIR, the southern boundary of Santa Maria Oceanic, and the North Pole, bounded in the east by the eastern boundaries of control areas Santa Maria Oceanic, Shanwick Oceanic and Reykjavik, and in the west by the western boundary of Reykjavik CTA, the western boundary of Gander Oceanic CTA, and the western boundary of New York Oceanic CTA, excluding the area west of 60° West and south of 38°30' North.

MOVING AIRSPACE RESERVATION - An airspace reservation whose position in space changes with time.

NAMED POINT - A reporting point identified by a name as well as by latitude and longitude.

OCEANIC ENTRY POINT - That point on the FIR boundary where the aircraft enters the first oceanic control area.

OCEANIC EXIT POINT - That point on the FIR boundary where the aircraft leaves the last oceanic control area.

OTHER MEANS - Position information derived from advanced ATC automation systems that take into account multiple sources of information namely voice reports, ADS and/or CPDLC reports, estimates and weather information, may be the basis for applying separation standards.

OPPOSITE DIRECTION AIRCRAFT - Aircraft operating on tracks whose angular differences are from 90° up to and including 180°.

PASSING POINT - The point where aircraft are at the minimum distance from each other and from which longitudinal separation is calculated. This may or may not coincide with the common point.

REDUCED VERTICAL SEPARATION MINIMUM – The application of 1000 feet vertical separation from FL290 thru FL410 between approved aircraft in RVSM designated airspace.

SAME DIRECTION AIRCRAFT - Aircraft operating on tracks whose angular differences are from 0° up to but not including 90°.

SAME IDENTICAL TRACK – Aircraft paths whose projections on the earth's surface are exactly the same.

SIGNIFICANT POINT - A significant point is a NAVAID, a fix derived from a NAVAID(s), a named point, or geographical coordinate(s) expressed in degrees of latitude, longitude or both, established for the purpose of providing separation, as a reporting point or to delineate a route of flight.

STATIONARY AIRSPACE RESERVATION - An airspace reservation whose position in space remains fixed with relation to the surface of the earth.

STEP CLIMB - A technique in which higher altitudes or flight levels are flight planned or achieved at a specified point or time.

STEEP TRACKS - Parallel tracks which are not laterally separated because the tracks exceed the allowable change in latitude for any ten-degree interval of longitude.

TRACK - The great circle projection on the earth's surface of the path of an aircraft, the direction of which path at any point is usually expressed in degrees from North (true, magnetic, or grid).

VERTICAL SEPARATION - Vertical separation is the specified spacing of aircraft expressed in altitudes or flight levels.

WEST ATLANTIC ROUTE SYSTEM (WATRS) - The WATRS area is defined beginning at a point 27° North 77° West direct to 20° North 67° West direct to 18° North 62° West direct to 18° North 60° West direct to 38°30' North 60° West direct to 38°30' North 69°15' West thence

counterclockwise along the New York Oceanic control area/flight information region boundary to the Miami Oceanic control area/flight information region boundary, thence southbound along the Miami Oceanic control area/flight information region boundary to the point of beginning.

1.2 ACRONYMS

ADS	AUTOMATIC DEPENDENT SURVEILLANCE
ATC	AIR TRAFFIC CONTROL
ATS	AIR TRAFFIC SERVICE
CPDLC	CONTROLLER/PILOT DATA LINK COMMUNICATIONS
CTA	CONTROL AREA
FIR	FLIGHT INFORMATION REGION
FL	FLIGHT LEVEL
ICAO	INTERNATION CIVIL AVIATION ORGANIZATION
MNT	MACH NUMBER TECHNIQUE
MNPS	MINIMUM NAVIGATION PERFORMANCE SPECIFICATIONS
NAT	NORTH ATLANTIC
NM	NAUTICAL MILES
PANS-ATM	PROCEDURES FOR AIR NAVIGATION SERVICES-AIR TRAFFIC MANAGEMENT (Doc 4444)
RVSM	REDUCED VERTICAL SEPARATION MINIMUM
WATRS	WEST ATLANTIC ROUTE SYSTEM

CHAPTER 2. - SEPARATION

2.1 Separation is the generic term used to describe action on the part of ATC in order to keep aircraft, operating in the same general area, at such distances from each other that the risk of their colliding with each other is reduced. Separation can be effected in two planes, horizontal and vertical. Separation in the horizontal plane can be achieved either longitudinally (by spacing aircraft behind each other at a specified distance, normally expressed in flying time) or laterally (by spacing aircraft side by side, but again at a specified distance from each other).

2.2 The required separation between aircraft is generally expressed in terms of minima, i.e. in distances which should not be infringed. Separation minima for the ICAO North Atlantic Region are specified in firm values of distance; horizontally in nautical miles (NM) or degrees of latitude; vertically in feet or flight levels, or in values of time between the moment a preceding aircraft passes over a given point and that time when the next aircraft is allowed to pass over the same point.

2.3 An air traffic control clearance shall not be given which would reduce the spacing between aircraft to less than the applicable separation minimum.

2.4 Where the type of separation or minimum used to separate aircraft cannot be maintained, action shall be taken to ensure that another type of separation or another minimum exists or is established prior to the time when the previously used separation would be insufficient.

2.5 The *PANS-ATM (Doc 4444)*, Chapter 5.11, permits the lateral and longitudinal separation minima, as detailed in this publication, to be reduced in the following circumstances:

A. As determined by the appropriate ATS authority, provided an appropriate safety assessment has shown that an acceptable level of safety will be maintained, and after prior consultation with users, as appropriate:

1. when special electronic or other aids enable the pilot-in-command of an aircraft to determine accurately the aircraft's position and when adequate communication facilities exist for that position to be transmitted without delay to the appropriate air traffic control unit; or
2. when, in association with rapid and reliable communication facilities, radar-derived information of an aircraft's position is available to the appropriate air traffic control unit; or
3. when special electronic or other aids enable the air traffic controller to predict rapidly and accurately the flight paths of aircraft and adequate facilities exist to verify frequently the actual aircraft positions with the predicted positions.

*Note: Attention is drawn to the guidance material contained in the **Air Traffic Services Planning Manual (Doc 9426)** regarding conditions governing the reduction of separation minima.*

B. In accordance with regional air navigation agreements, after prior consultation with the aircraft operators, when:

1. special electronic or other aids enable the aircraft to closely adhere to their current flight plans; and
2. the air traffic situation is such that the conditions in PANS-ATM (Doc 4444), Chapter 5.11.1.1, regarding communications between pilots and the appropriate ATC unit or units need not necessarily be met to the degree specified therein, in order to maintain an adequate level of safety.

CHAPTER 3. – SEPARATION MINIMA

3.1 INTRODUCTION

3.1.1 In defining appropriate minima the primary consideration is the accuracy with which the relevant parameters can be measured. Thus vertical minima depend on the accuracy of the altimetry system, lateral minima on navigational accuracy and longitudinal minima on the quality of meteorological information available.

3.2 VERTICAL SEPARATION MINIMA

3.2.1 Minimum vertical separation between aircraft, airspace reservations, and between airspace reservations and other aircraft shall be:

- A. 4000 feet at or above FL 450 between supersonic aircraft, and between supersonic aircraft and any other aircraft,
- B. 2000 feet at or above FL 290 between a formation flight and any other aircraft, or
- C. 2000 feet at or above FL 290, or
- D. 1000 feet from FL 290 to FL 410 inclusive between RVSM aircraft, or
- E. 1000 feet below FL 290

Note 1: Non-RVSM aircraft may be cleared to climb or descend through the RVSM-designated flight levels provided that the aircraft will carry out a continuous climb or descent through all RVSM-designated flight levels. Aircraft must also be MNPS approved in order for this to apply within MNPS airspace.

Note 2: Non-RVSM aircraft may also, under specific circumstances, be granted exemptions to operate in RVSM airspace. Such aircraft shall be vertically separated from other traffic by the non-RVSM separation minimum of 2000 feet. Aircraft must also be MNPS approved in order for this to apply within MNPS airspace.

Note 3: Formation flights are considered to be non-RVSM. Such flights shall be vertically separated from other traffic by the non-RVSM separation minimum of 2000 feet within the RVSM designated flight levels.

Note 4: Two RVSM approved aircraft with station-keeping equipment operating as a formation flight on the same route, at the same altitude with less than 4000' longitudinal separation are considered to be one aircraft for the purpose of separation. 1000 feet vertical separation can be applied between these and other RVSM approved aircraft. Currently, only formation flights of two C-17 aircraft qualify. NAT ANSP should prior co-ordinate all C-17 formation flights. Apply 2000 feet vertical separation when requested so as to meet domestic RVSM requirements.

