



ICAO/CANSO Regional PBN Workshop
Ciudad de México
25 - 29 Nov, 2013

PBN Operations Approval Process



Think the solution,
experience the change

Different Requirements in Existing PBN Regulation



- PBN Operations Approval Process
 - ✓ Different requirements in existing PBN regulation



Advanced Operational Approval : RNP

- ✓ Assessment of an operator is made by the State of Operation
- ✓ Assessment through appropriate advisory and guidance material
- ✓ Authorization from the State responsible for the RNP procedure

The assessment should take into account:

Operational evaluation of each RNP procedure

Flight Operational Safety Assessment (FOSA)

Training (Key personnel like flight crew, dispatcher, ...)

Operational Documentation

Navigation database integrity checks

Means to predict the GPS PRIMARY availability

RNP monitoring program



RNP APCH & RNP AR OPS Package

RNP APCH OPS Package

- Introduction + Ref Doc
- A/C qualification
- OPS procedure + RAIM prediction
- NDB validation
- Training program
- Operation manual and Checklist
- MEL

RNP AR OPS Package

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-Project Brief

-REF Doc:

ICAO 8168
Procedure design
ICAO 9905
RNP AR
procedure design
ICAO 9613
PBN manual
DGCA/ EASA/
FAA...
Approval
Guidance
Aircraft
Manufactory
Manual
AFM,
ACD,FCOM...
Operation
Analysis
Reference
...

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Airworthiness Compliance Document
RNP Operations with AR (SAAAR)
Airbus Single Aisle Aircraft
MCO 38973
EAA D3434UG0400680 Rev 3

This document provides guidelines for operational approval of RNP operations with AR, (SAAAR or equivalent).

Prepared with:	Compiled by:	Approved by:
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Date : August 14, 2007	Date : 14. 08. 2007	Date : 28. 08. 07

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RAIM Regulatory Background

Requirements for RNP AR (RAIM) Prediction capability

EASA - AMC 20-26

Dispatch RNP Assessment. The operator should have a predictive performance capability, which can determine whether or not the specified RNP will be available at the time and location of a desired RNP operation.

This capability can be a ground service and need not be resident in the aircraft's avionics equipment. The operator should establish procedures requiring use of this capability as both a preflight dispatch tool and as a flightfollowing tool in the event of reported failures. The RNP assessment should consider the specific combination of the aircraft capability (sensors and integration), as well as their availability.

FAA - AC 90-101A

RNP Prediction. The operator must have a predictive performance capability, which can forecast if the specified RNP value will be available at the time and location of a desired RNP AR operation. This capability can be a ground service and need not be resident in the aircraft's avionics equipment. The operator must establish procedures requiring use of this capability as both a preflight dispatch tool and as a flight-following tool in the event of reported failures.



RAIM Regulatory Background (Cu'ed)

Requirements for RNP (RAIM) Prediction capability

EASA - AMC 20-27 Appendix 4

1.1 Preflight Planning.

f) For those GNSS systems relying on RAIM, its availability 15 min before Estimated Time of Arrival (ETA) until 15 min after ETA should be verified during the **preflight planning**. In the event of a predicted continuous loss of fault detection of more than five (5) minutes, the flight planning should be revised (e.g. delaying the departure or planning a different approach procedure).

Note 1: For certain systems, prediction is not systematic but is only required in specific cases and shall be detailed in the relevant section of the AFM

Note 2: RAIM availability prediction services may be provided to users by the air navigation service provider (ANSP), an avionics manufacturer or other entities.

FAA - AC 90-105

Operational Considerations: Pre-Flight Planning

(1) For systems with RAIM-based integrity, RAIM prediction must be performed **prior to departure**. This capability can be a ground service and need not be resident in the aircraft's avionics equipment.

(2) Operators should be familiar with the prediction information available for the intended route. RAIM availability prediction should take into account the latest GPS constellation NOTAMs and avionics model (when available).

(4) In the event of a predicted, continuous loss of appropriate level of fault detection of more than 5 minutes, for any part of the RNP operation, the flight planning should be revised.



