

Air Traffic Control and Air Traffic Management

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Workbook Instruction

Read Chapter 13 in deneufville & Odoni and answer the following questions

Introduction (section 3-1, pg 500)

- Describe the function of the six elements of ATM. Complete the table below.

Element of ATM	Function
1. Navigation Systems	Real-time information on the position and velocity of individual flights
2. Surveillance Systems	
3. Communication Systems	
4 Procedures and Regulations	
5. Automation Systems	
6. Human Air Traffic Controllers	

Generations of ATM (Section 13.2, pg 502)

- Describe the four generations of ATM using the 6 elements of ATM. Complete the following table.

	1 st Generation	2 nd Generation	3 rd Generation	4 th Generation
1. Navigation Systems	- n/a	n/a	3-D position	Precision Instruments
2. Surveillance Systems				Position reporting + Primary Surveillance + Secondary Surveillance
3. Communication Systems				

4 Procedures and Regulations				
5. Automation Systems				
6. Human Air Traffic Controllers				

3. Describe the difference between Primary and Secondary Surveillance

Description of ATM System and Processes in Terminal Airspace

4. Describe each of the following terms

Visual Meteorological Conditions (VMC)

Instrument Meteorological Conditions (IMC)

Visual Flight Rules (VFR)

Instrument Flight Rules (IFR)

See-and-Avoid by Pilots

Separation Assurance for Air Traffic Control

5. Describe the relationship between Weather Conditions (VMC, IMC), Flight Rules (VFR, IFR), and Agent responsible for Separation. Complete the following table.

Flight Rules	Weather Conditions	Responsibility for Separation
VFR	VMC	
IFR	VMC or IMC	

Airspace Structure

6. Describe the properties of the three types of airspace by completing the table below

Type of Airspace	Who has Responsibility for Separation	Name given to Class of Airspace	Describe the location of the airspace
Uncontrolled	Pilots see-and-avoid (VFR only)	Class G airspace	Below 1200 ft AGL Below 18,000 ft away from major airports
Controlled			
Positive Controlled			

7. Describe the following terms

a. Traffic Advisory

b. Conflict Resolution

Handling of a Typical Airline Flight

8. Describe the roles of each of the elements of Air Traffic Control for a typical airline flight from push-back to gate-in. Complete the following table.

Stage of flight	Airspace	Air Traffic Controller	Surveillance	Navigation	Automation	Communications
Push-back from Gate	n/a	Ramp Controller	Visual (out the Tower Window)	None	None	Push-t-talk radio
Taxi-out	n/a			Visual – taxiway lights and markings		
Takeoff	Class B					
Departure Climb-out	Class B					
Climb – Cruise-Initial Descent	Class A			Airways using Enroute VOR/DME, GPS		
Descent	Class B					
Final Approach	Class B					

Taxi-in	n/a					
Gate-in	n/a					

Airport Traffic Control Tower

9. Describe the Air Traffic Control positions in the Tower and their responsibilities by completing the table below

Air Traffic Control Tower Positions	Responsibilities
Clearance Delivery	Pilot requests pre-departure clearance for push-back from gate. This is first interaction between flight and ATC. Transfer control to Gate Hold position (if exists) or ground controller

10. Explain what “Flight Strips” are. What is their purpose? Who uses them? When are they used? [External Sources Required]

Terminal Airspace Control Center (TRACON)

11. What does the acronym TRACON represent

12. Draw a diagram of generic “ideal” terminal airspace. Assume two east-west runways for departures and two east-west runways for arrivals. Include arrival fixes, sequence areas, down-wind legs, base legs, and final approach legs. Also include departure fixes and departure flows. Draw to scale and show approximate distances. Layers sectors for the TRACON positions (e.g. final control position)



Surveillance

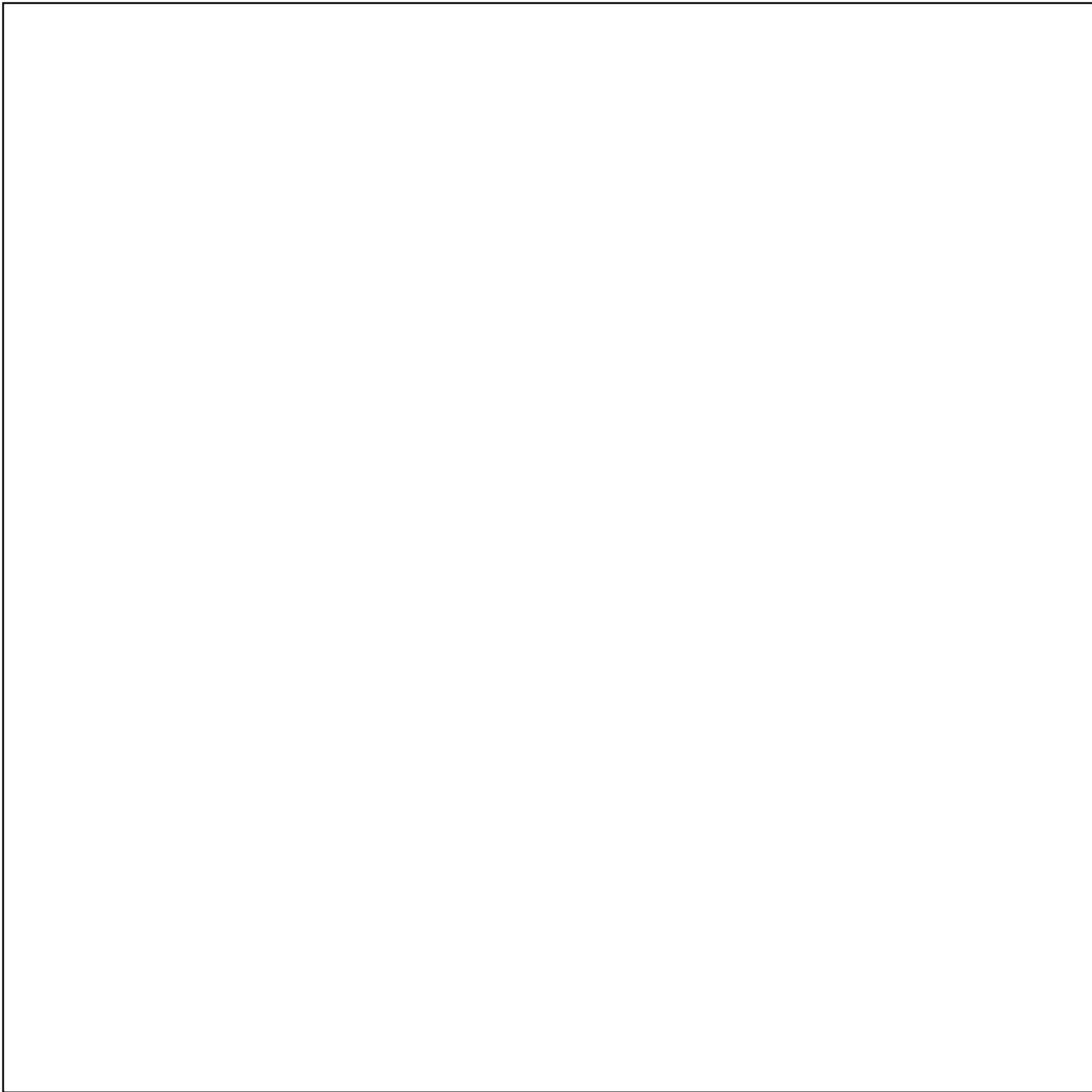
13. What "function" does "surveillance" provide to the Air Traffic Control System?