Note 5: RVSM minima shall not be applied between any aircraft and an airspace reservation.

Note 6: Under certain circumstances, ATS units may temporarily apply increased vertical separation. (e.g. in areas where greater than moderate turbulence has been reported).

3.3 LATERAL SEPARATION MINIMA

3.3.1 Lateral separation is applied between route segments. Segments may be wholly or partly separated but for aircraft to be laterally separated both must be within the separated segments or segment parts. The following lateral separation minima apply to all aircraft and include both moving and stationary airspace reservations:

- A.** 120 NM or 2 degrees between aircraft operating entirely outside MNPS airspace other than as prescribed below; or
- B.** 120 NM:
 - 1. between the closest tracks of any aircraft for which a moving airspace reservation is reserved; or
 - 2. between the track of an aircraft operating under the control of the ATC unit concerned and the closest track of any aircraft for which a moving airspace reservation is reserved; or
 - 3. between the track of an aircraft operating under the control of the ATC unit concerned or as part of a moving airspace reservation and the nearest limit of the reserved airspace of the stationary airspace reservation, when the aircraft does NOT meet the MNPS and the requesting agency has NOT guaranteed to confine its activities to the requested airspace; or
 - 4. between the boundaries of stationary airspace reservations other than those contained in 3.3.1D and 3.3.1G; or
- C.** 90 NM or 1 ½ degrees between aircraft operating entirely outside MNPS airspace:
 - 1. between USA/Canada and Bermuda; or
 - 2. west of 55°W between the USA, Canada or Bermuda and points in the ICAO CAR Region; or
 - 3. between aircraft operating outside the MNPS airspace and at least one of the aircraft does not meet the MNPS between Iceland and points in Scandinavia and in the United Kingdom; or

Note: Paragraph 3.3.1 C3. applies only to aircraft crossing the FIR boundaries Reykjavik/Stavanger or Reykjavik/Scottish as well as aircraft operating between Faroes and Iceland.
- D.** 90 NM:
 - 1. between the closest tracks of any aircraft for which a moving airspace reservation is reserved when in the New York OCA west of 60° West; or
 - 2. between the track of an aircraft operating in the New York OCA west of 60° West under the control of the ATC unit concerned and the closest track of any aircraft for which a moving airspace reservation is reserved; or
 - 3. between the track of an aircraft operating in the New York OCA west of 60° West under the control of the ATC unit concerned or as part of a moving airspace reservation and the nearest limit of the reserved airspace of the stationary airspace reservation, when the aircraft does

NOT meet the MNPS and the requesting agency has NOT guaranteed to confine its activities to the requested airspace: or

4. between the boundaries of stationary airspace reservations in the New York OCA west of 60° West: or
- E.** 60 NM or 1 degree between MNPS aircraft provided a portion of the route is within, above, or below MNPS airspace; or
- F.** 60 NM:
1. between the closest tracks of any aircraft for which a moving airspace reservation is reserved provided all aircraft or formation flights meet the MNPS; or
 2. between the track of an aircraft operating under the control of the ATC unit concerned and the track of any of a formation flight for which a moving airspace reservation is reserved, provided at least one aircraft in the formation and the aircraft operating under the control of the ATC unit meet the MNPS, and a portion of the route of the aircraft is above, within, or below MNPS airspace; or
 3. between the track of an aircraft operating under the control of the ATC unit concerned and the closest track of any of the aircraft for which a moving airspace reservation is reserved, provided all aircraft meet the MNPS, and a portion of the route of the aircraft is above, within, or below MNPS airspace; or
 4. between the track of an aircraft operating under the control of the ATC unit concerned or as part of a moving airspace reservation and the nearest limit of the reserved airspace of the stationary airspace reservation, provided the aircraft meets the MNPS, a portion of the route of the aircraft is above, within, or below MNPS airspace, and the requesting agency has NOT guaranteed to confine its activities to the requested airspace; or
 5. between the track of an aircraft operating under the control of the ATC unit concerned or as part of a moving airspace reservation and the nearest limit of the reserved airspace of the stationary airspace reservation, when the aircraft does NOT meet the MNPS and the requesting agency has guaranteed to confine its activities to the requested airspace: or
 6. between the boundaries of stationary airspace reservations provided the requesting agencies have guaranteed to confine their activities to the requested airspace; or

Note: A formation flight where the lead aircraft in the formation meets the MNPS is deemed to meet the requirements for the application of 60 NM.

- G.** 45 NM:
1. between the track of an aircraft operating in the New York OCA west of 60° West under the control of the ATC unit concerned or as part of a moving airspace reservation and the nearest limit of the reserved airspace of the stationary airspace reservation, when the aircraft does NOT meet the MNPS and the requesting agency has guaranteed to confine its activities to the requested airspace: or
 2. between the boundaries of stationary airspace reservations in the New York OCA west of 60° West provided the requesting agencies have guaranteed to confine their activities to the requested airspace.

H. 30 NM:

1. between the track of an aircraft operating under the control of the ATC unit concerned or as part of a moving airspace reservation and the nearest limit of the reserved airspace of the stationary airspace reservation, provided the aircraft meets the MNPS, a portion of the route of the aircraft is above, within or below MNPS airspace, and the requesting agency has guaranteed to confine its activities to the requested airspace; or

3.3.2 The above minima when expressed in terms of degrees are nominal values; the specific method of applying them using the Earth's coordinate system (the "gentle-slope" rule) provides slightly lower lateral distances. This issue is discussed in more detail in section 4.3 Lateral Separation Minima.

3.4 LONGITUDINAL SEPARATION MINIMA

3.4.1 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.

3.4.2 Longitudinal separation minima for aircraft flying along same/intersecting tracks shall be applied by ensuring that throughout the period where lateral separation does not exist (see Section 4.3 lateral separation) the aircraft are separated by a time interval equal to or greater than:

- A. 60 minutes** between moving airspace reservations, or

Note: This separation shall be ensured in the airspace reservation approval process. Apply longitudinal separation so that 60 minutes will be maintained with respect to any approved "Approval Void if Aircraft Not Airborne by (AVANA)" times. Minimum longitudinal separation is applied between the latest time of the first reservation against the earliest time of the second reservation.

- B. 30 minutes** between other than turbojet aircraft and any other aircraft, or

- C. 20 minutes** between other than turbojet aircraft and any other aircraft in the WATRS area, or

- D. 15 minutes** between turbojet aircraft, or

- E. 10 minutes** between turbojet aircraft provided the Mach Number Technique is applied as prescribed in paragraphs 3.4.5 and 3.4.6 and Section 4.5 whether in level, climbing or descending flight, provided:

1. that when the succeeding aircraft is maintaining a true Mach number higher than the preceding aircraft the provisions of 4.5.3 to 4.5.6 shall be applied, and
2. the aircraft concerned have reported over a common point and follow:
 - a) the same identical track; or
 - b) continuously diverging tracks until some other form of separation is provided, and
 - i) at least 10 minutes longitudinal separation exists at the point where the tracks diverge, and
 - ii) at least 5 minutes longitudinal separation exists where lateral separation is achieved, and

- iii) lateral separation will be achieved at or before the next significant point (normally ten degrees of longitude along track(s)) or, if not, within 90 minutes of the time the second aircraft passes the common point or within 600 NM of the common point, whichever is estimated to occur first.
 - 3. if the aircraft have not reported over a common point, it is possible to ensure, by radar, ADS-B or other means that the appropriate time interval will exist at the common point from which they either follow the same identical track or continuously diverging tracks.
- F.** Between 9 and 5 minutes inclusive between turbojet aircraft provided the Mach number technique is applied as prescribed in paragraphs 3.4.5 and 3.4.6 and Section 4.5, whether in level, climbing or descending flight, provided:
- 1. the aircraft concerned have reported over a common point and follow:
 - a) the same identical track, or
 - b) continuously diverging tracks until some other form of separation is provided.
 - 2. the preceding aircraft is maintaining a true Mach number greater than the following aircraft in accordance with the following table:
 - 9 minutes, if the preceding aircraft is Mach 0.02 faster than the following aircraft;
 - 8 minutes, if the preceding aircraft is Mach 0.03 faster than the following aircraft;
 - 7 minutes, if the preceding aircraft is Mach 0.04 faster than the following aircraft;
 - 6 minutes, if the preceding aircraft is Mach 0.05 faster than the following aircraft;
 - 5 minutes, if the preceding aircraft is Mach 0.06 faster than the following aircraft.
 - 3. if the aircraft have not reported over a common point, it is possible to ensure, by radar, ADS-B or other means that the appropriate time interval will exist at the common point from which they either follow the same identical track or continuously diverging tracks.
- G.** 5 minutes between climbing or descending same direction aircraft 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 a common point.

