



# Overview of Oceanic and Continental Remote Navigation Specifications

**RNAV 10 (RNP 10)  
and RNP 4**





# Overview

- Learning Objectives: At the end of this presentation, you should:
  - Understand how RNP 10 and RNP 4 operations are incorporated into the PBN Manual
  - Be familiar with general issues associated with implementing RNP 10 and RNP 4
  - Understand the related communication and surveillance capabilities required for 50 NM and 30 NM lateral and longitudinal separation
- Summary



# ICAO PBN Guidance Material General Considerations

- Navigation Specifications provide technical and operational criteria
  - Does not imply a need for recertification of existing implementations
- A PBN Manual Vol II Navigation Specification does not in itself constitute regulatory guidance material
- States issue regulations applicable to operators/aircraft for which they are responsible



# Prior Guidance Material

- ICAO guidance material on RNP 10 was published in ICAO Doc 9613 Appendix E (1999)
- ICAO Guidance Material on RNP 4 was published in State Letter AN 13/33.7 04/86 (September 2004)
- This material has been updated and included in Vol II of the PBN Manual
  - Updates should not affect aircraft or operator compliance



# RNAV 10 and RNP 10: Naming Convention Exception (1)

- RNP requires aircraft on-board performance monitoring and alerting
  - RNAV does not require such monitoring
- RNP 10 is addressed in RNAV section of PBN Manual because operation does not require on-board performance monitoring and alerting
- The designation “RNP 10” has been retained for operational and airworthiness approvals, charting, etc
  - Stakeholder feedback on costs of changing Airplane Flight Manuals, existing approval documentation, charting, automation



# RNAV 10 and RNP 10: Naming Convention Exception (2)

## CHAPTER 1

### IMPLEMENTING RNAV 10 (DESIGNATED AND AUTHORISED AS RNP 10)

#### 1.1. INTRODUCTION

##### 1.1.1. Background

This chapter addresses the implementation of RNP 10 to support 50 NM lateral and the 50 NM longitudinal distance-based separation minima in oceanic or remote area airspace. This guidance has been titled RNAV 10 for consistency with the PBN Manual. This designation and version of the material do not change any requirements, and do not affect operators who obtained an RNP 10 authorization from their relevant State regulatory authority. Recognizing the extent of existing airspace designations and operational approvals using the designation RNP 10, it is anticipated that any new airspace designations or aircraft approvals will continue to use the designation RNP 10. RNAV 10 does not require on-board performance monitoring and alerting. However, the designation of the airworthiness and operational approval as well as airspace/route designation remains "RNP 10" in order to grandfather the present publications and extensive approvals. Recognizing the extent of existing airspace designations and operational approvals under RNP 10 designation, it is anticipated that any new airspace designations and aircraft approvals will continue to use the "RNP 10" term while the required PBN application will be now known as "RNAV 10."

**RNP 10 is a recognized inconsistency in RNAV and RNP naming**





# RNP 4 Naming Convention

- RNP requires aircraft on-board performance monitoring and alerting
  - RNAV does not require such monitoring
- RNP 4 guidance did not require on-board performance monitoring and alerting
  - Classify as RNAV 4?
- Technical evaluation of means of compliance concluded all aircraft qualifying under AN 13/33.7 had on-board performance monitoring and alerting capability
  - Adding a requirement for monitoring and alerting resolves naming inconsistency
  - **New requirement does not affect qualified aircraft or qualifying methods**
- Retain designation of RNP 4