14. Describe the difference between Primary Surveillance Radar and Secondary Surveillance Radar?

Navigation for Precision Instrument Approaches

16. What is the motivation for Precision Approaches?

17. Draw a 3-D diagram of an Instrument Landing System relative to an arrival runway. Include the aircraft trajectory, navigation equipment (localizer, glideslope, inner marker, middle marker, and outer-marker, VOR/DME), fixes and altitudes at each fix, and distances.



18. What do the ILS system categories represent. What decision is made based on ILS category?

Enroute Control

The en route phase of flight has seen some of the most dramatic improvements in the way pilots navigate from departure to destination. Developments in technology have played a significant role in most of these improvements. Computerized avionics and advanced navigation systems are common place in both general and commercial aviation.

The procedures employed in the en route phase of flight are governed by a set of specific flight standards established by Title 14 of the Code of Federal Regulations (14 CFR), Federal Aviation Administration (FAA) Order 8260.3, *United States Standard for Terminal Instrument Procedures* (TERPS), and related publications. These standards establish courses to be flown, obstacle clearance criteria, minimum altitudes, navigation performance, and communications requirements. For the purposes of this discussion, the en route phase of flight is defined as that segment of flight from the termination point of a departure procedure to the origination point of an arrival procedure.

Part 91.181 is the basis for the course to be flown. To operate an aircraft within controlled airspace under instrument flight rules (IFR), pilots must fly the center of a Federal airway or the direct course between navigational aids or fixes defining a route. The regulation allows maneuvering to pass well clear of other air traffic or, if in visual flight rules (VFR) conditions, to clear the flight path both before and during climb or descent.

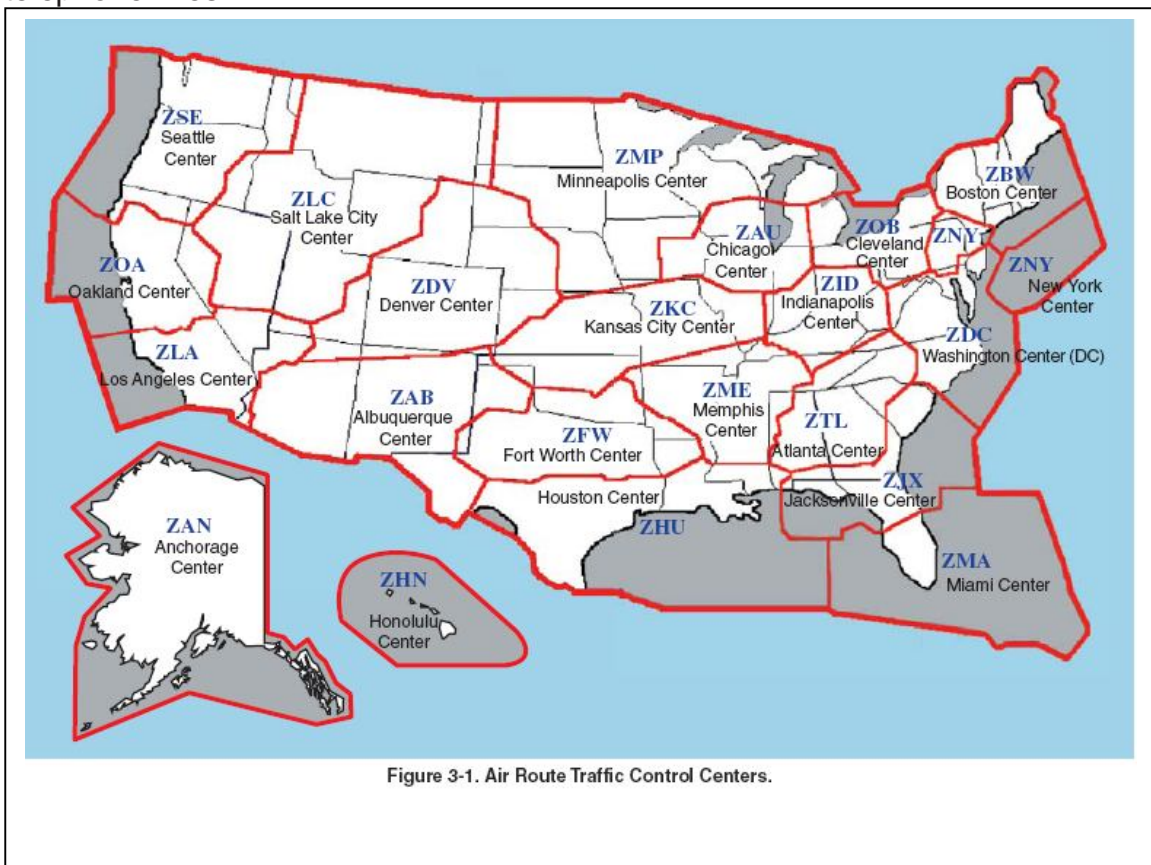
En route IFR navigation is evolving from the navigational aid (NAVAID)-based airway system to a sophisticated, computer-based system that can generate infinite courses to suit the operational requirements of any flight. Although the promise of the new navigation systems is limitless, the present system of navigation serves a valuable function and is expected to remain for a number of years.

The procedures pilots employ in the en route phase of flight take place in the structure of the National Airspace System (NAS) consisting of three strata. The first, or lower stratum, is an airway structure that extends from the base of controlled airspace up to but not including 18,000 feet mean sea level (MSL). The second stratum is an area containing identifiable jet routes as opposed to designated airways, and extends from 18,000 feet MSL to Flight Level (FL) 450. The third stratum, FL 450 and above is intended for random, point-to-point navigation.

Air route traffic control centers (artcc)

The **Air Route Traffic Control Center (ARTCC)** encompasses the en route air traffic control system air/ground radio communications, that provides safe and expeditious movement of aircraft operating on instrument flight rules (IFR) within the controlled airspace of the Center. ARTCCs provide the central authority for issuing IFR clearances and nationwide monitoring of each IFR flight. This applies primarily to the en route phase of flight, and includes weather information and other inflight services.

There are 20 ARTCCs in the conterminous United States (U.S.), and each Center contains between 20 to 80 sectors, with their size, shape, and altitudes determined by traffic flow, airway structure, and workload. Appropriate radar and communication sites are connected to the Centers by microwave links and telephone lines.