Note 1: Both aircraft must be GNSS equipped.

Note 2: When issuing the clearance through third party communication or CPDLC, a restriction must be added to the clearance to ensure that the 10 minute condition is satisfied.

Note 3: 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 be obtained while vertical separation does not exist.

3.4.3 The minimum longitudinal separation between a moving airspace reservation and other (non-reservation) aircraft shall be the applicable longitudinal minima as contained in paragraph 3.4.2 above.

Minimum longitudinal separation may be applied between aircraft operating under the control of the ATC unit concerned and the first and last aircraft operating within a moving airspace reservation.

3.4.4 Longitudinal separation between aircraft flying along opposite direction tracks (and not laterally separated) cannot apply throughout. Vertical separation must therefore be ensured during a period equal to the appropriate minimum stated below prior to and after the aircraft are estimated to meet:

- A.** 30 minutes for other than turbojet aircraft, or
- B.** 20 minutes for other than turbojet aircraft in the WATRS area, or
- C.** 15 minutes for turbojet aircraft, or
- D.** 10 minutes for turbojet aircraft provided that the aircraft have passed each other and have reported over a common point.

3.4.5 Turbojet aircraft shall adhere to the true 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.

3.4.6 If it is not feasible, due to aircraft performance, to maintain the last assigned true Mach number during en-route climbs and descents, pilots of aircraft concerned shall advise ATC at the time of the climb/descent request.

3.4.7 When the Mach number technique is applied and provided that:

- A.** the aircraft concerned have reported over the same reporting point and follow the same identical 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 radar or other means that the appropriate time interval exists and will exist at the common point from which they either follow the same identical track or continuously diverging tracks; minimum longitudinal separation between turbojet aircraft on the same track, whether in level, climbing or descending flight shall be:
 - 1. 10 minutes; or
 - 2. between 9 and 5 minutes inclusive, provided: the preceding aircraft is maintaining a Mach number greater than the following aircraft in accordance with the following table:
 - 9 minutes, if the preceding aircraft is Mach 0.02 faster than the following aircraft;
 - 8 minutes, if the preceding aircraft is Mach 0.03 faster than the following aircraft;
 - 7 minutes, if the preceding aircraft is Mach 0.04 faster than the following aircraft;
 - 6 minutes, if the preceding aircraft is Mach 0.05 faster than the following aircraft;
 - 5 minutes, if the preceding aircraft is Mach 0.06 faster than the following aircraft.

CHAPTER 4. -APPLICATION OF SEPARATION

4.1 INTRODUCTION

4.1.1 With the possible exception of vertical, the application of separation is a far more difficult subject to address than the minima. In this edition of the NAT ASM a new approach is adopted, the automated application is described first, then the manual one. This reflects the increased level of automation in NAT centres.

4.2 VERTICAL SEPARATION

Overview

4.2.1 Vertical separation is obtained by requiring aircraft to operate at different flight levels (or altitudes). While aircraft are normally restricted to maintain a single flight level, cruise climbs between two levels (or above a level) may also be employed to enhance efficiency.

4.2.2 During a cruise climb, the aircraft shall be considered to occupy all levels specified in the cruise climb clearance.

4.2.3 An aircraft at a cruising level shall normally have priority over other aircraft desiring that cruising level. When two or more aircraft are at the same cruising level, the preceding (leading) aircraft shall normally have priority.

Level changes

4.2.4 An aircraft's change in cruising level may be subject to constraints on its commencement (time or place), completion (time or place) and rate (feet per minute).

4.2.5 The type of constraint should reflect the form of separation which is being replaced by (or is replacing) vertical separation; time being used for longitudinal and place for lateral separation.

4.2.6 When an aircraft is cleared for a change in flight level, the aircraft concerned is considered to occupy all flight levels involved in the change unless specific flight level reports are received.

4.2.7 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;
- b) the higher aircraft is effecting a cruise climb; 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.

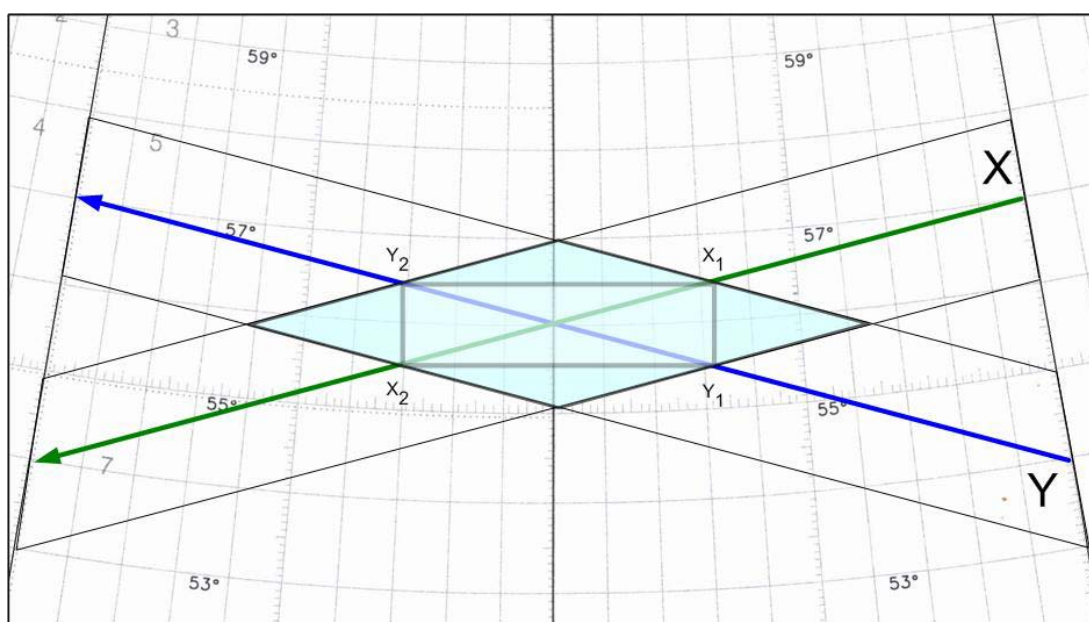
4.2.8 In all cases, the applicable vertical separation minima must be established prior to the loss of horizontal separation and be maintained until either lateral or longitudinal separation is regained.

4.3 LATERAL SEPARATION

Overview

4.3.1 The PANS-ATM (Doc 4444), states in paragraph 5.4.1.1.1 that “lateral separation shall be applied so that the distance between those portions of the intended routes for which the aircraft are to be laterally separated is never less than an established distance to account for navigational inaccuracies plus a specified buffer..

4.3.2 As the following diagram makes clear, lateral separation exists between the segments on which the aircraft are operating, independent of the actual location of the aircraft along those segments (which is a longitudinal consideration). In the diagram below (variations on which will be met in the ensuing sections) aircraft “X” and “Y” are laterally separated when at least one of the aircraft is outside of the area of conflict – namely outside the shaded area.



4.3.3 As described above, three lateral separation minima are published for the ICAO NAT Region, namely 120 NM or 2 degrees, 90 NM or 1 1/2 degrees and 60 NM or 1 degree where the earth’s coordinate system is used to define tracks and effect separation.

4.3.4 On a flat earth, and if all tracks ran due east/west, this would indeed be a true equivalence. On the spherical Earth it is not, even tracks along adjacent parallels are separated by less than 60 NM.

4.3.5 In order to bridge this gap between the formal specification and the real world, the ICAO NAT Region has adopted “gentle slope” rules that ensure that the actual separation never falls below distances which vary with latitude but never fall short of 50.5 NM.

4.3.6 The application of the gentle slope rule varies from centre to centre, some allow it only to be used between segments anchored at major meridians spaced 10 degrees apart, others allow extrapolation from points (typically nav aids) located between such meridians to the nearest major meridian to establish the slope.

4.3.7 It is important to realize that lateral separation is measured between the routes and segments along which two aircraft fly, not between the aircraft themselves.