# Application of Navigation Specification by Flight Phase

## PBN Manual Vol II, Part A

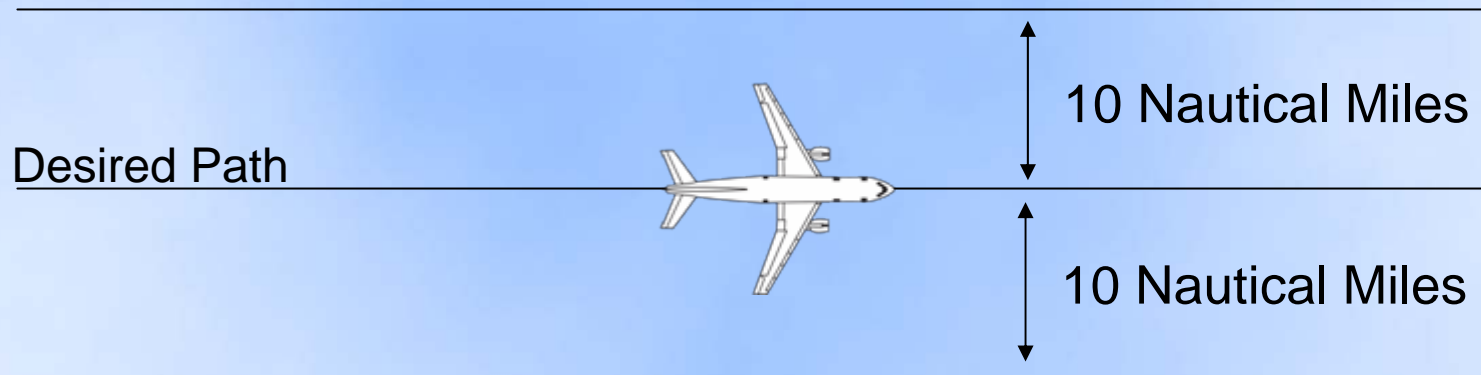
Table 1-1: Application of Navigation Specification by Flight Phase

NAVIGATION SPECIFICATION	FLIGHT PHASE							
	En Route OCEANIC /REMOTE	En Route Continental	ARR	APPROACH				DEP
				Initial	Interm.	Final	MISSED	
RNAV 10	10							
RNAV 5		5	5					
RNAV 2		2	2					2
RNAV 1		1	1	1	1		1 <sup>b</sup>	1
RNP 4	4							
Basic-RNP 1			1 <sup>a,c</sup>	1 <sup>a</sup>	1 <sup>a</sup>		1 <sup>ab</sup>	1 <sup>a,c</sup>
RNP APCH				1	1	0.3	1	
RNP AR APCH				1-0.1	1-0.1	0.3 – 0.1	1-0.1	





# RNP 10





# RNP 10 Oceanic Applications

- Pacific Ocean Flight Information Regions (FIRs) including
  - North Pacific and Central East Pacific Route Systems and Pacific Organized Track System
- European – South America (EUR-SAM) routes
- Peru – Chile routes
- Routes connecting Australia, Asia, Mid-East and Europe



# Communications and Surveillance Requirements Associated With RNP 10

- 50 NM Lateral Track Spacing (Annex 11, Attachment B)
  - COMMUNICATIONS: Voice communications through third party
  - SURVEILLANCE: Procedural pilot position reports
- 50 NM Longitudinal Separation Using Automatic Dependent Surveillance (ADS) (Doc 4444, Ch 5)
  - COMMUNICATIONS: Direct controller-pilot communications (data link or voice)
  - SURVEILLANCE: Maximum ADS periodic report interval 27 minutes
- 50 NM Longitudinal Separation Not Using ADS: (Doc 4444, Ch 5)
  - COMMUNICATIONS: Direct controller-pilot communications (data link or voice)
  - SURVEILLANCE: Distance verification every 24 minutes



# State Regulatory Guidance Material

- FAA Order 8400.12A

## REQUIRED NAVIGATION PERFORMANCE 10 (RNP-10) OPERATIONAL APPROVAL

- EASA AMC 20-12

## RECOGNITION OF FAA ORDER 8400.12A FOR RNP-10 OPERATIONS

- Civil Aviation Safety Authority of Australia (CASA) Advisory Circular (AC) 91U-2(0)

## REQUIRED NAVIGATION PERFORMANCE 10 (RNP 10) OPERATIONAL AUTHORISATION

ORDER

U.S. DEPARTMENT OF TRANSPORTATION  
FEDERAL AVIATION ADMINISTRATION

8400.12A

2/9/98

Caution: This document has been downloaded from [www.faa.gov/ats/ato/rnp.htm](http://www.faa.gov/ats/ato/rnp.htm) consequently users must be alert to possible conversion and formatting errors particularly in tables, diagrams and mathematical formulae.


