

FAA View on Performance Based Navigation (PBN) Airworthiness and Operational Approvals

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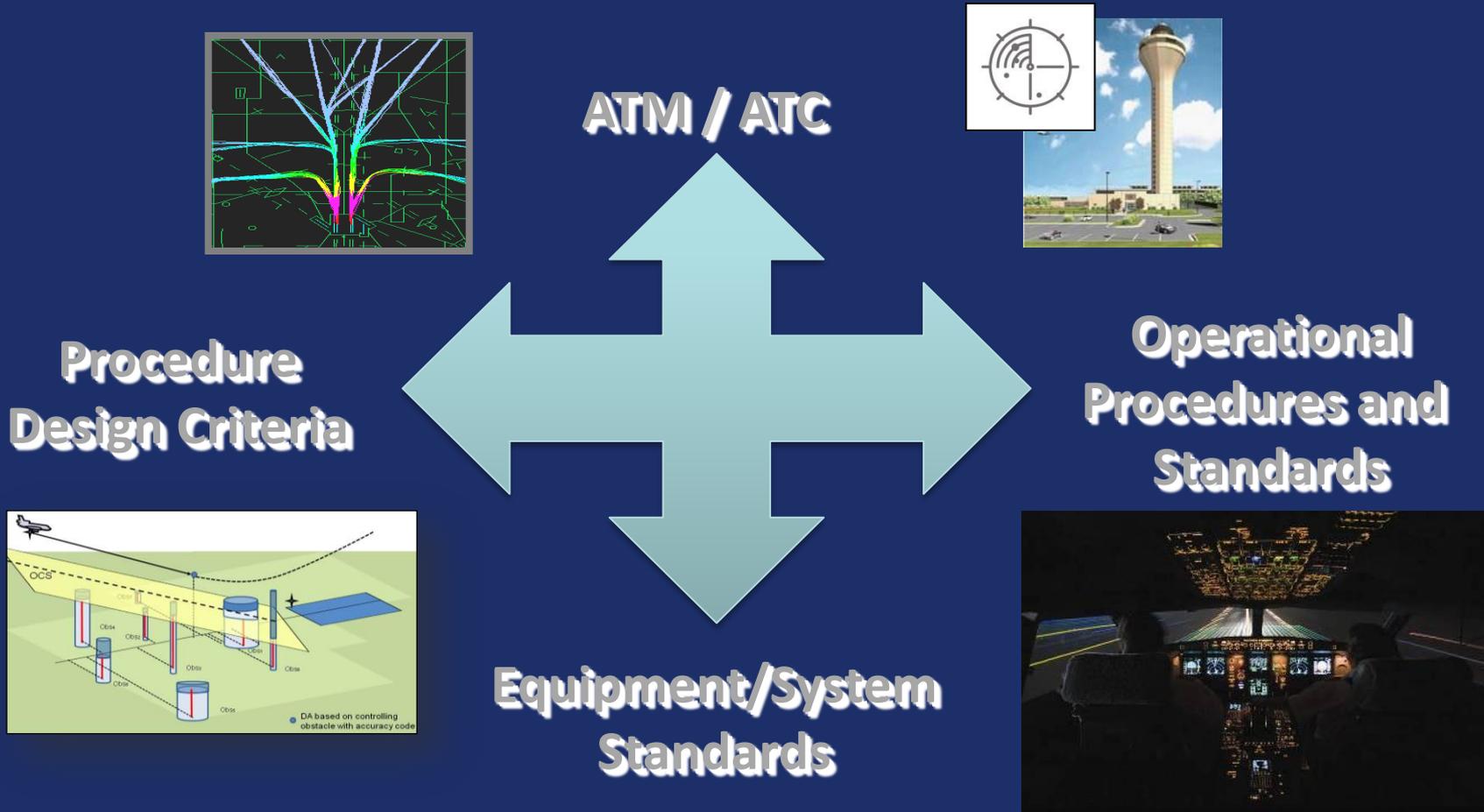