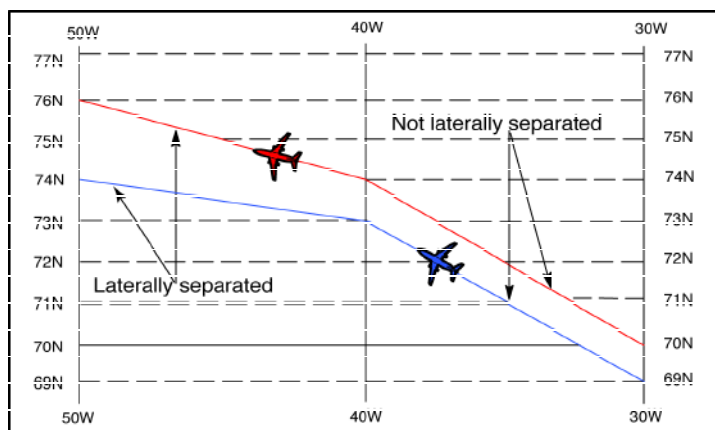
4.3.8 In order to increase safety, a “Strategic Lateral Offset” procedure has been implemented. Pilots have the authority to offset from the centre line of their cleared route up to 2 NM right-of-course. Pilots are not required to notify ATC when applying a Strategic Lateral Offset manoeuvre and the calculation of non-radar lateral separation need not take this into consideration.

Gentle Slope Rules

4.3.9 In the manual application of the lateral separation minima specified in section 3.3, tracks may be spaced with reference to their difference in latitude, using one degree instead of 60 NM, one and one-half degrees instead of 90 NM, and two degrees instead of 120 NM, provided that in any interval of ten degrees of longitude the change in latitude of one of the tracks does not exceed:

- A. three degrees at or south of 58° North
- B. two degrees north of 58° North and south of 70° North
- C. one degree at or north of 70° North and south of 80° North.

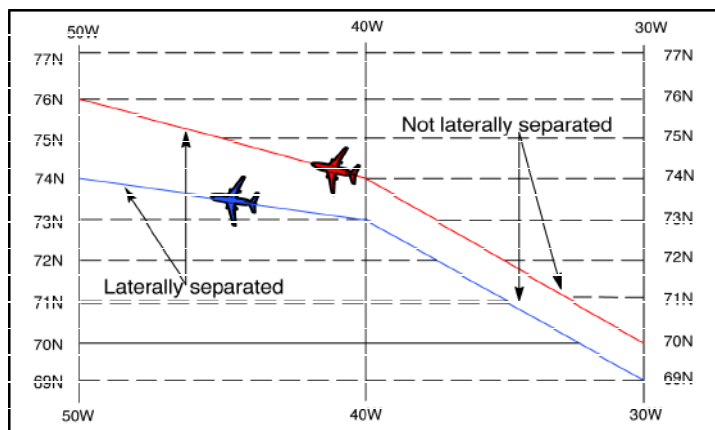
Note: The “degrees to nautical miles” relativities contained in this paragraph do not apply to applications involving airspace reservations.



-- From 30° to 40°W, the tracks are not laterally separated because both tracks exceed the maximum 1° change in latitude for a 10° interval of longitude permitted at or 70°N and south of 80°N.

-- Lateral separation exists when the “north” aircraft passes 40°W.

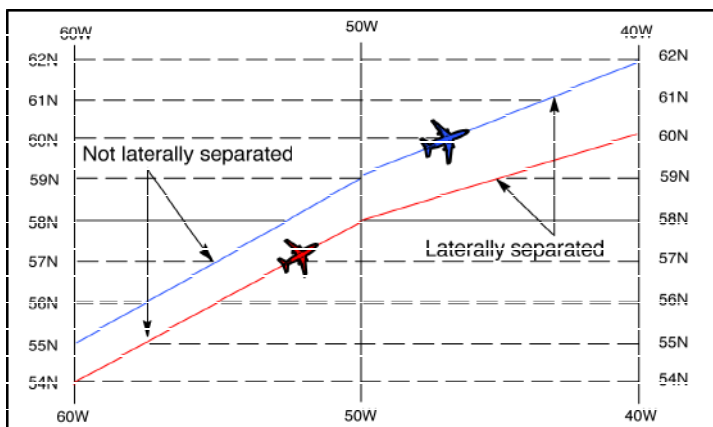
-- From 40° to 50°W, the tracks are laterally separated because at least one of the tracks meets the maximum 1° change in latitude for a 10° interval of longitude permitted at or north of 70°N and south of 80°N.



-- From 30° to 40°W, the tracks are not laterally separated because both tracks exceed the maximum 1° change in latitude for a 10° interval of longitude permitted at or north of 70°N and south of 80°N.

-- Lateral separation exists when both aircraft have passed 40°W.

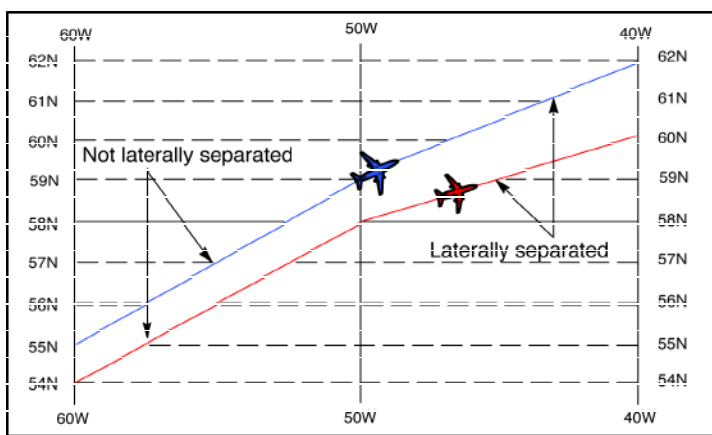
-- From 40° to 50°W, the tracks are laterally separated because at least one of the tracks meets the maximum 1° change in latitude for a 10° interval of longitude permitted at or north of 70°N and south of 80°N.



-- From 60° to 50°W, the tracks are not laterally separated because both tracks exceed the maximum 3° change in latitude for a 10° interval of longitude permitted at or south of 58°N.

-- Lateral separation exists when the "north" aircraft passes 50°W.

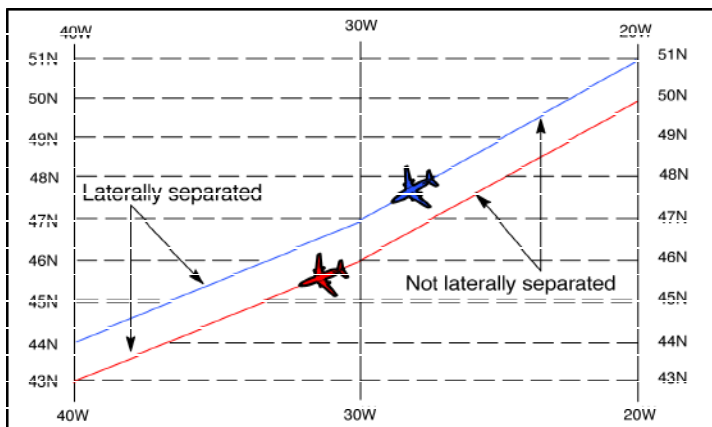
-- From 50° to 40°W, the tracks are laterally separated because at least one of the tracks meets the maximum 2° change in latitude for a 10° interval of longitude permitted between north of 58°N and south of 70°N.



-- From 60° to 50°W, the tracks are not laterally separated because both tracks exceed the maximum 3° change in latitude for a 10° interval of longitude permitted at or south of 58°N.

-- Lateral separation exists when both aircraft have passed 50°W.

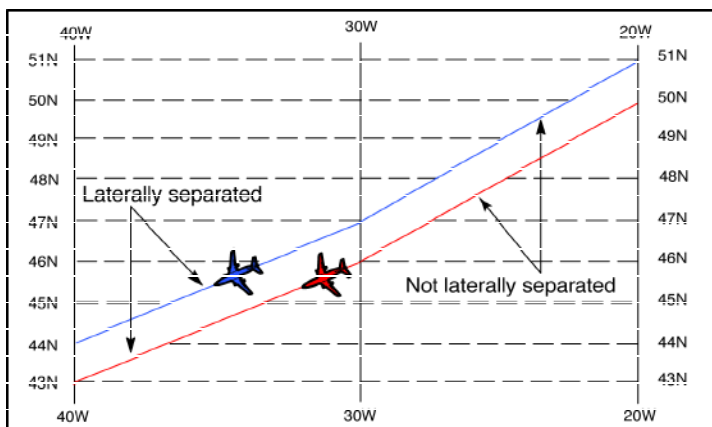
-- From 50° to 40°W, the tracks are laterally separated because at least one of the tracks meets the maximum 2° change in latitude for a 10° interval of longitude permitted north of 58°N and south of 70°N



-- From 20° to 30°W, the tracks are not laterally separated because both tracks exceed the maximum 3° change in latitude for a 10° interval of longitude permitted south of 58°N.