RAIM availability report (via email)



Predictions validity
FROM: 1210261400Z (26 OCT 2012 1400Z)
TO: 1210281400Z (28 OCT 2012 1400Z)

ALL NECESSARY INFORMATION IS CONTAINED IN A SINGLE E-MAIL

PREDICTION RESULTS WITH OUTAGES				
ICAO CODE	TERMINAL MODE		APPROACH MODE	
	Starting time	Ending time	Starting time	Ending time
LFLL	No outages	No outages		

OVERVIEW OF AIRPORT(S) WITH OUTAGE ON TOP OF THE REPORT FOR RAPID CHECK

PREDICTION RESULTS WITHOUT OUTAGES				
ICAO CODE	TERMINAL MODE		APPROACH MODE	
	Starting time	Ending time	Starting time	Ending time
EGKK	No outages	No outages	No outages	No outages
EGMC	No outages	No outages	No outages	No outages
EGSS	No outages	No outages	No outages	No outages
FVHA	No outages	No outages	No outages	No outages
FWKI	No outages	No outages	No outages	No outages
HAAB	No outages	No outages	No outages	No outages

ALL AIRPORTS FOR WHICH PREDICTIONS ARE PROVIDED ARE REMINDED



GPS prediction service

Sat4flight®: web portal



Current Almanac	
GPS Week	565
GPS TOA	319488

[Home](#) | [Predictions by emails](#) | [Help](#)

Connected as: VGE [[Logout](#)]

[CGx AERO in SYS](#) | [ENAC](#) | [QUOVADIS](#)

Aerodrome selection

ICAO code [▼](#)

IATA code [▼](#)

Type: [▼](#)

Starting time settings

Date:

Time: : UTC

Prediction settings

Prediction duration: [▼](#)

Time step: [▼](#) Min

Aerodrome prediction outages (Airbus configuration)

Airport: ZPLJ
Algo. type: FDE_SA_Off
Min. mask angle (degrees): 5
GPS week: 565
GPS TOA: 319488
NANUs: No NANU

Valid From: 1006231000Z (23 JUN 2010 1000Z)
Valid To: 1006231030Z (23 JUN 2010 1030Z)

Arrivals:
Effective outages:
 Baro aided:
 No outages
 Non baro aided:
 No outages

Powered by SAT4Flight version V1R0
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RNP AR APCH : NDB requirements

6.3.6 Navigation database

ICAO PBN Manual extract

6.3.6.1 The procedure stored in the navigation database defines the lateral and vertical path. Navigation database updates occur every 28 days, and the navigation data in every update are critical to the integrity of every RNP AR APCH procedure. Given the reduced obstacle clearance associated with these procedures, validation of navigation data warrants special consideration. This section provides guidance for the operator's procedures for validating the navigation data associated with RNP AR APCH procedures.

6.3.6.2.4 *Initial data validation.* The operator must validate every RNP AR procedure before flying the procedure in instrument meteorological conditions (IMC) to ensure compatibility with their aircraft and to ensure the resulting path matches the published procedure. As a minimum, the operator must:

- a) compare the navigation data for the procedure(s) to be loaded into the flight management system with the published procedure;
- b) validate the loaded navigation data for the procedure, either in a simulator or in the actual aircraft in visual meteorological conditions (VMC). The depicted procedure on the map display must be compared to the published procedure. The entire procedure must be flown to ensure the path does not have any apparent lateral or vertical path disconnects, and is consistent with the published procedure; and
- c) once the procedure is validated, retain and maintain a copy of the validated navigation data for comparison to subsequent data updates.

6.3.6.2.6 *Data suppliers.* Data suppliers must have a Letter of Acceptance (LOA) for processing navigation data (e.g. FAA AC 20 153, EASA Conditions for the issuance of Letters of Acceptance for navigation database Suppliers by the Agency, or equivalent). An LOA recognizes the data supplier as one whose data quality, integrity and quality management practices are consistent with the criteria of DO-200A/ED-76. The operator's supplier (e.g. the FMS company) must have a Type 2 LOA, and their respective suppliers must have a Type 1 or 2 LOA.



RNP AR APCH : NDB requirements

2.5 Navigation Data Base

RNP RNAV routes are assumed to use series of fixes, and all navigation data published are assumed to be referenced to WGS-84 earth model.

Concerning fixes, it is assumed that source data, used within the navigation system, comply with DO-201A/ED-77, and that data processing complies with DO-200A/ED-76.

The content of the Navigation Data Base (NDB) is essential for RNP operations with AR (SAAAR). Any modification of the NDB affecting the concerned procedures should be assessed in a dedicated validation process using a flight simulator or an equivalent training tool (MFTD) fitted with software representative of the aircraft FMGC. This assessment should also include the means the operator uses to validate the NDB at each ARAC cycle. This is an important aspect even if the NDB is obtained from an “approved” supplier (DO-200A / ED-76 or AC 20-153).