The CFRs require the pilot in command under IFR in controlled airspace to continuously monitor an appropriate Center or control frequency. When climbing

after takeoff, an IFR flight is either in contact with a radar equipped local departure control or, in some areas, an ARTCC facility. As a flight transitions to the en route phase, pilots typically expect a handoff from departure control to a Center frequency if not already in contact with the Center. The FAA National Aeronautical Charting Office (NACO) publishes en route charts depicting Centers and sector frequencies, as shown in figure 3-2.



Figure 3-2. ARTCC Centers and Sector Frequencies.

During handoff from one Center to another, the previous controller assigns a new frequency. In cases where flights may be still out of range, the Center frequencies on the face of the chart are very helpful. In figure 3-2, notice the boundary between Memphis and Atlanta Centers, and the remoted sites with discrete very high frequency (VHF) and ultra high frequency (UHF) for communicating with the appropriate ARTCC. These Center frequency boxes can be used for finding the nearest frequency within the aircraft range. They also can be used for making initial contact with the Center for airfiled “pop up” clearances. The exact location for the Center transmitter is not shown; although the frequency boxes are placed as close as possible to the known location.

During the en route phase, as a flight transitions from one Center facility to the next, a handoff or transfer of control is required as previously described. The handoff procedure is similar to the handoff between other radar facilities, such as departure or approach control.

During the handoff, the controller whose airspace is being vacated issues instructions that include the name of the facility to contact, appropriate frequency, and other pertinent remarks. While the Center is monitoring a flight by radar, it is possible that air traffic control (ATC) computers may go down, power fails, or radio communications fail, leaving a flight without ATC guidance. In other cases, there may be gaps in radar coverage along the route of flight. Accepting radar vectors from controllers does not relieve pilots of their responsibility for safety of flight. Pilots must maintain a safe altitude and keep track of their position, and it is their obligation to question controllers, request an amended clearance, or, in an emergency, deviate from their instructions if they believe that the safety of flight is in doubt.

Keeping track of altitude and position when climbing, and during all other phases of flight, are basic elements of situational awareness. Aircraft equipped with a ground proximity warning system (GPWS) and traffic alert and collision avoidance system (TCAS) help pilots detect and correct unsafe altitudes and traffic conflicts. Regardless of equipment, pilots must always maintain situational awareness regarding their location and the location of traffic in their vicinity.

19. How many ARTCC “Centers” are in the contiguous US?

20. What is the range (min and max) of sectors in an ARTCC “Center”?

21. What factors determine the number of sectors and shape of sectors in an ARTCC “Center”?

22. What is a “hand-off” and how does it work”?

Airway and route system

The present en route system is based on the VHF airway/ route navigation system. Low frequency (LF) and integrated LF/VHF airways and routes have gradually been phased out in the conterminous U.S., with some remaining in Alaska.

VHF airways/routes

Figure 3-6 depicts numerous arrowed, single direction jet routes on this excerpt from a NACO en route high altitude chart, effective at and above 18,000 feet MSL up to and including FL 450. Notice the MAAs of 41,000 and 29,000 associated with J24 and J193, respectively. Additionally, note the BAATT, NAGGI, FUMES, and MEYRA area navigation (RNAV) waypoints.

VHF en route obstacle clearance areas

All published routes in the NAS are based on specific obstacle clearance criteria. An understanding of **enroute obstacle clearance areas** helps with situational awareness and may help avoid controlled flight into terrain (CFIT). Obstacle clearance areas for the enroute phase of flight are identified as primary, secondary, and turning areas.

The primary and secondary area obstacle clearance criteria, airway and route widths, and the ATC separation procedures for en route segments are a function of safety and practicality in flight procedures. These flight procedures are dependent upon the pilot, the aircraft, and the navigation system being used, resulting in a total VOR system accuracy factor, along with an associated

probability factor. The pilot/aircraft information component of this criteria includes pilot ability to track the radial and the flight track resulting from turns at various speeds and altitudes under different wind conditions.

The navigation system information includes navigation facility radial alignment displacement, transmitter monitor tolerance, and receiver accuracy. All of these factors were considered during development of en route criteria. From this analysis, the computations resulted in a total system accuracy of $\pm 4.5^\circ$ 95 percent of the time and $\pm 6.7^\circ$ 99 percent of the time. The 4.5° figure became the basis for primary area obstacle clearance criteria, airway and route widths, and the ATC separation procedures. The 6.7° value provides secondary obstacle clearance area dimensions. Figure 3-7 depicts the primary and secondary obstacle clearance areas.

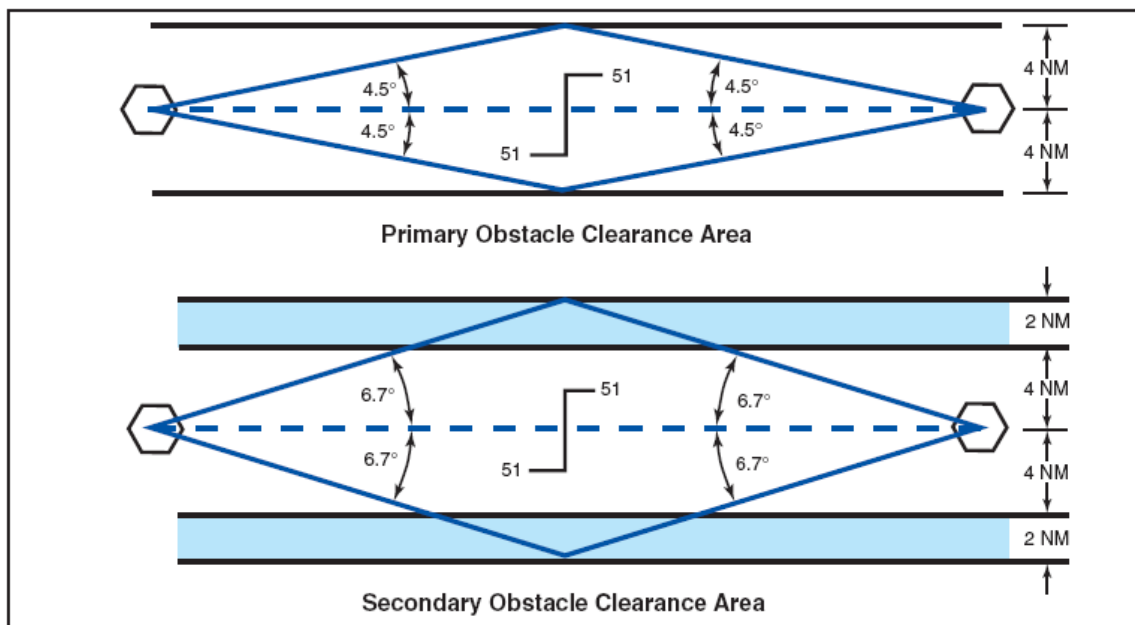


Figure 3-7. VHF En Route Obstacle Clearance Areas.