Overview

- **Introductory Thoughts**
- **Organizational Structure**
- **Guiding Principles and Mechanisms**
- **Status of PBN Operational Approvals in U.S.**
- **FAA Airworthiness and Operations Guidance Documents for PBN**
- **Challenges**
- **U.S. Operational Approval Processes**
- **RNP AR Operations**
- **Non-Standard Operations**



Integration of Efforts for PBN



Components of Operational Approval

- Eligible/qualified/approved **aircraft and navigation equipment** - performance and functionality

+

- **Procedures** for flight crew/pilots, maintenance, and dispatch - as appropriate

+

- **Training** for personnel – ground/simulator/flight



- **Approval/authorization** mechanism (for example, Operations Specification) - as necessary

Avionics Enabler	AVS Service	Requirements	Status	Guidance	Schedule	Additional Information	
XXX	AIR	Aircraft Requirements					
		Special condition/rule					
Equipment standard							
Installation guidance							
Technical training							
AFS	AFS	Airworthiness and Maintenance					
		Maintenance rules					
		Inspector guidance (Order 8900.1...)					
		Inspector training					
		Maintenance authorizations					
		Flight Operational Requirements					
		Operating rule					
		Simulation, modeling, analysis					
		User information (AIM, PCG...)					
		Operational approval guidance (AC...)					
		Operational authorization (OpSpec, Mspec, LOA...)					
		Inspector guidance (Order 8900.1...)					
		Inspector training					
		Aeronautical information and charting					
Procedure/route design criteria							
SRM/OSA panel participation							

Some Thoughts on PBN Operational Approvals

- **Performance based operations (such as PBN) have inherent flexibility, which can introduce additional complexity for operators and regulators**
- **Implementation can sometimes amplify existing issues with operational approval processes and capabilities**
- **States and Regions have different regulatory frameworks, organizational structure and operating environments, all of which contribute to necessary differences**
- **RNP AR is very much “PBN” but requires greater expertise and should normally be treated in bit different manner...**



Challenges

- Development and synchronization of necessary operator and inspector guidance...along with training to promote understanding of requirements
- Determination of aircraft/equipment, procedures, and training suitability for proposed operation
- Availability of authorization mechanisms (and adequate resources)

Notional Levels of Difficulty

“Easy”

“Challenging”

RNAV 5 RNAV 2 RNAV 1 RNP APCH RNAV 10 RNP 4 RNP AR APCH

FAA - Three Levels of Organization

- **Headquarters**
 - Regulations, policies, and procedures
 - Program (e.g. PBN) support offices
 - Budget/training planning and programming
 - National work program
 - International coordination
- **Regional Offices**
 - Regional annual work program
 - Liaison between field and HQ
 - Expertise in regional differences
- **Field Offices**
 - Certification & surveillance of regulated entities
 - Field office annual work program



Guiding Principles (1 of 2)

- **Promote and enable implementation of new technologies for enhanced safety and greater efficiency**
- **Leverage current aircraft capabilities**
- **Design operations to appropriate level of complexity**
- **Ensure adequate training and operational guidance**
- **Focus on “Public” procedures but allow for “Special” operations**
 - Advance technology
 - Account for investment in equipment and training
- **Incorporate safety management**
 - Design to reduce risk
 - Use suitable operational mitigations
 - Maintain or increase (overall) level of safety



Guiding Principles (2 of 2)

- **Seek harmonization (charting, phraseology, design, and operational procedures) across phases of flight and borders**
- **Coordinate with stakeholders throughout development process**
 - Wide variety of users and operators
 - Via
 - Public comment period on “NextGen” guidance materials
 - International forums
 - FAA/Industry meetings (e.g., Performance-based Operations Aviation Rulemaking Committee)
- **Coordinate plans and efforts of Flight Standards Service, Aircraft Certification, and Air Traffic Organization**



RNAV 1 and RNP AR Authorization Status

RNAV 1 Departure and Arrival Operations

- 800+ U.S. operators (primarily commercial operators) – approximately 93% participation
- 90 foreign air carriers