The operator must in addition implement a process to ensure that the FMS are loaded with up to date NDB.

Airbus EASA approved Airworthiness Compliance Document



NDB Validation and Verification

OGV AERO in SYS, all rights reserved
 Generation data: 7.PROC_IAP_RINV09A
 Used template: 7.PROC_IAP_RINV09A

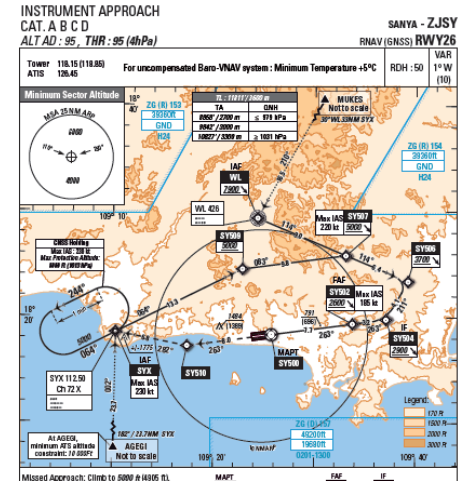
ADHP ICAO Code	ZU
ADHP ICAO Identifier	ZULS
Type	IAP
Nav. Type	R
Category	LN
Designator	RINV09A

Seq N°	PT	W/P ID	Overfly	Fix role	ID	RIMD VWF	THETA (°) magnetic	RH O Val	CRS Val (°)	CRS Typ e	TIME val	TIME val	DIST val	DIST val	ALT DESC	ALT
10	IF	LK900		IAP					278.026	TT			8.488	NM	=	21600
20	TF	LK400	N						274.789	TT			25.017	NM	=	16200
30	TF	LK424	N						274.651	TT			10.263	NM		
40	TF	LK422	N						274.651	TT			10.263	NM		
50	RF	LK418		R			375.839		290.642	TT			4.000	NM		
60	RF	LK414		R			291.642		308.725	TT			4.583	NM		
70	RF	LK811	IF	L			309.736		288.741	TT			1.606	NM	@	16200
80	RF	LK508		L			269.741		254.730	TT			3.668	NM	=	15110
90	RF	LK406		L			255.730		154.727	TT			3.675	NM	=	14200
10	IF	LK480		IAP												21600
20	TF	LK444	N						236.650	TT			17.500	NM	=	20000
30	RF	LK440		R					274.913	TT			6.678	NM	=	16200
40	TF	LK424	N						274.789	TT			25.017	NM	=	16200

Legend: 1. Aerodromes, 2. Runways, 3. Runway Directions, 4. Naviga, 5. ILS, 6. Waypoints, 7. PROC_IAP_RINV27A