SUBJ: REQUIRED NAVIGATION PERFORMANCE 10 (RNP-10) OPERATIONAL APPROVAL

ED Decision 2006/12/R  
22/12/2006  
Annex I  
AMC 20-12

AMC 20-12 Recognition Of FAA Order 8400.12a For RNP-10 Operations.

1. PURPOSE

This AMC calls attention to the FAA Order 8400.12A "Required Navigation Performance 10 (RNP-10) Operational Approval", issued 9<sup>th</sup> February 1998. FAA Order 8400.12A addresses RNP-10 requirements, the operational approval process, application principles, continuing airworthiness and operational requirements. This AMC explains how the technical content and the operational principles of the Order may be applied as a means, but not the only means, to obtain EASA approval for RNP-10 operations.



Australian Government  
Civil Aviation Safety Authority

## Advisory Circular

AC 91U-2(0)

NOVEMBER 2005

REQUIRED NAVIGATION PERFORMANCE 10  
(RNP 10) OPERATIONAL AUTHORISATION





# Key Elements of Operational Approval: RNP 10

## Operational Approval

**Route Design  
Criteria**



**Operational  
Procedures and  
Standards**

**Equipment/System  
Standards**



# Route Design Criteria: RNP 10

- Applicable guidance in
  - ICAO Doc 8168, Vol II, *PANS OPS*:
    - Parts 1 and Part 3 General Criteria
    - Part 3, Section 1, Chapter 7
      - Provisions for 10 NM
    - Part 3, Section 3, Chapter 8
- ICAO Annex 11 Attachment B
  - Route spacing for RNP 10 is minimum of 50 NM lateral



# Key Elements of Operational Approvals: RNP 10

## Operational Approval

**Route Design  
Criteria**



**Operational  
Procedures and  
Standards**

**Equipment/System  
Standards**



# Equipment/Systems: NAVAID Infrastructure

- RNP 10 is specifically prescribed for oceanic and continental remote applications
  - No ground NAVAID infrastructure is required
- Navigation is provided by inertial navigation or GNSS
- Status monitoring
  - Enroute NAVAID structure that supports aircraft position updating prior to entry into RNP 10 operations should be monitored
  - Notify users of outages (NOTAM)





# Equipment/Systems: Aircraft Requirements

- Aircraft must be equipped with at least two (2) independent and serviceable Long-Range Navigation Systems (LRNSs) comprised of some combination of
  - Inertial navigation system (INS)
  - Inertial Referencing System (IRS)/Flight Management System (FMS)
  - Global Navigation Satellite System (GNSS)
    - Integrity and reliability through Fault Detection and Exclusion (FDE)



# Criteria for Navigation Services RNP 10

	RNP 10
<b>Dual GNSS</b>	Meets RNP 10 requirements without time limitations. GNSS constellation must support operation.
<b>Dual INS or IRU (Standard Time Limit)</b>	Meets RNP 10 requirements for up to 6.2 hours if approved under 14 CFR Part 121, Appendix G or for NAT MNPS or RNAV operations in Australia
<b>Dual INS or IRU (Extended Time Limit)</b>	Additional certification action is required to extend time limit beyond standard
<b>Single INS/IRU and Single GNSS</b>	Meets RNP 10 requirements without time limitations