Primary area

The primary obstacle clearance area has a protected width of 8 nautical miles (NM); 4 NM on each side of the centerline. The primary area has widths of route protection based upon system accuracy of a $\pm 4.5^\circ$ angle from the NAVAID. These 4.5° lines extend out from the NAVAID and intersect the boundaries of the primary area at a point approximately 51 NM from the NAVAID. Ideally, the 51 NM point is where pilots would change over from navigating away from the facility, to navigating toward the next facility, although this ideal is rarely achieved.

If the distance from the NAVAID to the changeover point (COP) is more than 51 NM, the outer boundary of the primary area extends beyond the 4 NM width along the 4.5° line when the COP is at midpoint. This means the primary area, along with its obstacle clearance criteria, is extended out into what would have been the secondary area. Additional differences in the obstacle clearance area result in the case of the effect of an offset COP or dogleg segment. For protected en route areas the minimum obstacle clearance in the primary area, not designated as mountainous under Part 95 — IFR altitude is 1,000 feet over the highest obstacle.

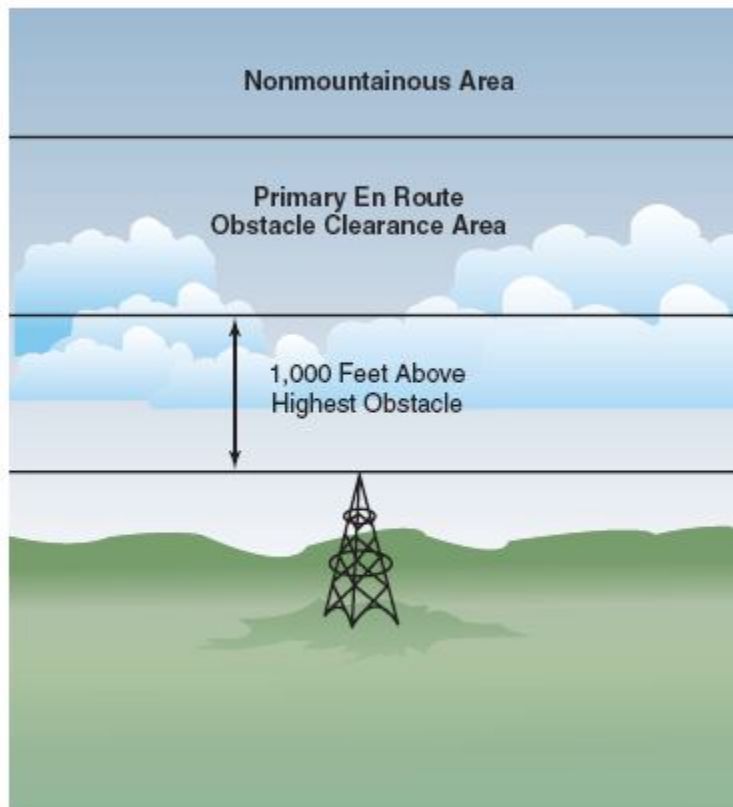


Figure 3-8. Obstacle Clearance - Primary Area.

NAVAID service volume

Each class of VHF NAVAID has an established operational service volume to ensure adequate signal coverage and frequency protection from other NAVAIDs on the same frequency. The maximum distances vary with altitude. When using VORs for direct route navigation, the maximum distances between NAVAIDs specified with the appropriate altitudes are as follows:

- 12,000 feet and below (T facilities) 50 NM
- • Below 18,000 feet 80 NM
- • 14,500 feet to 17,999 feet 200 NM
- • 18,000 feet to FL 450 260 NM
- • Above FL 450 200 NM

There may be a time when ATC clears pilots for a direct route that exceeds the stated distances. When that happens, ATC provides radar monitoring and navigational assistance as necessary

Changeover points

When flying airways, pilots normally change frequencies midway between navigation aids, although there are times when this is not practical. If the navigation signals cannot be received from the second VOR at the midpoint of the route, a **changeover point (COP)** is depicted and shows the distance in NM to each NAVAID, as depicted in figure 3-15. COPs indicate the point where a frequency change is necessary to receive course guidance from the facility ahead of the aircraft instead of the one behind. These changeover points divide an airway or route segment and ensure continuous reception of navigation signals at the prescribed minimum en route IFR altitude. They also ensure that other aircraft operating within the same portion of an airway or route segment receive consistent azimuth signals from the same navigation facilities regardless of the direction of flight.

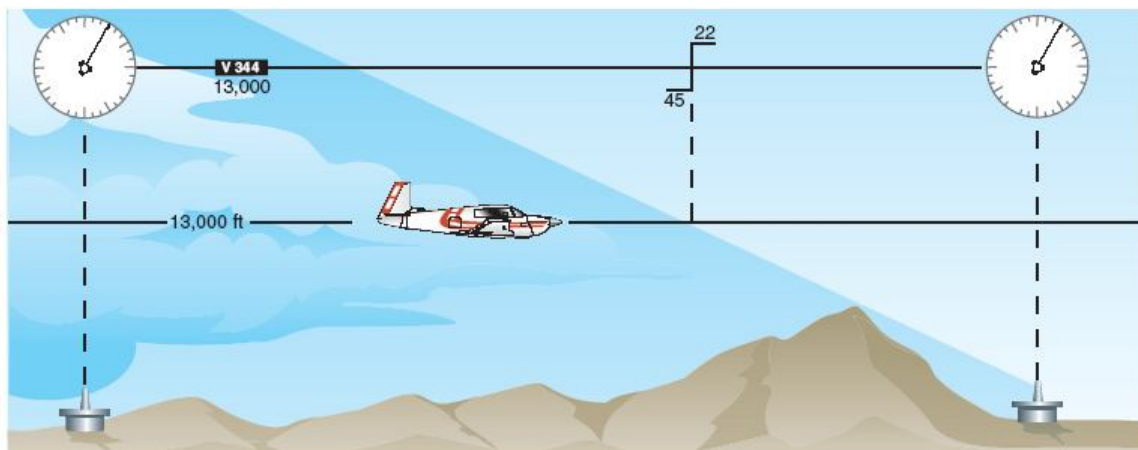


Figure 3-15. Changeover Points.

Minimum En Route Altitude

The **minimum enroute altitude (MEA)** is the lowest published altitude between radio fixes that assures acceptable navigational signal coverage and meets obstacle clearance requirements between those fixes. The MEA prescribed for a Federal airway or segment, RNAV low or high route, or other direct route applies to the entire width of the airway, segment, or route between the radio fixes defining the airway, segment, or route. MEAs for routes wholly contained within controlled airspace normally provide a buffer above the floor of controlled airspace consisting of at least 300 feet within transition areas and 500 feet within control areas. MEAs are established based upon obstacle clearance over terrain and manmade objects, adequacy of navigation facility performance, and communications requirements, although adequate communication at the MEA is not guaranteed.