-- Lateral separation exists when the "south" aircraft passes 30°W.

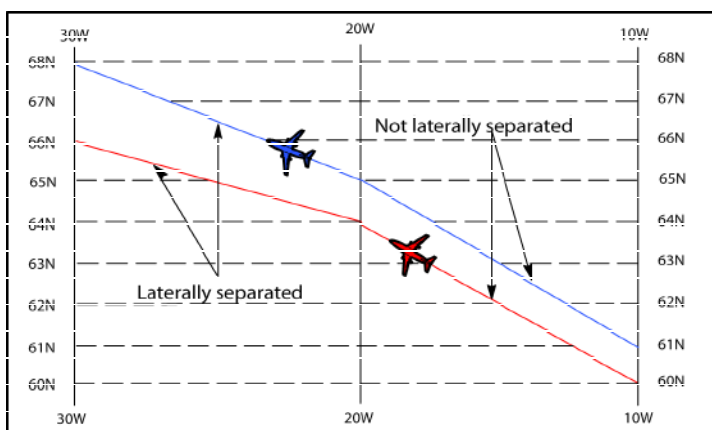
-- From 30° to 40°W, the tracks are laterally separated because at least one of the tracks meets the maximum 3° change in latitude for a 10° interval of longitude permitted south of 58°N.



-- From 20° to 30°W, the tracks are not laterally separated because both tracks exceed the maximum 3° change in latitude for a 10° interval of longitude permitted south of 58°N.

-- Lateral separation exists when both aircraft have passed 30°W.

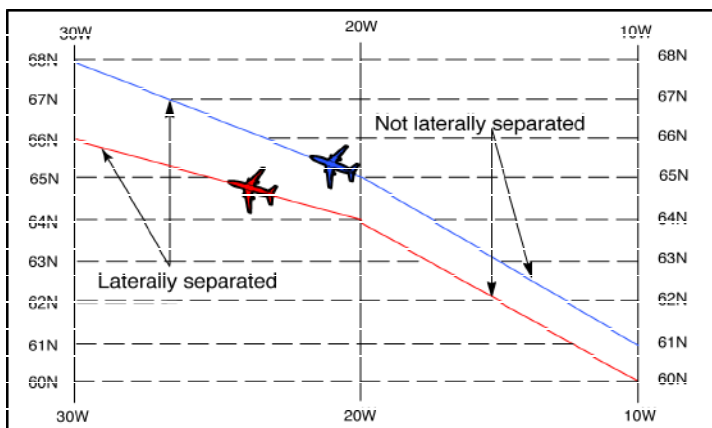
-- From 30° to 40°W, the tracks are laterally separated because at least one of the tracks meets the maximum 3° change in latitude for a 10° interval of longitude permitted south of 58°N.



-- From 10° to 20°W, the tracks are not laterally separated because both tracks exceed the maximum 2° change in latitude for a 10° interval of longitude permitted north of 58°N and south of 70°N.

-- Lateral separation exists when the "north" aircraft passes 20°W.

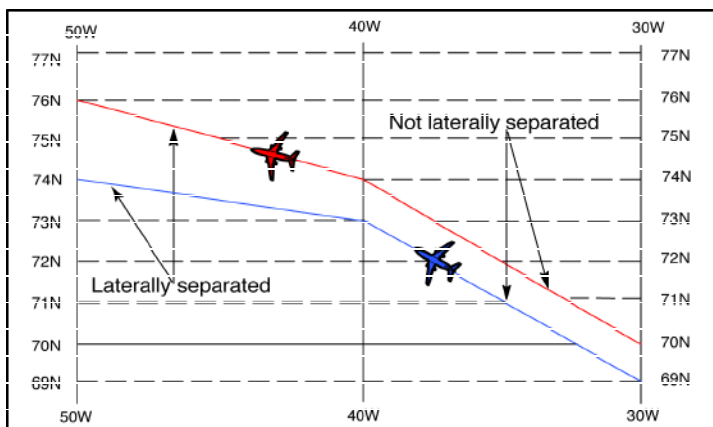
-- From 20° to 30°W, the tracks are laterally separated because at least one of the tracks meets the maximum 2° change in latitude for a 10° interval of longitude permitted north of 58°N and south of 70°N.



-- From 10° to 20°W, the tracks are not laterally separated because both tracks exceed the maximum 2° change in latitude for a 10° interval of longitude permitted north of 58°N and south of 70°N.

-- Lateral separation exists when both aircraft have passed 20°W.

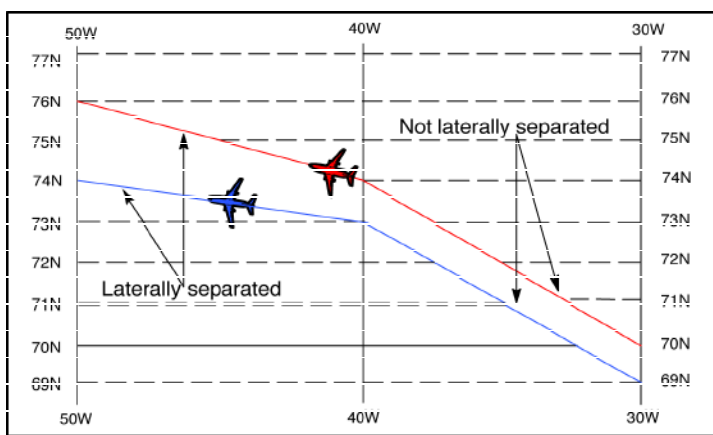
-- From 20° to 30°W, the tracks are laterally separated because at least one of the tracks meets the maximum 2° change in latitude for a 10° interval of longitude permitted north of 58°N and south of 70°N.



-- From 30° to 40°W, the tracks are not laterally separated because both tracks exceed the maximum 1° change in latitude for a 10° interval of longitude permitted at or 70°N and south of 80°N.

-- Lateral separation exists when the "north" aircraft passes 40°W.

-- From 40° to 50°W, the tracks are laterally separated because at least one of the tracks meets the maximum 1° change in latitude for a 10° interval of longitude permitted at or north of 70°N and south of 80°N.

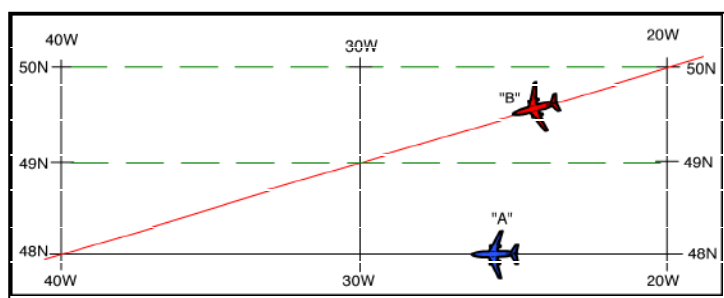


-- From 30° to 40°W, the tracks are not laterally separated because both tracks exceed the maximum 1° change in latitude for a 10° interval of longitude permitted at or north of 70°N and south of 80°N.

-- Lateral separation exists when both aircraft have passed 40°W.

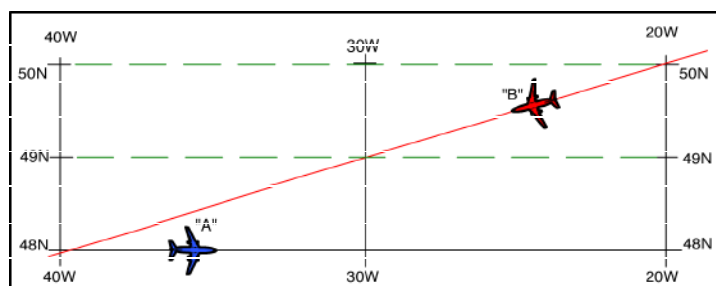
-- From 40° to 50°W, the tracks are laterally separated because at least one of the tracks meets the maximum 1° change in latitude for a 10° interval of longitude permitted at or north of 70°N and south of 80°N.

4.3.10 For tracks where the spacing falls below the appropriate criteria, lateral separation exists up until the time that an aircraft on one of the tracks reaches the appropriate criterion (60 NM or 1°, 90NM or 1 1/2°, 120 NM or 2°) as measured perpendicularly from the other track.