# System Performance (1)

- Accuracy
  - Lateral total system error: within  $\pm 10$  NM for at least 95% of total flight time
  - Along-track error: within  $\pm 10$  NM for at least 95% of total flight time
- Integrity
  - Malfunction of the aircraft navigation equipment classified as a Major Failure Condition under airworthiness regulations (i.e.,  $10^{-5}$  per hour)



# System Performance (2)

- Continuity
  - Loss of function classified as a Major Failure Condition
  - Continuity requirement is satisfied by the carriage of dual independent LRNSs (excluding signal in space)
- Signal-in-Space (if using GNSS)
  - Aircraft navigation equipment shall provide an alert if the probability of signal-in-space errors causing a lateral position error greater than 20 NM exceeds  $10^{-7}$  per hour (ICAO Annex 10, Table 3.7.2.4-1)



# Key Elements of Operational Approvals: RNP 10

## Operational Approval

**Route Design  
Criteria**



**Operational  
Procedures and  
Standards**

**Equipment/System  
Standards**



# Operating Procedures (Pre-Flight)

- Review maintenance logs and forms to determine the status of equipment required for RNP 10 operations
- Check the condition of the navigation antennas and surrounding aircraft skin
- Review applicable contingency procedures
  - Doc 4444 oceanic contingency procedures
  - Any additional Regional contingency procedures
  - Added: crews must be able to recognize, and advise ATC, when the aircraft is no longer able to navigate to its RNP 10 approval capability



# Flight Plan Example

“R” placed in block 10 of the ICAO Flight Plan indicates that the pilot has reviewed the planned route of flight and is authorized the applicable RNP Nav Spec

Form Approved: OMB NO. 7502-0001

U.S. Department of Transportation  
Federal Aviation Administration

### International Flight Plan

PRIORITY: FF      ADDRESSEE(S):

FILING TIME:      ORIGINATOR:

SPECIFIC IDENTIFICATION OF ADDRESSEE(S) AND / OR ORIGINATOR:

3 MESSAGE: (FPL)      7 AIRCRAFT IDENTIFICATION:      8 FLIGHT RULES:      TYPE OF FLIGHT:

9 NUMBER:      TYPE OF:      WAKE TURBULENCE CAT.:      10 EQUIPMENT: R

13 DEPARTURE AERODROME:      TIME:      15 CRUISING SPEED:      LEVEL:      ROUTE:

16 DESTINATION:      TOTAL FEET:      PERSONS ON BOARD: P /

SURVIVAL EQUIPMENT: POLAR DESER MARITIM JUNGLE → J / L F U V

DINGHIES: NUMBER CAPACITY COVER COLOUR → D / C

AIRCRAFT COLOR AND MARKINGS: A /

REMARKS: → N /

PILOT-IN-COMMAND: C /

FILED BY:      ACCEPTED BY:      ADDITIONAL INFORMATION:

FAA Form 7233-4 (7-83)





# Operating Procedures

## RNP 10

- Availability of NAVAIDs
  - The operator must ensure that adequate navigation aids are available en route to permit aircraft position updating prior to entry into RNP 10 operations
    - System updating prior to entering RNP 10 operations
    - GNSS systems: operators should ensure adequate en route coverage and FDE availability





# Operator Calculation of RNP 10 Time Limit for Specific Flights

- Dual INS/IRU standard time limit: 6.2 flight hours
  - Provisions to approve extended time limits in Navigation Specification
- Operator must establish that aircraft will comply with the time limit on the planned route
  - Route Start and Stop Point calculations
  - Head wind component data from acceptable sources
    - “One time” calculation
    - “Flight plan” winds aloft
  - Automatic or Manual Radio Position Updating



# Pilot Knowledge and Training

- Operators must ensure flight crews know:
  - Guidance material
  - Limits of navigation system capabilities
  - Effects of updating
  - Applicable contingency procedures