Coding Table

OR



AIP chart

to check with NDB Data

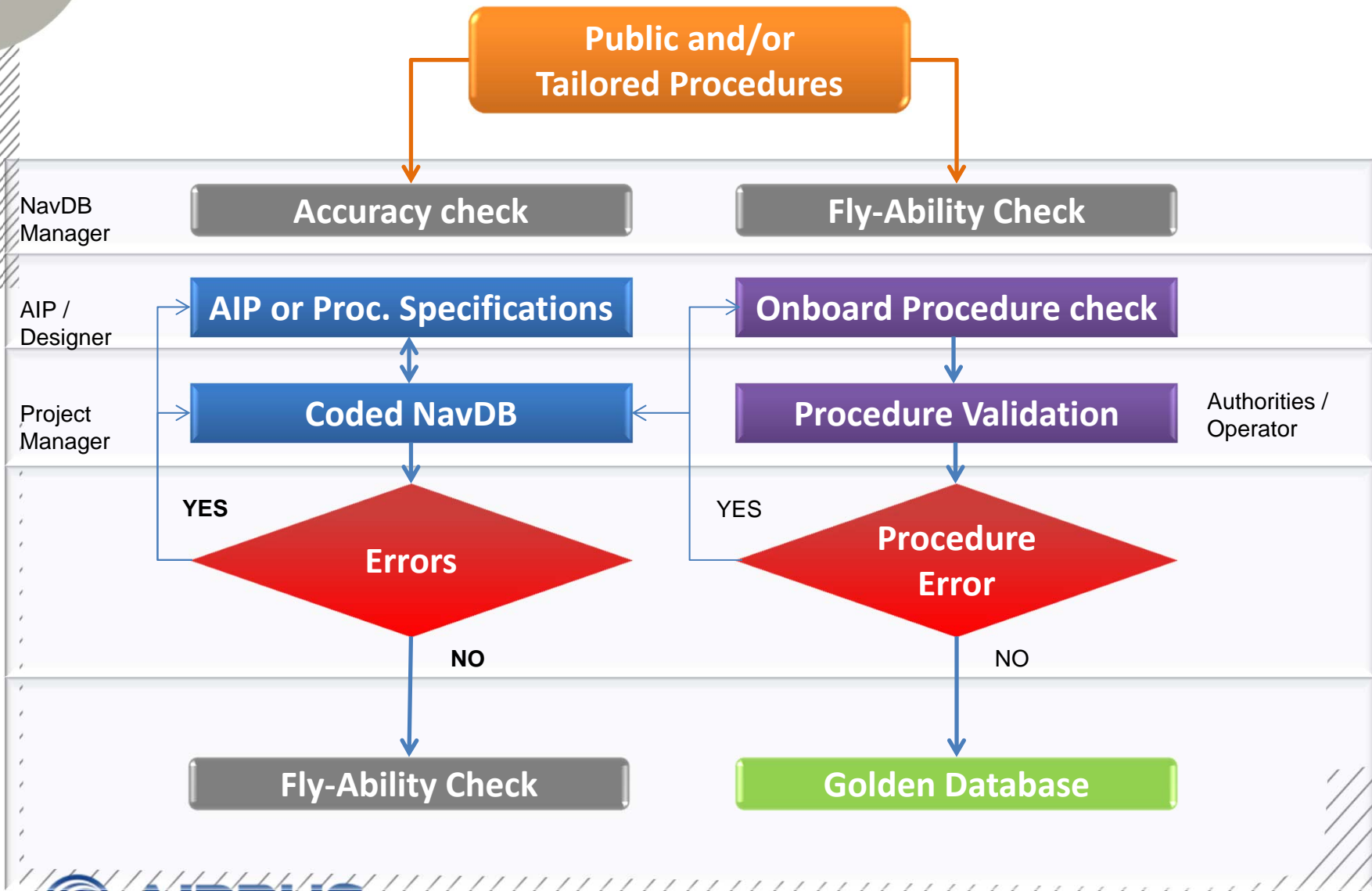


And





NDB Reference for Validation

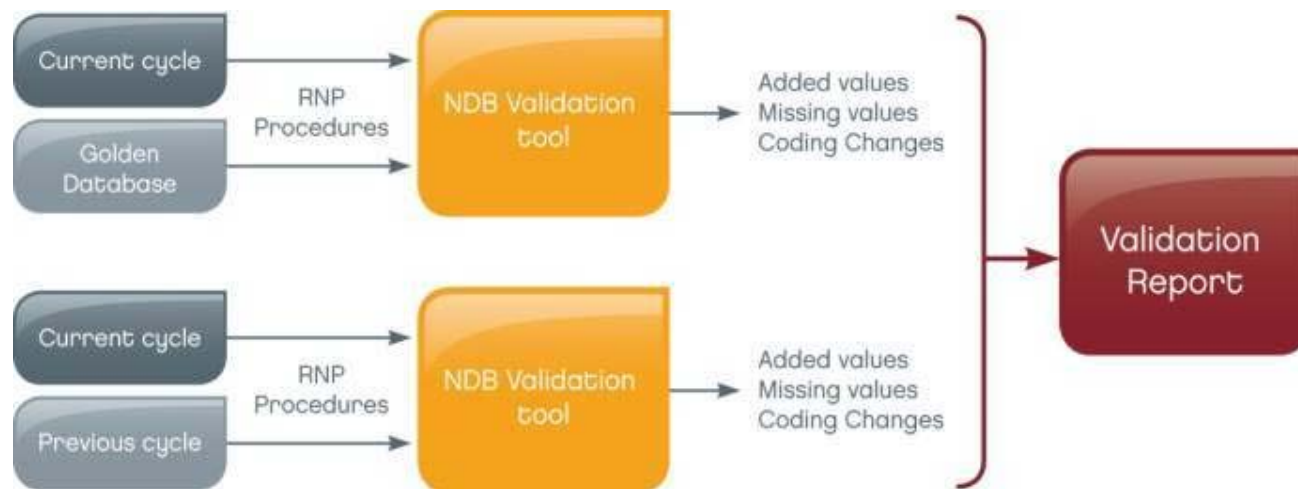


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Navigation database validation

At each AIRAC Cycle comparison of the NavDB with the “Golden database” (*when available*) or specification coding document (*source*), and with the previous cycle NavDB.