60 NM or 1°

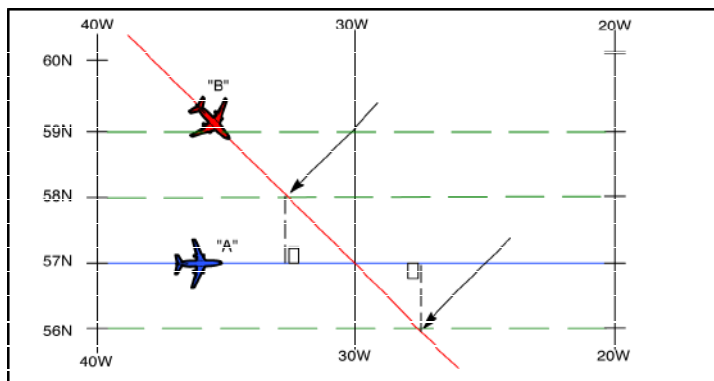
Lateral separation exists until aircraft "B" reaches 49°N.



60NM or 1°

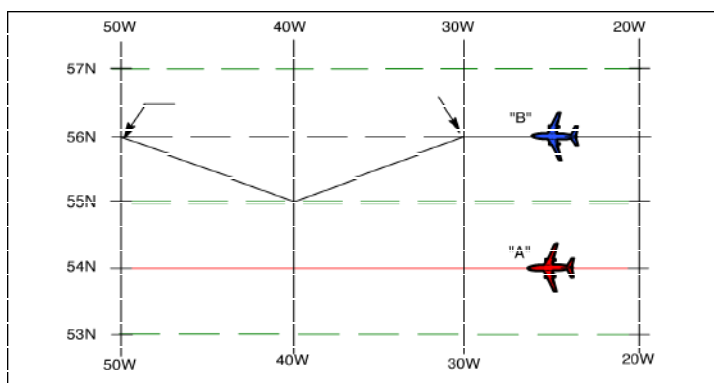
Lateral separation exists until aircraft "B" reaches 49°N

4.3.11 If longitudinal separation does not exist, vertical separation must be established prior to the second aircraft reaching the appropriate lateral minimum and be maintained until another form of separation is established.



60 NM or 1°

Lateral separation exists until aircraft "B" reaches 58°N, and is regained after aircraft "B" passes 56°N.



120 NM or 2°

Lateral separation exists until aircraft "B" reaches 30°W, and is regained after aircraft "B" passes 50°W.

4.3.12 At or north of 80° North, or where the above rates of change of latitude are exceeded, the required lateral separation minima must be ensured by reference to the track spacing expressed in nautical miles.

4.4 LONGITUDINAL SEPARATION

Overview

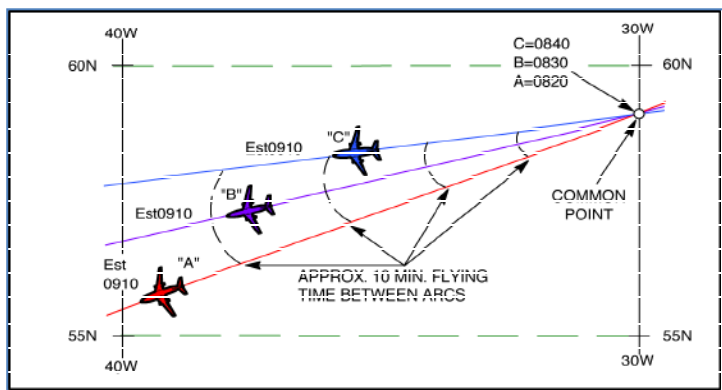
4.4.1 Longitudinal separation shall be applied so that the spacing between the estimated positions of the aircraft being separated is never less than a prescribed minimum.

4.4.2 Conflict prediction calculations, whether automated or manual, will extend to an exit point, or into an adjacent Control Centre's airspace to a mutually agreed limit.

Same Direction

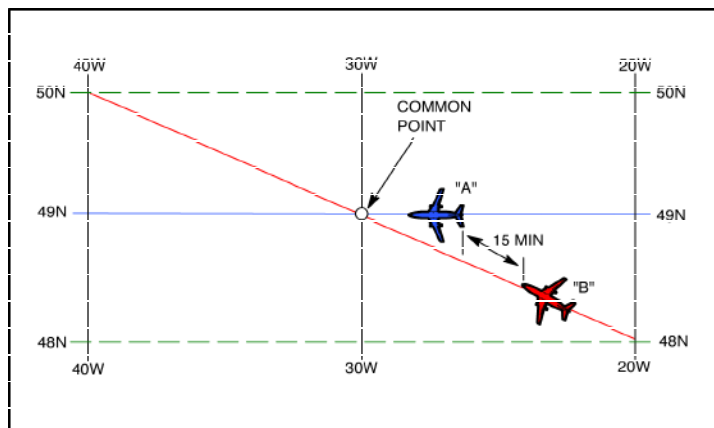
4.4.3 The application of same direction minima is for same direction aircraft, unless otherwise specified.

4.4.4 Where automated conflict prediction capability exists, longitudinal separation calculations for same direction aircraft should be centered around a common point instead of successive degrees of longitude/latitude. The common point may be a real common point if the aircraft tracks intersect or a system calculated common point if the aircraft tracks do not intersect. In this way, a consistent application of longitudinal separation will be achieved (see figure below).



4.4.5 For aircraft that have not reported over a common point and will follow tracks which intersect, the following longitudinal separation is required:

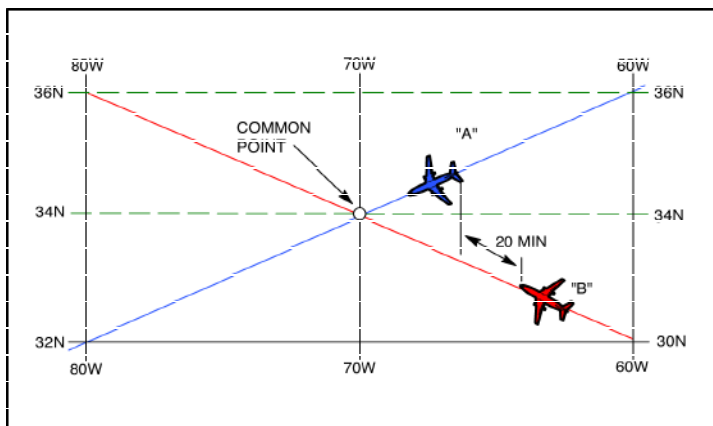
Both Aircraft Have Not Reported Over A Common Point



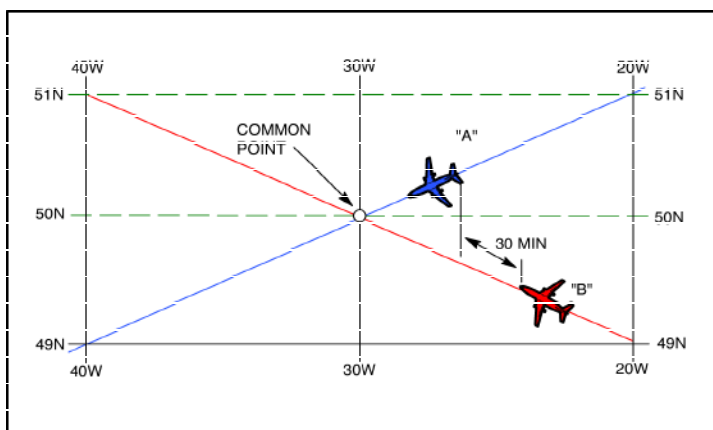
For turbojet aircraft, at least 15 minutes longitudinal separation between the aircraft must be maintained between 20° W and 30° W.

Note: Some ANSPs may restrict same direction minima to angular differences from 0° up to but not including 45°.

Both Aircraft Have Not Reported Over A Common Point (cont.)

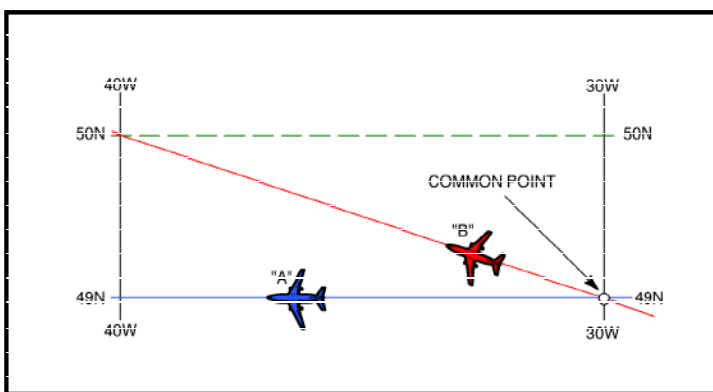


For other than turbojet aircraft, at least 20 minutes longitudinal separation between the aircraft must be maintained in the WATRS area.