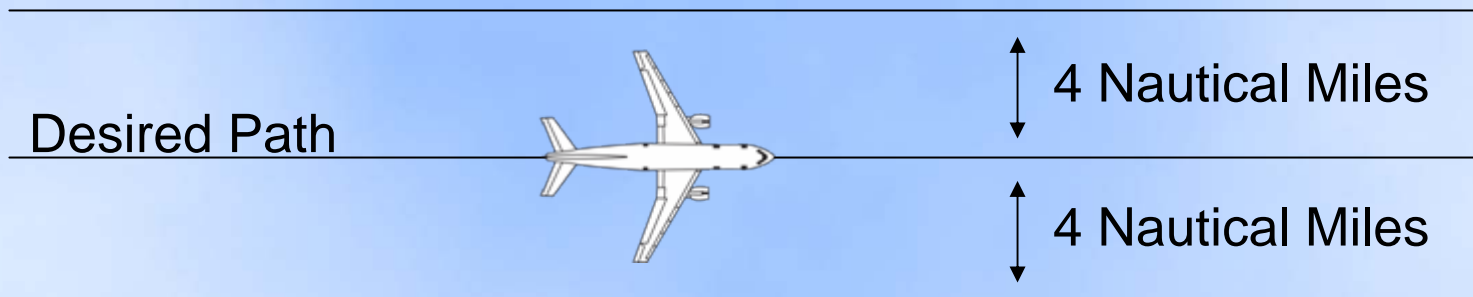


# Additional Considerations

- State AIP should clearly indicate RNP 10 application
- All routes based on WGS-84 coordinates
- Recommended Controller Training
  - Core Training (RNAV System basic information)
  - Flight Plan requirements
  - ATC Procedures including
    - Separation
    - Contingencies
    - Transition between Oceanic/Remote and En Route
- Reporting of Gross Navigational Errors



# RNP 4





# RNP 4 Application

- 30 NM lateral and longitudinal separation is applied in Pacific oceanic FIRs between aircraft meeting prescribed CNS requirements
- RNP 4 is the prescribed navigation specification for 30/30
- RNP 4 authorization is not a requirement for Pacific oceanic operations; it is an operator option



# Communications and Surveillance Requirements Associated With RNP 4

- 30 NM Lateral Track Spacing (Annex 11, Attachment B)
  - COMMUNICATIONS: Direct Controller-Pilot Communications (Voice or controller-pilot data link)
  - SURVEILLANCE: ADS providing 5 NM lateral deviation alert
- 30 NM Longitudinal Separation Using ADS (Doc 4444, Ch 5)
  - COMMUNICATIONS: Direct controller-pilot communications (data link or voice)
  - SURVEILLANCE: Maximum ADS periodic report interval 14 minutes



# State Regulatory Guidance Material

- Civil Aviation Safety Authority of New Zealand Advisory Circular 91-10


**REQUIRED NAVIGATION PERFORMANCE 4 (RNP 4) OPERATIONAL APPROVAL**

- Civil Aviation Safety Authority of Australia Advisory Circular 91U-3(0)

**REQUIRED NAVIGATION PERFORMANCE 4 (RNP 4) OPERATIONAL AUTHORISATION**

- FAA Order 8400.33


**PROCEDURES FOR OBTAINING AUTHORIZATION FOR REQUIRED NAVIGATION PERFORMANCE 4 (RNP 4) OCEANIC AND REMOTE AREA OPERATIONS**



**Advisory Circular**  
**AC 91-10**

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Required Navigational Performance 4 (RNP 4) Operational Approval 19 January 2005



**Advisory Circular**

AC 91U-3(0) NOVEMBER 2005

REQUIRED NAVIGATION PERFORMANCE 4 (RNP 4) OPERATIONAL AUTHORISATION

**ORDER** U.S. DEPARTMENT OF TRANSPORTATION  
FEDERAL AVIATION ADMINISTRATION 8400.33

9/15/05

SUBJECT: PROCEDURES FOR OBTAINING AUTHORIZATION FOR REQUIRED NAVIGATION PERFORMANCE 4 (RNP-4) OCEANIC AND REMOTE AREA OPERATIONS