Minimum Obstruction Clearance Altitude

The **minimum obstruction clearance altitude (MOCA)** is the lowest published altitude in effect between radio fixes on VOR airways, off-airway routes, or route segments that meets obstacle clearance requirements for the entire route segment. This altitude also assures acceptable navigational signal coverage only within 22 NM of a VOR. The MOCA seen on the NACO en route chart, may have been computed by adding the required obstacle clearance (ROC) to the controlling obstacle in the primary area or computed by using a TERPS chart if the controlling obstacle is located in the secondary area. This figure is then rounded to the nearest 100 - foot increment, i.e., 2,049 feet becomes 2,000, and 2,050 feet becomes 2,100 feet. An extra 1,000 feet is added in mountainous areas, in most cases.

The MOCA is based upon obstacle clearance over the terrain or over manmade objects, adequacy of navigation facility performance, and communications requirements.

ATC controllers have an important role in helping pilots remain clear of obstructions. Controllers are instructed to issue a safety alert if the aircraft is in a position that, in their judgement, places the pilot in unsafe proximity to terrain, obstructions, or other aircraft. Once pilots inform ATC of action being taken to resolve the situation, the controller may discontinue the issuance of further alerts. A typical terrain/obstruction alert may sound like this: *“Low altitude alert. Check your altitude immediately. The MOCA in your area is 12,000.”*

Published RNAV Routes

Although RNAV systems allow you to select any number of routes that may or may not be published on a chart, en route charts are still crucial and required for RNAV flight. They assist you with both flight planning and inflight navigation. NACO en route charts are very helpful in the context of your RNAV flights. Published RNAV routes are fixed, permanent routes that can be flight planned and flown by aircraft with RNAV capability. These are being expanded worldwide as new RNAV routes are developed, and existing charted, conventional routes are being designated for RNAV use. It is important to be alert to the rapidly changing

application of RNAV techniques being applied to conventional en route airways. Published RNAV routes may potentially be found on any NACO en route chart. The published RNAV route designation may be obvious, or, on the other hand, RNAV route designations may be less obvious, as in the case where a published route shares a common flight track with a conventional airway. Note: Since the use of RNAV is dynamic and rapidly changing, NACO en route charts are continuously being updated for information changes and you may find some differences between charts.

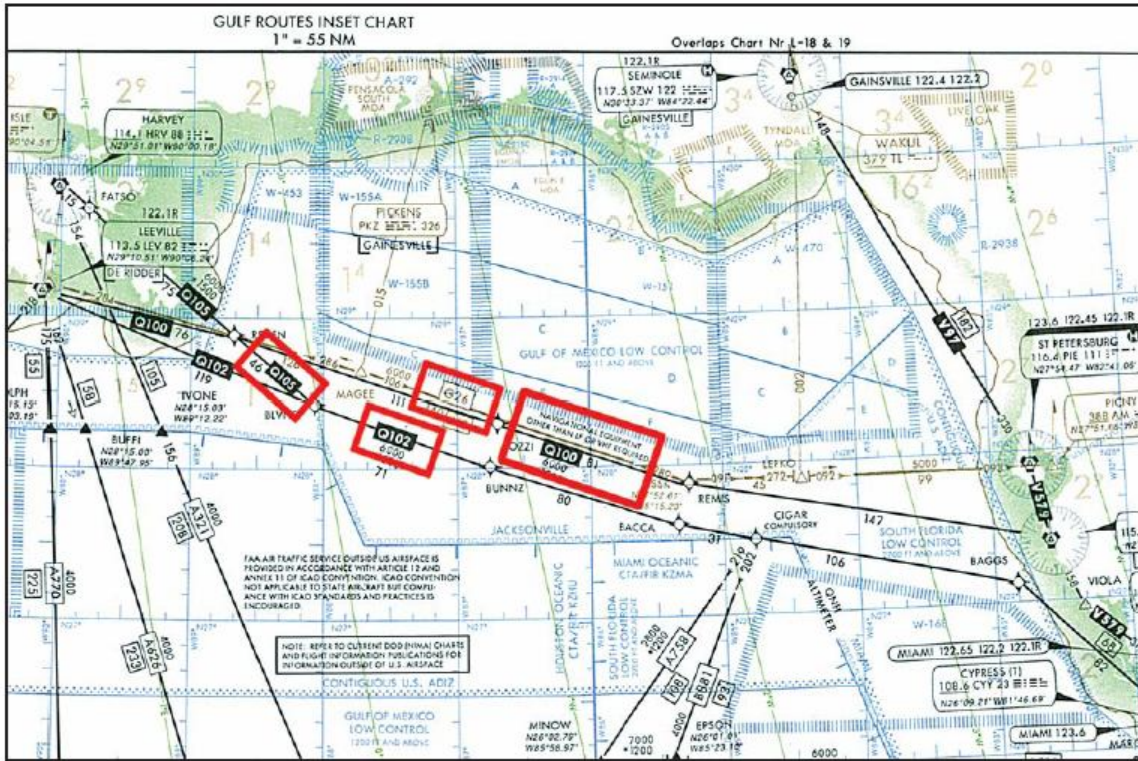


Figure 3-37. Published RNAV Routes Replacing LF Airways.

Waypoints

Waypoints are specified geographical locations, or fixes, used to define an RNAV route or the flight path of an aircraft employing RNAV. Waypoints may be any of the following types: predefined, published waypoints, floating waypoints, or user-defined waypoints. Predefined, published waypoints are defined relative to VOR-DME or VORTAC stations or, as with GPS, in terms of latitude/longitude coordinates.

- Describe the capabilities for enroute navigation aids by completing the table below [External Resources Required]

Navigation Aid	Type of Navigation (Visual or Electronic)	Availability (VMC or IMC)	Data Provided to Airplane

Landmark	Visual		
Bonfires			
Non-directional Beacon (NDB)	Electronic		Location of beacon
Very High Frequency Omni-bearing Radio (VOR)			Course to the VOR
Distance Measuring Equipment (DME)			
Ground Positioning Satellite (GPS)			

24. Use the attached *IFR Enroute Low Altitude Chart for region around Chicago O'Hare Airport (and it's Legend)* to answer the following questions

VOR/DME is located at Chicago O' Hare.

a) What is the ICAO Identifier for the VOR/DME _____

b) What Frequency and Channel does the pilot tune to use the VOR/DME

_____MHz__, Channel _____

The 314 degree radial outbound from the Chicago O'Hare VOR along with a 29nm range from the Chicago O'Hare DME defines an intersection. What is the name of the intersection?

The 235 degree radial outbound from the Chicago O'Hare VOR along with a 25 nm range from the Chicago O'Hare DME defines an intersection. What is the name of the intersection?