RNP AR Approach Operations

- 11 airlines (including 2 foreign air carriers) have been approved for RNP AR operations in the U.S.
- 22 corporate, charter, and fractional operators
- Approximately 2,300 aircraft associated with RNP AR approvals
 - Airbus A-320
 - Boeing B-737NG, 757, 767, and 777
 - Bombardier Q-400
 - Embraer E-170/190
 - Gulfstream G-350/450/500/550
 - Cessna Sovereign
 - Dassault Falcon 900 EASy II ()



Current and Proposed FAA Guidance Materials for PBN

ICAO Navigation Specification	Operations*	Airworthiness**	Procedure / Airspace Design
RNP APCH (Part A and B) Procedure Title – RNAV (GPS)	AC 90-105 (to be revised for Advanced RNP, RNP 0.3, RNP 2, FRT, and TOAC)	AC 20-138C (to be revised for Advanced RNP, RNP 0.3, RNP 2, FRT, and TOAC)	Order 8260.58*** (to be revised for Advanced RNP, RNP 0.3, and RNP 2)
Baro-VNAV			
Radius-to-Fix (RF)			
RNP 1			
Advanced-RNP (A-RNP)			
RNP 0.3			
RNP 2			
RNP AR APCH Procedure Title- RNAV (RNP)	AC 90-101A		
RNAV 1 – Departures and Arrivals RNAV 2 – RNAV “Q” and “T” routes	AC 90-100A		
RNAV 5 – not implemented in U.S.	AC 90-96A		N/A
RNP 4	Guidance is moving to AC 90-105A		N/A
RNAV 10 [Designated as RNP 10]			N/A

*Inspector guidance and operational approval mechanisms are available in *Order 8900.1 FSIMS* available at <http://fsims.faa.gov/>

**Additional guidance materials, such as other ACs and Technical Standards Orders (TSOs), may also apply

***Compilation and rationalization of previous PBN design criteria documents



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FAA PBN Airworthiness Approval Guidance Material

- ***AC 20-138C, Airworthiness Approval of Positioning & Navigation Systems***
 - Consolidates multiple navigation guidance materials into one volume
 - Harmonized with the ICAO PBN Manual
- ***AC 20-174, Development of Civil Aircraft & Systems***
 - Recognizes the Society of Automotive Engineers (SAE) Aerospace Recommended Practice (ARP) 4754A, *Guidelines/or Development of Civil Aircraft & Systems*
 - Defines an acceptable method for establishing a development assurance process to meet airworthiness requirements.
 - Eliminates use of nonstandard issue papers for airworthiness approval.
- ***AC 20-153A Acceptance of Aeronautical Data Processes and Associated Databases***



FAA Technical Standard Orders (TSO)* Updates & PBN

- **TSO-C115c – *Flight Management Systems with Multi-Sensor Inputs***
 - Invokes RTCA DO-283A, *Minimum Operational Performance Standards for RNP for RNAV*
 - Standardizes RNP capability with existing industry criteria – harmonized with PBN Manual
- **TSO-C196 – *GPS with ABAS***
- **TSO-C151c – *TAWS – Support for PBN***
- **TSO-C194 – *Helicopter TAWS***

**Many of the relevant TSOs do not directly relate to nav spec requirements*



Relationship of 20- and 90-/120-Series ACs

- **20-Series ACs**

- Intended for use during equipment certification activities
- Forward-looking and more detailed concerning airworthiness requirements
- Incorporate/reference material from RTCA documents (such as DO-236 updates out of SC-227)

- **90-/120-Series ACs**

- Intended for operations community
- Reflect some legacy standards for existing approvals

Future FAA Airworthiness Concerns

- OEM PBN Compliance → aircraft & avionics
 - Make PBN compliance formal part of airworthiness projects → new TCs, STCs, navigation-related projects
 - Develop clear, concise AFM entries; recommended flight crew operating procedures; avionics operating guides
- Update & enhance our guidance material → example: refine guidance on demonstrating flight technical error
- Must ensure PBN aircraft qualification becomes part of projects' system safety assessments → impact?
- International Harmonization (PBN Manual & PANS-OPS reflect tremendous success but implementation needs to continue)