# Key Elements of Operational Approval: RNP 4

## Operational Approval

**Route Design  
Criteria**



**Operational  
Procedures and  
Standards**

**Equipment/System  
Standards**





# Route Design Criteria: RNP 4

- Applicable guidance in
  - ICAO Doc 8168, Vol II, *PANS OPS*:
    - Parts 1 and Part 3 General Criteria
    - Part 3, Section 1, Chapter 7
      - Provisions for 4 NM
    - Part 3, Section 3, Chapter 8
  - ICAO Annex 11 Attachment B
    - RNP 4 prescribed for 30 NM track or route spacing
    - May support application of separation standards/route spacing less than 30 NM in continental airspace provided a State has undertaken the necessary safety assessment



# Key Elements of Operational Approvals: RNP 4

## Operational Approval

**Route Design  
Criteria**



**Operational  
Procedures and  
Standards**

**Equipment/System  
Standards**



# Equipment/Systems: NAVAID Infrastructure

- RNP 4 is prescribed for oceanic and continental remote airspace operations
  - No ground NAVAID infrastructure is required
- GNSS is the required sensor
- Air Traffic Service Provider must monitor status of GNSS
  - Issue timely warnings of outages



# Aircraft Requirements

- Two (2) Long Range Navigation Systems (LRNS)
  - GNSS is a required sensor
    - Stand-alone navigation system or
    - Part of a multi-sensor system
    - Integrity and reliability through Fault Detection and Exclusion (FDE)
  - Design meets aircraft standards and is reflected in AFM



# Aircraft Functional Requirements

## RNP 4

On-board navigation system must have :

- Display of navigation data
- Path Terminator (ARINC 424)
  - Track to Fix (TF)
  - Direct to Fix (DF)
  - Direct-To function
  - Course to Fix (CF)
- Parallel offset
- Fly-by transition criteria
- User interface displays
- Flight planning path selection
- Flight planning fix sequencing
- User defined course to fix
- Path steering
- Alerting requirements
- WGS-84 reference system
- Automatic radio position updating



# System Performance Monitoring and Alerting (1)

- Accuracy
  - Lateral total system error: within  $\pm 4$  NM for at least 95% of total flight time
  - Along-track error: within  $\pm 4$  NM for at least 95% of total flight time
- Integrity
  - Malfunction of the aircraft navigation equipment classified as a Major Failure Condition under airworthiness regulations (i.e.,  $10^{-5}$  per hour)



# System Performance Monitoring and Alerting (2)

- Continuity
  - Loss of function classified as a Major Failure Condition
  - Continuity requirement is satisfied by the carriage of dual independent LRNSs (excluding signal in space)
- Performance Monitoring and Alerting
  - RNP system, or RNP System and pilot in combination, shall provide an alert if
    - The accuracy requirement is not met, or
    - The probability that lateral Total System Error exceeds 8 NM is greater than  $10^{-5}$
- Signal-in-Space (if using GNSS)
  - Aircraft navigation equipment shall provide an alert if the probability of signal-in-space errors causing a lateral position error greater than 8 NM exceeds  $10^{-7}$  per hour (ICAO Annex 10, Table 3.7.2.4-1)



# Key Elements of Operational Approvals: RNP 4

## Operational Approval

**Route Design  
Criteria**



**Operational  
Procedures and  
Standards**

**Equipment/System  
Standards**





# Operating Procedures (Pre-Flight)

- Review the maintenance logs and forms to ascertain the status of equipment required for flight in RNP 4 airspace or on routes requiring RNP 4 navigation capability
- Ensure maintenance action has been taken to correct defects in the required equipment
- Review contingency procedures for operations in RNP 4 airspace or on routes requiring RNP 4 capability
  - Generally same as normal oceanic contingency procedures
  - Added: Crews must be able to recognize, and inform ATC when aircraft can no longer navigate to RNP 4 capability