The LAIRD intersection is east of the Chicago O'Hare VOR/DME on the 89 degree radial outbound of the VOR and 14 nm range from the DME.

The LAIRD intersection is located on which airway running east-west?

The LAIRD intersection is located on which airway running north-south

Starting at the LAIRD intersection and heading roughly due north, the 5th intersection is PETTY?

a) What airway runs between LAIRD and PETTY

b) What are the sequence of intersections between LAIRD and PETTY

LAIRD - _____ - _____ - _____ - _____ - PETTY

c) What is the total distance distance between LAIRD and PETTY? (Show work)

Northbrook VOR/DME (OBK) is located just north of the Chicago O'Hare VOR/DME. MADISON VORTAC (MSN) is located in the upper left of the chart.

a) List the sequence of intersections and nav aids flying the V191 and the V2 airways from OBK to MSN.

OBK - _____ - _____ - _____ - _____ - _____ -

MSN

b) What is the distance between the intersections/navaids

From: OBK _____ - To: _____ Distance = _____ nm

From: _____ - To: _____ Distance = _____ nm

From: _____ - To: _____ Distance = _____ nm

From: _____ - To: _____ Distance = _____ nm

From: _____ - To: _____ Distance = _____ nm

From: _____ - To: MSN _____ Distance = _____ nm

c) What is the total distance between OBK and MSC flying V191 and V2?

_____ nm

d) V191 lists 2900 feet and V2 lists 2800 feet as the Minimum Enroute Altitude (MEA).

How should pilots use the MEA? _____

What is likely to happen if the pilot flies the aircraft well below the MEA ?

Required Navigation Performance

As RNAV systems grow in sophistication, high technology FMS and GPS avionics are being phased in as NDBs, VORs, and LORAN are being phased out. As a result, new procedures are being introduced, including RNP, RVSM, and

minimum navigation performance specifications (MNPS). In addition to route designators, RNAV routes may also be appended with RNP values. ICAO defines **required navigation performance** as a statement of required navigation accuracy in the horizontal plane (lateral and longitudinal position fixing) necessary for operation in a defined airspace.

Even such terms as **gross navigation errors (GNEs)** are being introduced into the navigation equation. If you commit a gross navigation error in the North Atlantic oceanic region of more than 25 NM laterally or 300 feet vertically, it has a detrimental effect on the overall targeted level of safety of the ATC airspace system in this region. This applies to commercial operators, as well as Part 91 operators, all of whom must be knowledgeable on procedures for operations in North Atlantic airspace, contained in the *North Atlantic MNPS Operations Manual*.

RNP types are identified by a single accuracy value. For example, RNP 1 refers to a required navigation performance accuracy within 1 NM of the desired flight path at least 95 percent of the time flying. Required navigation performance values are being established by countries around the world. For example, Japan was the first to declare all their airways with RNP 4. Europe is beginning with RNP 5, otherwise referred to as B-RNAV.

Since all the airways in the U.S. are 4 NM wide on either side of the airway centerline, the U.S. airways have an equivalent RNP of 2. Establishing RNP values is an evolving process that guarantees to impact navigation procedures now and for years to come. RNP parameters are slowly becoming more stringent. For example, Europe's goal is to reach RNP 1 by the year 2005. Figure 3-43 shows ICAO RNP containment parameters, including reference to lateral and longitudinal total system errors (TSEs).

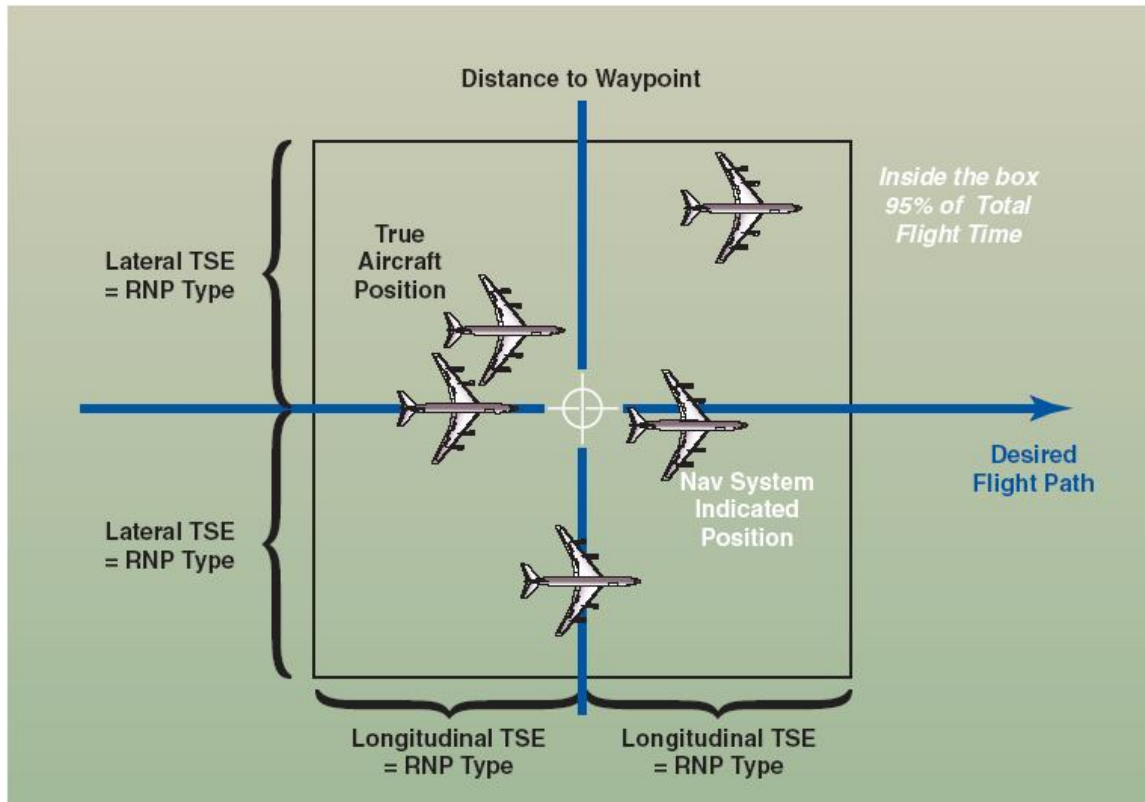


Figure 3-43. ICAO RNP Containment Parameters.

The U.S. standard RNP values or levels are for routes supporting RNAV operations based on GPS or earth-referenced navigation systems such as the inertial navigation system (INS) and the inertial reference system (IRS). RNP levels will be depicted on affected aeronautical charts and procedures, and these references may include a notation referring to eligible aircraft by specific navigation sensors.