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-Flight crew training
-Dispatcher training
-Mainten. training

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-(OM, FCOM, MEL and checklists) will be updated to reflect RNP operations.

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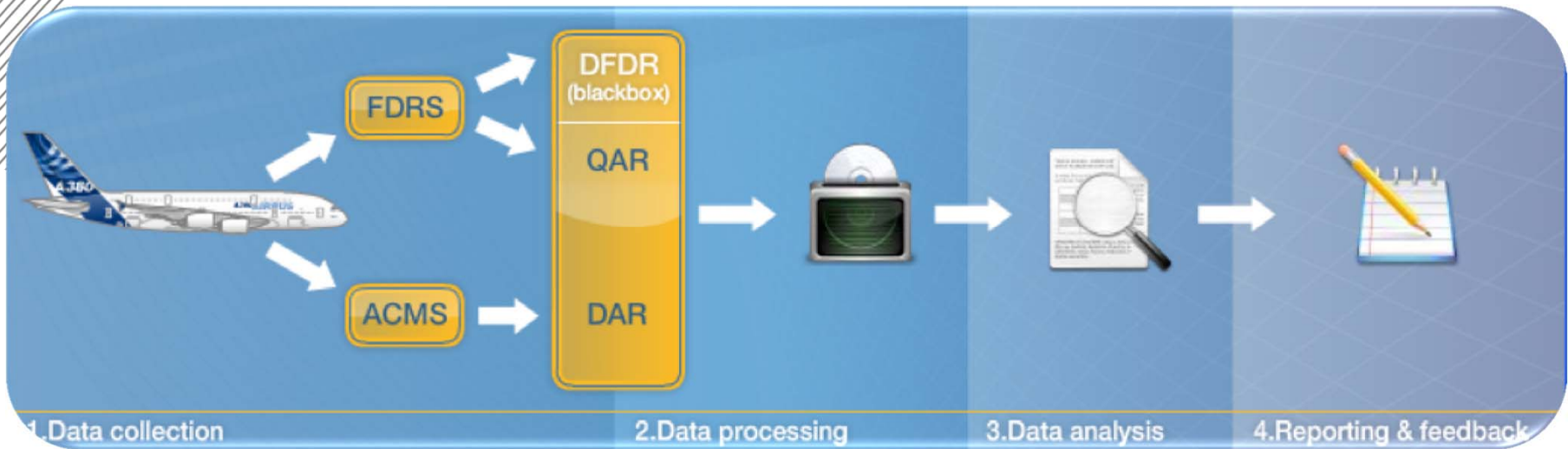
RNP Monitoring program

6.3.7.3 Operators must have an RNP monitoring programme to ensure continued compliance with the guidance of this chapter and to identify any negative trends in performance. At a minimum, this programme must address the following information. During the interim approval, operators must submit the following information every 30 days to the authority granting their authorization. Thereafter, operators must continue to collect and periodically review these data to identify potential safety concerns, as well as maintain summaries of these data:

- a) total number of RNP AR APCH procedures conducted;
- b) number of satisfactory approaches by aircraft/system (satisfactory if completed as planned without any navigation or guidance system anomalies);
- c) reasons for unsatisfactory approaches, such as:
 - i) UNABLE REQ NAV PERF, NAV ACCUR DOWNGRAD, or other RNP messages during approaches;
 - ii) excessive lateral or vertical deviation;
 - iii) TAWS warning;
 - iv) autopilot system disconnect;
 - v) navigation data errors; and
 - vi) pilot report of any anomaly;
- d) crew comments.



RNP Monitoring Process





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Refer to MMEL and
ACD recommendations.