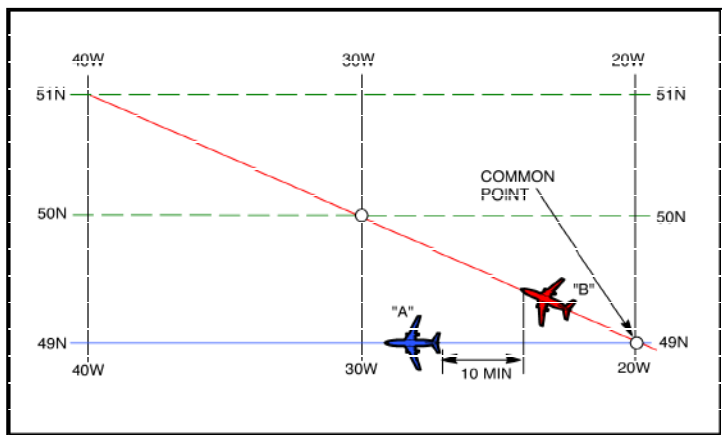


For other than turbojet aircraft outside of the WATRS area, at least 30 minutes longitudinal separation between the aircraft must be maintained.

4.4.6 For turbojet aircraft that have reported over a common point and are following tracks which have intersected, 10 minutes longitudinal separation is required at the point where the tracks diverge, provided the Mach Number Technique is applied, and at least 5 minutes longitudinal separation exists where the required lateral separation is achieved, in accordance with the requirements contained in paragraph 3.4.2E.2.b.



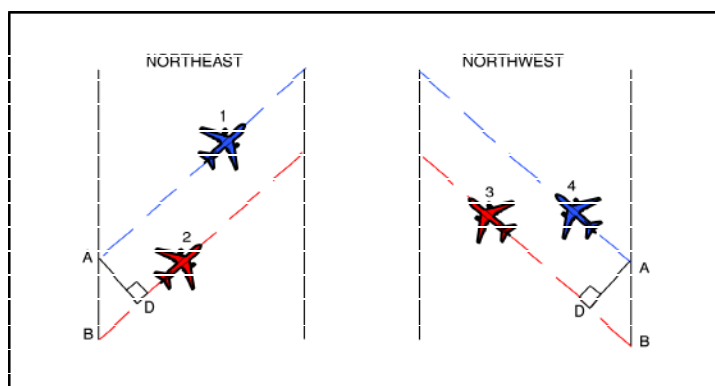
At least 10 minutes longitudinal separation exists at 30° W. The diverging aircraft continue to be separated provided that at least 5 minutes longitudinal separation exists where lateral separation is achieved.



For turbojet aircraft that have reported over a common point provided the Mach Number Technique is applied and are following tracks which have intersected, 10 minutes longitudinal separation is required.

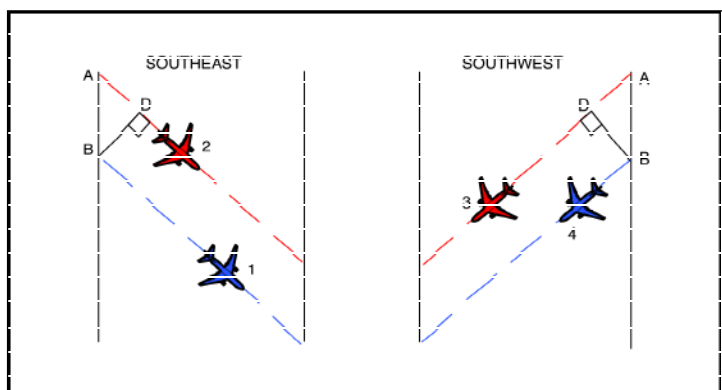
4.4.7 Where aircraft are operating on different parallel tracks which are not laterally separated because the tracks exceed the allowable change in latitude for any ten degree interval of longitude (in accordance with paragraph 4.3.9), it may be necessary to apply an additional time increment to ensure that sufficient longitudinal separation is maintained. In the northwest example below, separation must be ensured at points “A” and “D”. In the southwest example below, separation must be ensured at points “B” and “D”. The requirement to apply an additional time increment is directly related to the alignment of the tracks and which aircraft passes the relevant meridian first.

Steep Parallel Tracks—Tracks Not Laterally Separated



In the “Northeast” illustration (aircraft 1 passes point A first), the required longitudinal separation minima may be applied either at point B or D.

In the “Northwest” illustration (aircraft 3 passes point B first), apply the required longitudinal separation minima at point A plus the time required to fly distance B to D.



In the “Southeast” illustration (aircraft 1 passes point B first), the required longitudinal separation minima may be applied either at point A or D.

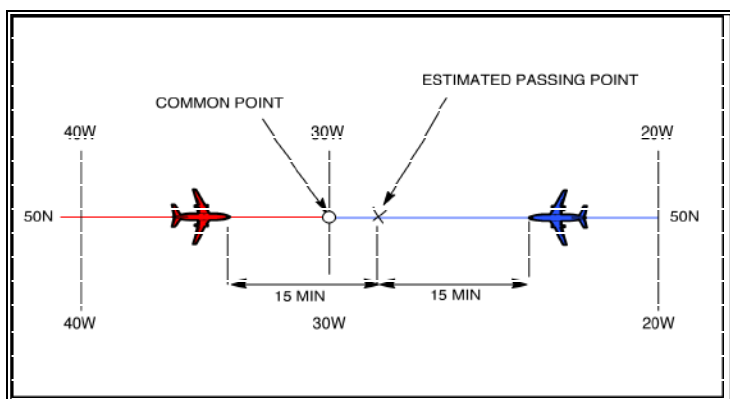
In the “Southwest” illustration (aircraft 3 passes point A first), apply the required longitudinal separation minima at point B plus the time required to fly distance A to D.

Opposite Direction

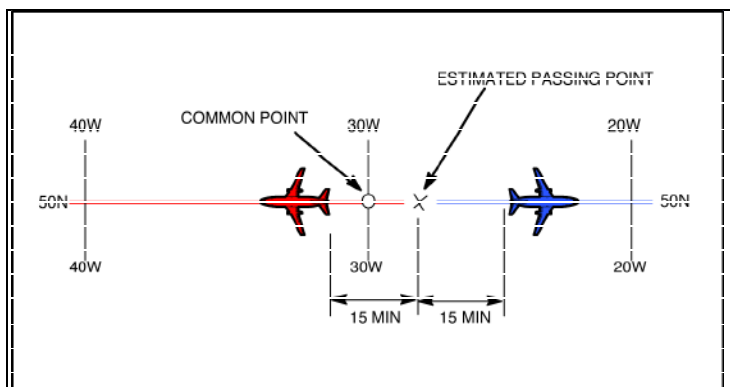
4.4.8 The application of opposite direction minima is for opposite direction aircraft, unless otherwise specified.