RNP requires you to learn new procedures, communications, limitations, and to learn new terminology that defines and describes navigation concepts. Some of these terms include, RNP Airspace, a generic term designating airspace, routes, legs, operations, or procedures where minimum RNP has been established. P-RNAV represents a 95 percent containment value of ± 1 NM. B-RNAV provides a 95 percent containment value of ± 5 NM. RNP is a function of RNAV equipment that calculates, displays, and provides lateral guidance to a profile or path.

Estimated position error (EPE) is a measure of your current estimated navigational performance, also referred to as actual navigation performance (ANP). RNP RNAV is an industry-expanded specification beyond ICAO-defined RNP. Some of the benefits of RNP RNAV includes being an aid in both separation and collision risk assessment. RNP RNAV can further reduce route

separation. Figure 3-44 depicts route separation, that can now be reduced to four times the RNP value which further increases route capacity within the same airspace. The containment limit quantifies the navigation performance where the probability of an unannounced deviation greater than $2 \times \text{RNP}$ is less than 1×10^{-5} . This means that the pilot will be alerted when the total system error can be greater than the containment limit. Figure 3-45 shows the U.S. RNP RNAV levels by airspace control regions, including RNP 2 for the en route phase of flight, and figure 3-46 illustrates the U.S. standard RNP (95%) levels.

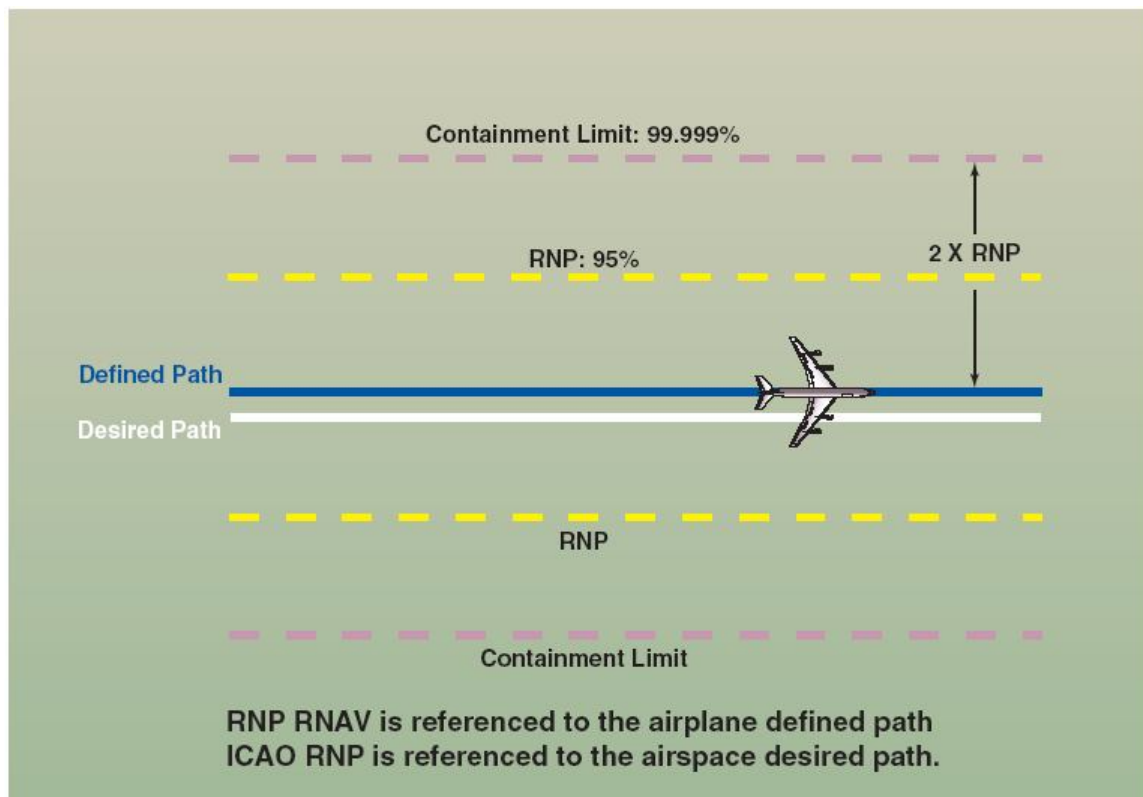


Figure 3-44. RNP RNAV Containment.

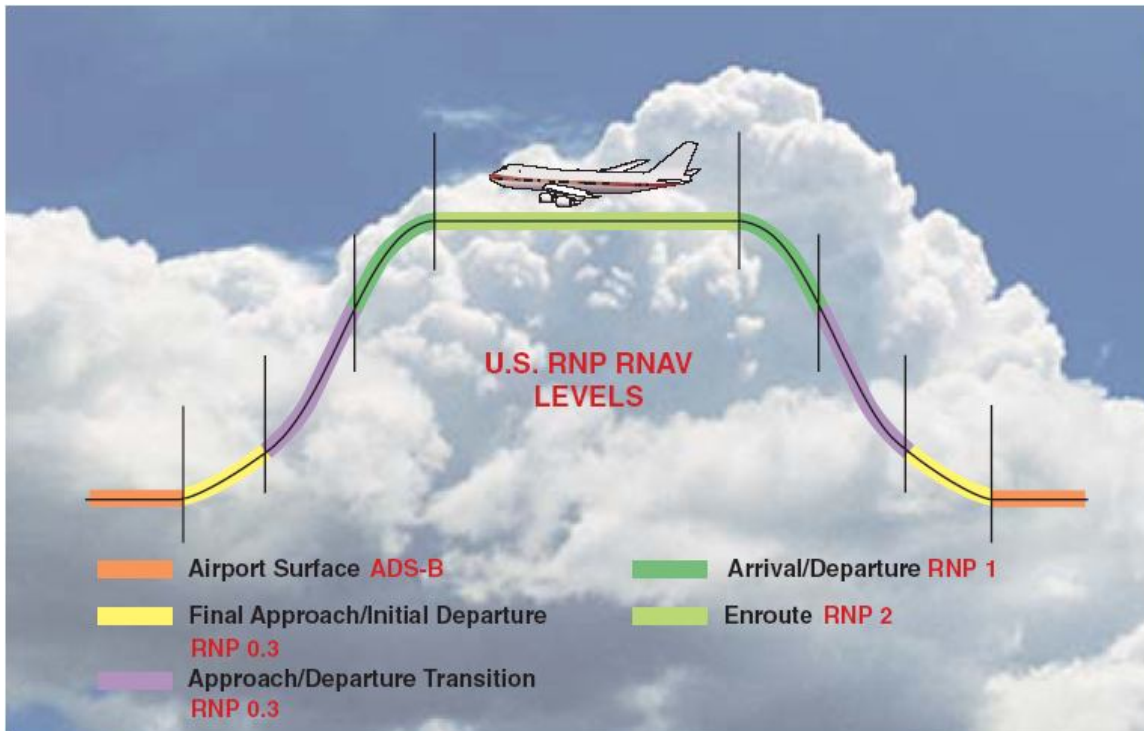


Figure 3-45. Airspace Control Regions.