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Flight Operational Safety Assessment (FOSA)

6.4 SAFETY ASSESSMENT

6.4.1 Flight Operational Safety Assessment

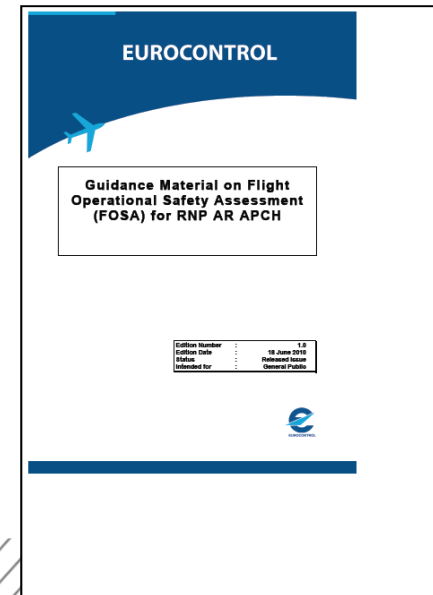
6.4.1.1 The safety objective for RNP AR APCH operations is to provide for safe flight operations. Traditionally, operational safety has been defined by a target level of safety and specified as a risk of collision of 10^{-7} per approach. For RNP AR APCH a flight operational safety assessment (FOSA) methodology is used. The FOSA is intended to provide a level of flight safety that is equivalent to the traditional TLS, but instead using methodology oriented to performance-based flight operations. Using the FOSA, the operational safety objective is met by considering more than the aircraft navigation system alone. The FOSA blends quantitative and qualitative analyses and assessments for navigation systems, aircraft systems, operational procedures, hazards, failure mitigations, normal, rare-normal and abnormal conditions, hazards, and the operational environment. The FOSA relies on the detailed criteria for aircraft qualification, operator approval and instrument procedure design to address the majority of general technical, procedural and processing factors. Additionally, technical and operational expertise and experience are essential to the conduct and conclusion of the FOSA.

Extract of PBN Manual (Doc 9613)



Flight Operational Safety Assessment (FOSA)

- The Flight Operational Safety Assessment (FOSA) is a key part of the RNP AR procedures operational evaluation, and is a support for the authorization by the National Aviation Authority.
- FOSA should be based on the Eurocontrol « Guidance Material on Flight Operational Safety Assessment (FOSA) for RNP AR APCH » or ICAO recommendations





When should a FOSA be conducted?

A FOSA should be conducted for each RNP AR approach procedure where the more stringent aspects of the nominal procedure design criteria (as per ICAO Doc 9905) are applied (i.e. RF legs after the FAF, RNP missed approaches less than 1.0, RNP final approaches less than 0.3) or where the application of the default procedure design criteria is in an operating environment with special challenges or demands.

How should a FOSA be carried out?

The FOSA should ensure that for each specific set of operating conditions, aircraft and environment, all failure conditions are assessed and, where necessary, mitigations are implemented to meet the safety criteria. The assessment should give proper attention to the inter-dependence of the elements of procedure design, aircraft capability, crew procedures and operating environment.

The functional areas presented in the figure below have been identified as elements to assess collectively in a typical FOSA. The FOSA should act as the ‘glue’ to combine and analyse the risks associated with the RNP AR system.



FOSA

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Operational and obstacle environment

If the procedure is being introduced for noise alleviation purposes and there are no obstacles close to the route (within $2 \times \text{RNP}$), a less detailed FOSA may be appropriate. No FOSA is required if the default RNP values of 1, 1, 0.3 and 1 are used for the procedure.

If a very complex and challenging procedure is being introduced for better access to a runway surrounded by challenging terrain/ obstacles, a more detailed FOSA may be considered advisable (if no prior examination/ assessment is found to be applicable – see below).