4.4.9 For aircraft in level, climbing or descending flight which have not reported over a common point that will follow opposite direction tracks, maintain vertical separation as follows:

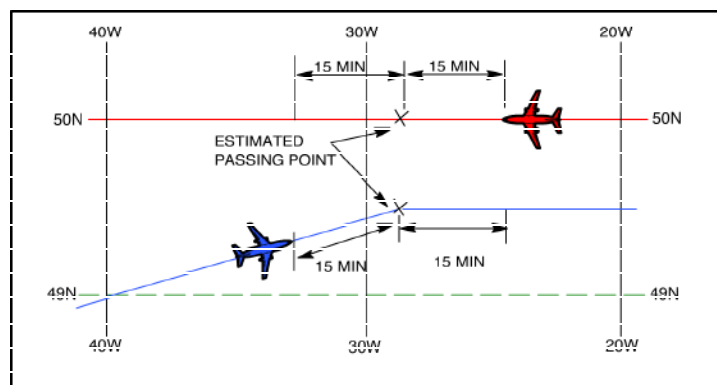
Opposite Direction—Both Aircraft Have Not Reported Over A Common Point



Establish vertical separation between turbojet aircraft at least 15 minutes prior to the estimated passing point

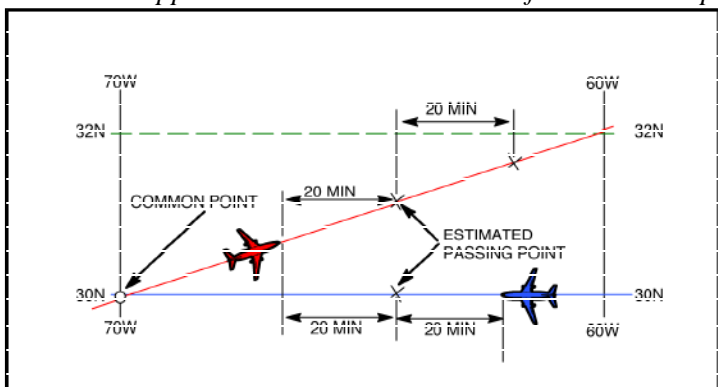


Maintain vertical separation between turbojet aircraft at least 15 minutes after the estimated passing point

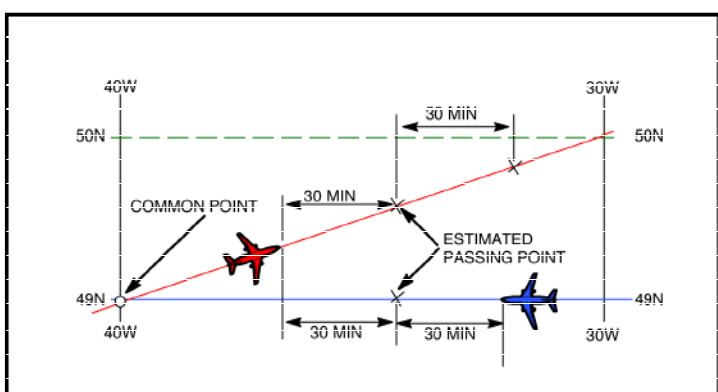


Establish vertical separation between turbojet aircraft at least 15 minutes prior to the estimated passing point, and maintain vertical separation for at least 15 minutes after the estimated passing point

Opposite Direction—Both Aircraft Have Not Reported Over A Common Point (cont.)



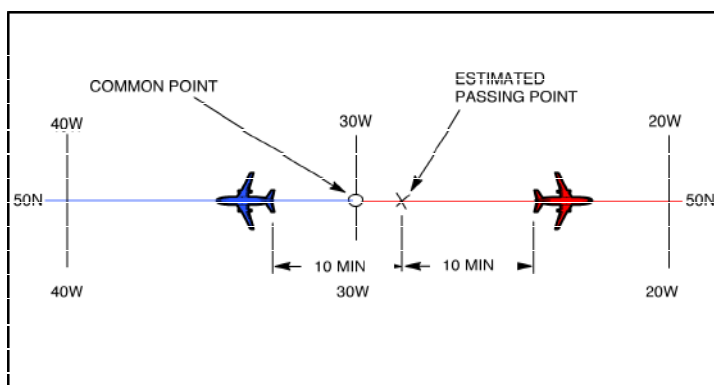
Establish vertical separation between other than turbojet aircraft in the WATRS area at least 20 minutes prior to the estimated passing point, and maintain vertical separation for at least 20 minutes after the estimated passing point.



Establish vertical separation between other than turbojet aircraft outside of the WATRS area at least 30 minutes prior to the estimated passing point, and maintain vertical separation for at least 30 minutes after the estimated passing point.

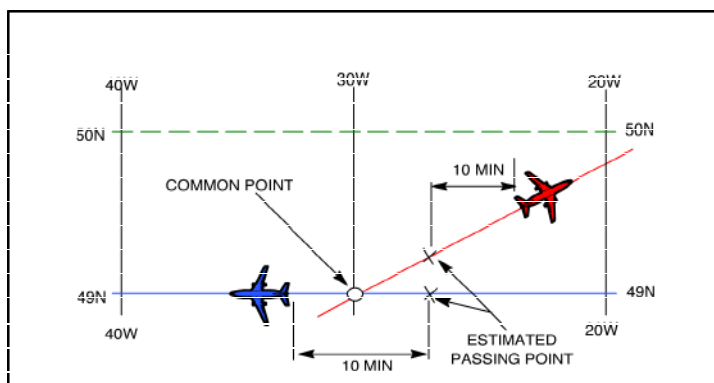
4.4.10 Maintain vertical separation between opposite direction turbojet aircraft for at least 10 minutes after they are estimated to have passed, provided the aircraft concerned have reported over a common point while operating in opposite directions.

Opposite Direction—Both Aircraft Have Reported Over A Common Point



Maintain vertical separation between turbojet aircraft until at least 10 minutes after the estimated passing point.

Opposite Direction—Both Aircraft Have Reported Over A Common Point (cont.)



Maintain vertical separation between turbojet aircraft until at least 10 minutes after the estimated passing point.

4.4.11 For other than turbojet aircraft that will follow opposite direction tracks which are not laterally separated, 20 minutes longitudinal separation is required within the WATRS area, otherwise 30 minutes longitudinal separation is required.

4.5 MACH NUMBER TECHNIQUE

4.5.1 The ATC approved Mach number shall be included in each oceanic clearance given to turbojet aircraft for operations within Gander, New York, Reykjavik, Santa Maria, Shanwick, and Bodo Oceanic Control Areas.

4.5.2 The Mach Number Technique as prescribed in the PANS-ATM (Doc 4444) may be used as a means of applying longitudinal separation between same track and diverging track aircraft in level flight, and between aircraft carrying out step climbs or descents and other aircraft. The latter is applicable provided that at least the minimum prescribed longitudinal separation between the climbing/descending aircraft and other affected en route aircraft exists at the time a step climb/descent clearance is issued and will continue to exist during climb/descent and at the recleared level.

Note: Application of the climb/descent procedure is based on the assumption that the last assigned Mach number will be maintained during step climbs or descents, and that in the event that is not feasible, ATC will be informed at the time of the climb/descent request or clearance.

Application of Mach Number Technique (succeeding aircraft faster)

4.5.3 Automated Conflict Prediction - Longitudinal separation at the oceanic entry point will be increased to a value as determined by automatic conflict prediction to ensure that at least 10 minutes will exist between the aircraft concerned at the oceanic exit point, where the tracks diverge, or to the mutually agreed limits.

4.5.4 No Automated Conflict Prediction - A “rule of thumb” requires an increase of separation between the aircraft concerned by one minute at the common point for each 0.01 difference in Mach numbers for each 600 NM segment of flight. When this rule of thumb is used to initially establish longitudinal separation over a common point, the expected minimum separation over subsequent points must be confirmed when calculated flight progress strip data and actual position reports become available. The following table may be used to calculate the additional separation required over a common point for use of Mach Number Technique when the succeeding aircraft is faster:

Difference in Mach	Distance to Fly/Additional Separation required at common point to ensure at least minimum separation at exit/divergence/limit point				
	001-600 NM	601-1200 NM	1200-1800 NM	1801-2400 NM	2401-3000 NM
.01	01	02	03	04	05
.02	02	04	06	08	10
.03	03	06	09	12	15
.04	04	08	12	16	20
.05	05	10	15	20	25
.06	06	12	18	24	30
.07	07	14	21	28	35
.08	08	16	24	32	40
.09	09	18	27	36	45
.10	10	20	30	40	50

Caution in the use of Mach Number Technique (succeeding aircraft faster)

4.5.5 Since for practical purposes, the value of Mach 0.01 remains constant at a given temperature, it is evident that the rate of closure between two aircraft operating at speeds differing by Mach 0.01 will be the same whether they operate at high or low Mach numbers. One minute of flight at a low speed, however, produces fewer miles of additional separation than does the same minute of flight at a higher speed. The potential for loss of separation is compounded by the fact that the slower aircraft will take longer to fly 600 miles and the closure will therefore act over a longer time.

4.5.6 Increased separation over the common point is required to compensate for the fact that the second aircraft is overtaking the first. Since the increase must take into account the relative speeds and the remaining track distance, it is necessary to verify that the required separation will, in fact, continue to exist.

Application of Mach Number Technique (preceding aircraft faster)

4.5.7 In some cases, it is possible to further reduce the longitudinal minimum applicable to Mach Number Technique. This reduction is applicable only when the required differential in Mach number exists and it is possible to determine through radar or other means that the time interval exists and will exist at the common point.

– END –