# Flight Plan Example

“R” placed in block 10 of the ICAO Flight Plan indicates that the pilot has reviewed the planned route of flight and is authorized the applicable RNP Nav Spec; “Z” indicates “Other Information” in Item 18

Form Approved: OMB NO. 2120-0026

U.S. Department of Transportation  
Federal Aviation Administration

### International Flight Plan

PRIORITY: FF      ADDRESSEE(S):

FILING TIME:      ORIGINATOR:

SPECIFIC IDENTIFICATION OF ADDRESSEE(S) AND / OR ORIGINATOR:

3 MESSAGE: (FPL)      7 AIRCRAFT IDENTIFICATION:      8 FLIGHT RULES:      TYPE OF FLIGHT:

9 NUMBER:      TYPE OF:      WAKE TURBULENCE CAT.:      10 EQUIPMENT: **R**

13 DEPARTURE AERODROME:      TIME:      15 CRUISING SPEED:      LEVEL:      ROUTE:

16 DESTINATION:      TOTAL FEET:      SURVIVAL EQUIPMENT:      PERSONS ON BOARD:      EMERGENCY:      ELBA:      E

→ S POLAR      DESER D      MARITIM M      JUNGLE J      → J / L LIGHT      FLUORE F      UHF U      VHF V

DINGHIES:      NUMBER:      CAPACITY:      COVER:      COLOUR:      AIRCRAFT COLOR AND MARKINGS:

A / REMARKS: **N / NAV/RNP4** PILOT-IN-COMMAND

C / FILED BY:      ACCEPTED BY:      ADDITIONAL INFORMATION:

FAA Form 7233-4 (7-93)

Annotation in Item 18 (Other Information)





# Operating Procedures RNP 4

- Availability of GNSS
  - Operator must ensure adequate navigation capability is available enroute to enable the aircraft to navigate to RNP 4
  - Includes availability of Fault Detection Error
    - Receiver Autonomous Integrity Monitoring (RAIM) Prediction capability



# Pilot Knowledge and Training

- Operators must ensure flight crews know:
  - Guidance material
  - Limits of their RNP 4 navigation capabilities
  - Applicable contingency procedures





# Operating Procedures: Navigation Database

- Navigation database should be obtained from a supplier that complies with RTCA DO-200A/EUROCAE Doc ED 76, *Standards for Processing Aeronautical Data*
- Discrepancies that invalidate a route must be
  - Reported to the database provider and
  - Use prohibited by an operator's notice to flight crews
- Operators should consider the need to conduct periodic checks of their operational navigation databases



# Additional Considerations

- State AIP should clearly indicate RNP 4 application
- All routes based on WGS-84 coordinates
- Recommended Controller Training
  - Core Training (RNAV System basic information)
  - Flight Plan requirements
  - ATC Procedures including
    - Separation
    - Contingencies
    - Transition between Oceanic/Remote and En Route
    - Phraseology
  - CPDLC communication
  - ADS-C system and simulation training
  - Effects of periodic reporting delay/failure on longitudinal separation



# Summary

- RNP 10 and RNP 4 navigation specifications intended for Oceanic and Remote Continental Applications
  - RNP 10 remains a valid designation per the PBN Manual
- Requirements in new ICAO PBN Manual Vol II have not changed from earlier ICAO guidance
- Navigation Specifications are implemented along with Communications and Surveillance elements
- Learning Objectives were
  - Understand how RNP 10 and RNP 4 operations are incorporated into the PBN Manual
  - Be familiar with general issues associated with implementing RNP 10 and RNP 4
  - Understand the related communication and surveillance capabilities required for 50 NM and 30 NM lateral and longitudinal separation



Bearing in mind the target audience in ICAO Regions

# Feedback and Questions