Break



U.S. Operational Approval Mechanisms (1 of 2)

- A number of factors influence the decision concerning whether to require a formal operational approval process and specific documentation of approval:
 - Degree of linkage to aircraft/avionics certification basis,
 - Complexity of operation,
 - Maturity of operation/operational concept,
 - Risk associated with improper conduct of operation and system-/operator-specific safety expectations by operating part/community, and
 - Relationships to current/proposed pilot/maintenance/dispatcher training standards and procedures
- These decisions also hinge upon balancing how to efficiently use available regulatory resources to ensure proper operator compliance and promote ongoing operational safety while also enabling use of new technologies and operations in the interest of enhanced safety and efficiency
- In general, commercial operators require specific authorization for PBN operations (not the case with less “complex” operations for non-commercial/general aviation operators)



U.S. Approval Mechanisms (2 of 2)

- For domestic operations, approvals are categorized by flight phase/operation not “navigation specification” (e.g., RNAV 1 SIDs and STARs)
- For oceanic operations, separate approvals are given for navigation specification and area of operation (plus other CNS/ATM requirements such as RVSM and datalink)
- Variety of OpsSpecs, MSpecs, and LOAs for different purposes
 - C052 Approaches
 - C384 RNP AR Approaches
 - C063 RNAV 1 Departures and Arrivals
 - B035 RNAV 2 Routes
 - And a few others...
- Non-standard, 300-series OpsSpecs require HQ-level concurrence prior to approval (for example, RNP AR)

U.S. Operational Approval Process

- **Phase 1 PRE-APPLICATION:** Application initiated
- **Phase 2 FORMAL APPLICATION:** Operator submits a proposal
- **Phase 3 DOCUMENT COMPLIANCE:** FAA's analysis and evaluation
- **Phase 4 DEMONSTRATION AND INSPECTION:** Operator's demonstration
- **Phase 5 CERTIFICATION:** Approval or Acceptance via...
 - Operations Specifications (OpsSpecs)
 - Management Specifications (MSpecs)
 - Letter of Authorization (LOA)



Flexibility in Approval Processes

- **Inspector Assessment.** The complexity of the certification process is based on the inspector's assessment of the applicant's proposed operation. For simple certifications, some steps can be condensed or eliminated.
- **Differences Among Applicants.** Some applicants may lack a basic understanding of what is required for certification. Other applicants may propose a complex operation, but be well prepared and knowledgeable. Because of the variety in proposed operations and differences in applicant knowledge, the process must be thorough enough and flexible enough to apply to all possibilities.

-FAA Order 8900.1



Approval / Concurrence by Field, Region, and Headquarters Offices

- **Headquarters** - develops policy development and national guidance
- **Regions** - provides technical and geographic expertise
- **Field** (local operations inspectors)- approves operation if equipment, procedures, and training are satisfactory
 - Includes review by maintenance / avionics inspectors
 - Additional HQ / Region concurrence for approval may be required
 - Evolution and complexity of technologies affects HQ / Region involvement
 - RNP AR (HQ and Region concurrence)
 - ILS Category II and III (Region concurrence)
 - RNP APCH (Field approval...with Region/HQ assistance if necessary)



Some Thoughts on Training...

- **“Core” subjects are common across PBN operations**
 - Form foundation (for example, what is RNAV?)
 - No need to repeat information for each operation
- **Initial and recurrent ground/flight training requirements need to be addressed**
- **Some items are embedded in pilot certification requirements**
- **Training device/simulator equipage may be an issue**



RNP AR Operations

- AC 90-101A is relevant guidance document
- Requirements incorporated into a matrix
 - Tool used to organize and track package contents
 - Example:

AC 90-101 Text and Requirements Identification				OEM / System	
<u>Reference Number</u>	<u>Document Text</u>	<u>Section Content</u>	<u>#</u>	<u>Compliance (Yes/No/Partial)</u>	<u>Compliance Description</u>
A2 3a(1)(a)	The sensor must comply with the guidelines in AC 20-138(). For systems that comply with AC 20-138(), the following sensor accuracies can be used in the total system accuracy analysis without additional substantiation: GPS sensor accuracy is better than 36 meters (95%), and augmented GPS (GBAS or SBAS) sensor accuracy is better than 2 meters (95%).	Requirement	1		

Items of Interest

- **PANS versus TERPs**
 - Speeds
 - Assumptions for winds
 - Assumptions for bank angles
- **FAA-EASA differences in RNP AR aircraft qualification**
 - One engine inoperative
 - Acceptance of operational mitigations



RNP AR Operational Approval Summary

- **Ensure operator package is processed in timely manner and includes the following:**
 - Operator package must address all AC 90-101A requirements
 - Use AC 90-101A matrix (optional but recommended)
 - Identify and address / mitigate any known aircraft RNP AR issues (e.g., crew procedures and training)
 - All RNP AR requirements must be satisfied prior to operational approval
- **Operators are approved for all U.S. operations for which there are qualified based up accuracy/RNP, RF capability, and RNP < 1.0 in MAS (no procedure-specific approvals for public operations)**

Appendix 2 Changes: Aircraft Qualification

- **Clarified “design assurance” requirements for loss of lateral/vertical guidance vs. misleading guidance**
 - Loss of vertical guidance is minor – stop descending
- **Introduced an alternate means of compliance for loss of GNSS during the approach**
 - Relies on conditional probabilities related to the operation
 - Requires automatic reversion to alternate means of navigation supporting the RNP upon loss of GNSS
 - No need to alert just for loss of GNSS
- **Both apply to approach ops below RNP 0.3 & when missed approach procedure requires less than RNP 1.0**

Appendix 2 changes, continued

- **A/P / flight director min bank angle command on RF legs reduced to 25° from 30° above 400 feet**
- **Identifies AC 20-138B *Airworthiness Approval of Positioning and Navigation Systems* as the additional source aircraft qualification info**
 - May contain additional airworthiness information
- **Prior to the IAF, the flight crew may manually set the lowest RNP accuracy value for the IAP**
 - In lieu of the aircraft automatically setting lateral navigation accuracy values during the approach

Appendix 4: Operational Considerations

- **Better “english,” less redundancy, more clarity**
- **Explained when DME updating may be used in lieu of GNSS**
- **Established a “standard” for track deviation monitoring that is in agreement with ICAO PBN**
- **Altimeter setting and crosscheck requirements revised to reflect policy decisions made earlier (e.g., 100 ft vice 75 ft limit)**

Appendix 3: Navigation Data Validation

- **Significant industry input resulted in major changes to the database validation requirements**
- **Identified specific data parameters, and acceptable tolerances, for comparing RNP AR procedures between the aircraft database and government “source data”**
- **Flyability checks no longer required for U.S. public procedures**
- **Operators now have flexibility in the manner in which they confirm data accuracy at 28 day updates**

Appendix 5: Training

- **Significant revision driven by industry input**
 - Although the appendix looks very different from the version in 90-101, the required RNP AR subject matter has changed very little...It's better organized and easier to understand
- **Made “flight training” requirements more straightforward and simplified**
 - Dropped requirement for an “evaluation module”
- **Clarified number and format of RNP AR approaches to be flown during initial and recurrent training**

“Non-Standard” Instrument Flight Procedures

- For U.S. operations, these are referred to as “Specials” and handled via separate approval process using distinct method
- Leverage demonstrated aircraft capabilities and specific operational procedures/training
- Charts are distinctly identified and procedures/data are segregated from public procedures
- Foreign non-standard procedures can present challenges
 - Titled in similar manner as other procedures e.g., RNAV (RNP)
 - Difficult to decipher differences from standard designs
 - Recommendation: explicit charting or restricted access

FAA Order 8900.1, Flight Standards Information Management System (FSIMS)