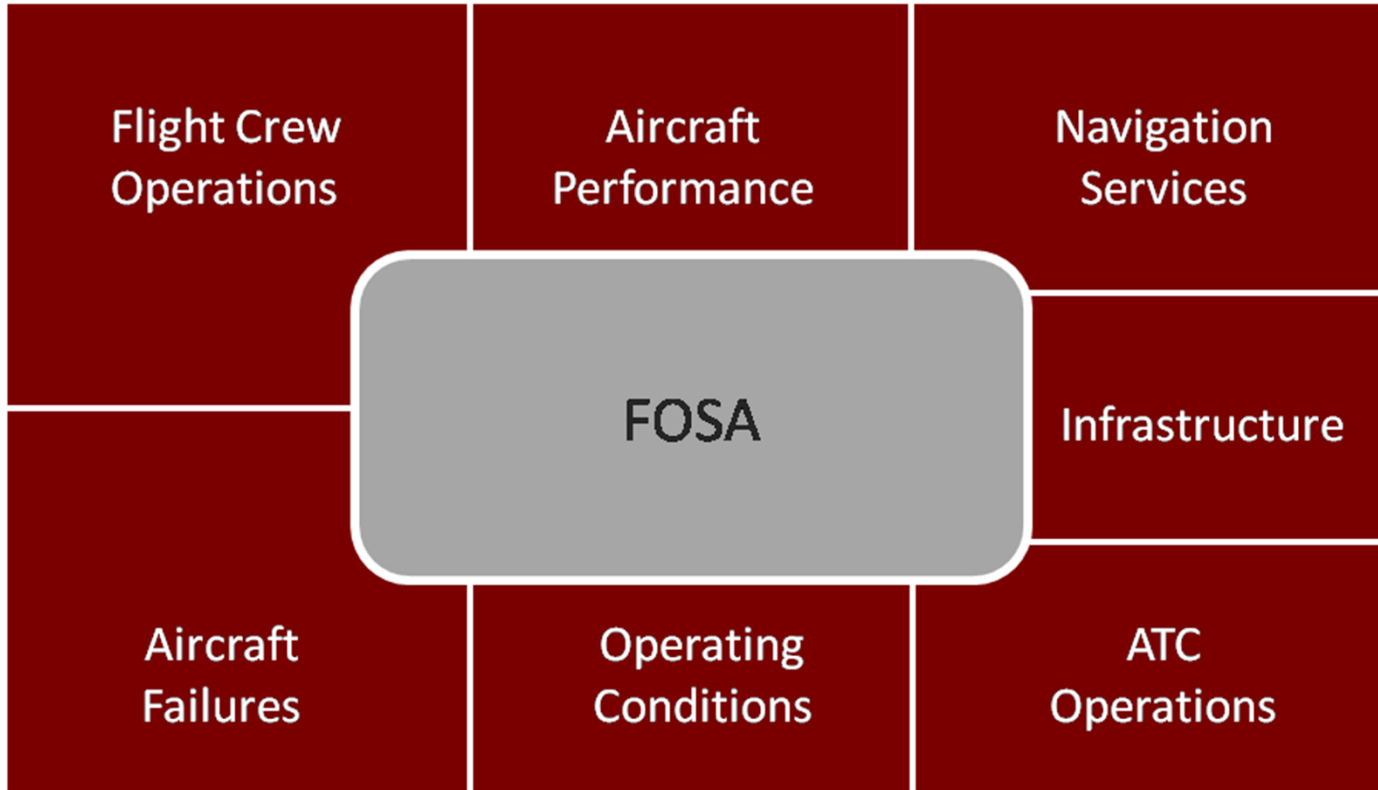
ity document.