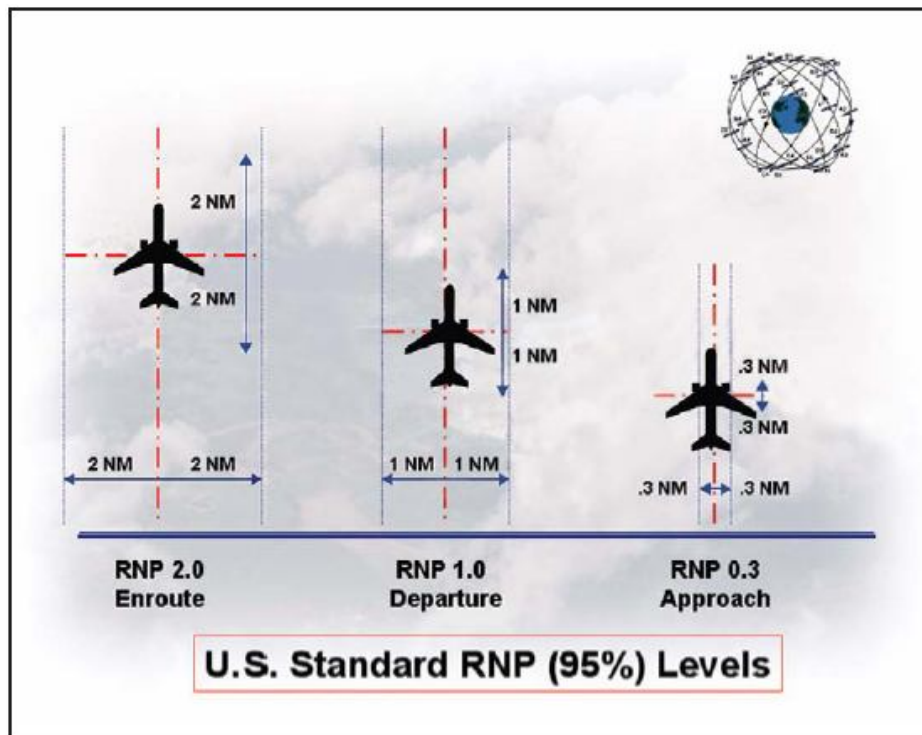


Figure 3-46. U.S. Standard RNP Levels.

Reduced Vertical Separation Minimums

RVSM airspace is any airspace between FL 290 and FL 410 inclusive, where airplanes are separated by 1,000 feet vertically. In the early 1980's programs were established to study the concept of **reduced vertical separation minimums (RVSM)**. RVSM was found to be technically feasible without imposing unreasonable requirements on equipment. Reasons for implementing RVSM primarily center around significant air traffic increases worldwide.

RVSM is the most effective way to increase airspace capacity to cope with traffic growth. Reduced vertical separation minimums airspace is quickly becoming a standard around the world. By the year 2005 most of the preferred international and domestic flight routes will be under both RVSM and RNP RNAV rules.

The history and background of RVSM includes the year 1960, when vertical separation between airplanes was officially increased to 2,000 feet above FL 290. The reason at that time was due to unreliability of accurate pressure sensing barometric altimeters at high altitudes. In 1966, the FL 290 change-over altitude was adopted globally by ICAO. [Figure 3-47]

By 1997, however, the nature of traffic flow allowed implementation of the first RVSM 1000 feet separation between FL 330 and FL 370 over the North Atlantic. In 1998, RVSM was further implemented from FL 310 to FL 390. Today RVSM from FL 290 to FL 410 is being implemented by States (governments) around the globe. There are many requirements for operator approval of RVSM. Each aircraft must be in compliance with specific RVSM criteria. A program must be in place to assure continued airworthiness of all RVSM critical systems. Flight crews, dispatchers, and flight operations must be properly trained, and operational procedures, checklists, etc. must be established and published in the Ops Manual and AFM, plus operators must participate in a height monitoring program.

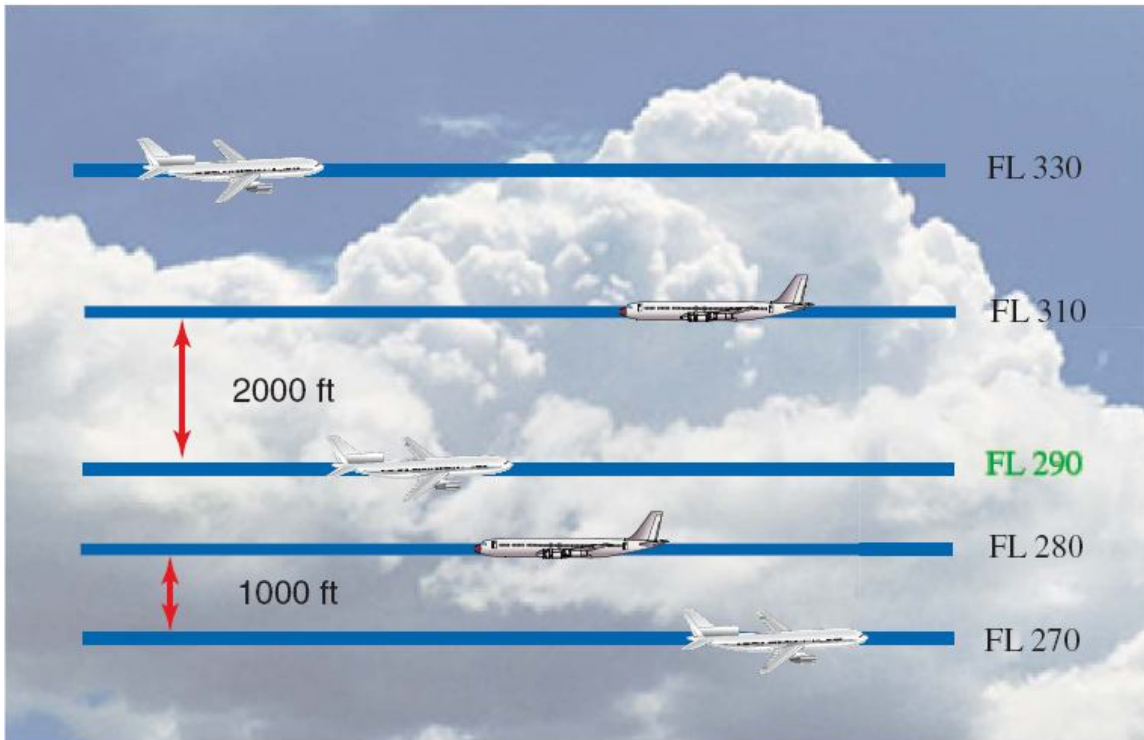


Figure 3-47. History of RVSM.

25. RVSM
a. What is the value of RVSM? What problem does it solve

- b. What changes are required on the aircraft to fly in an RVSM environment.