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FSIMS

Flight Standards Information Management System

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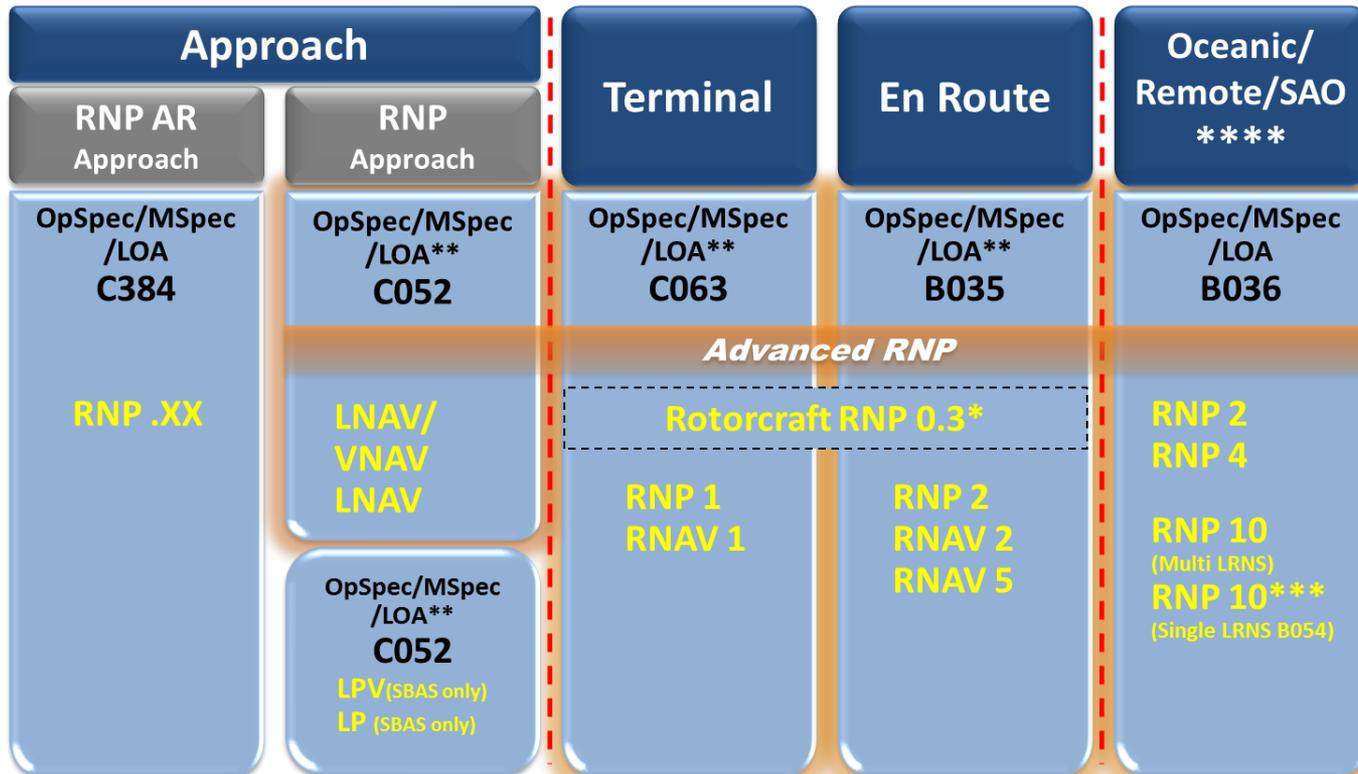


Thank You



Bundling Concept

Bundling Options



- * See Helicopter Specifications for Terminal and En Route
- ** LOA are only required for RNP AR and Oceanic/Remote /SAO
- *** Single LRNS may not be compatible with Advanced RNP requirements
- **** Additional communication and surveillance requirements may be required

Task

- **Implementation**

- PBN Information Box

- Follow-up to PARC PBN Charting recommendation in 2011
 - What needs to be the content of the PBN information Box on Terminal Procedure
 - Where it should be placed

- Procedure Title changes

- Follow-up to PARC PBN Charting recommendation in 2011
 - Impact on:
 - FAA Guidance
 - Equipment display requirements
 - Training for users