29

Extract of PBN Operational Approval Manual (Doc 9997) DRAFT



FOSA



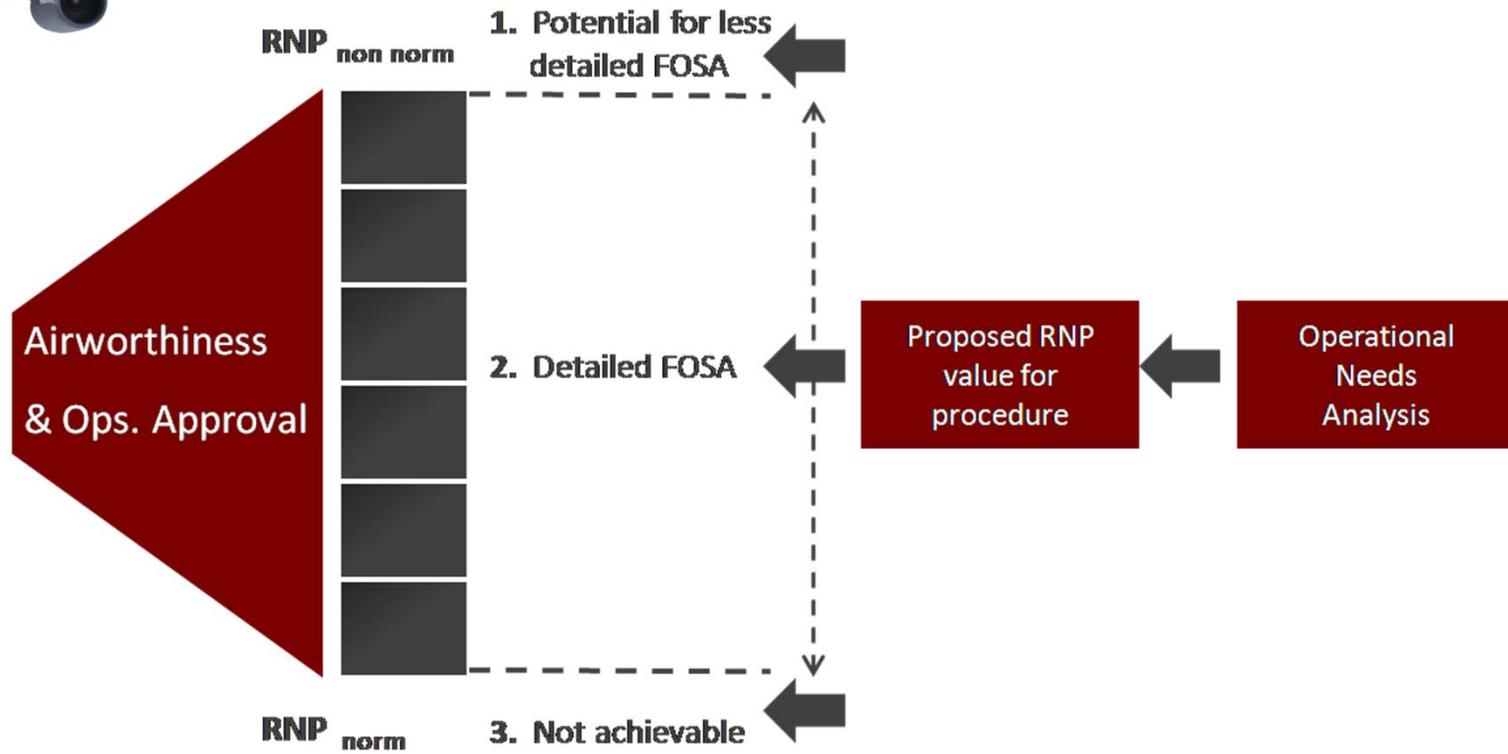


FOSA content

- Performance assessment on SID in Engine Out condition
- Performance assessment on Missed Approach in Engine Out condition
- Positioning of DP, performance on EOSID and performance on remaining SID path (for complex SID trajectories)
- Use of specific performance data (EO ACC ALT, Go Around speeds, CONF) and required highlights in training
- Minor deviations from procedure design criteria for operational benefits and mitigation by actual risk study
- Bank angle assessment, and mitigation of risk versus presence of obstacles
- Presence of known possible TAWS alerts, and recommendation for highlight in the specific training briefing
-



FOSA



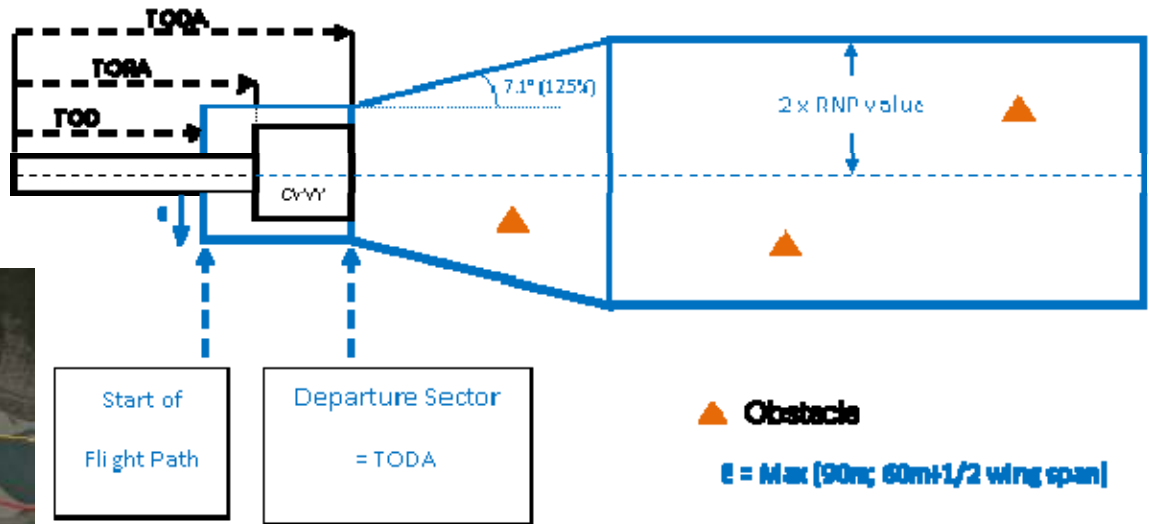
The proposed RNP value for the procedure is in between $RNP_{non\ norm}$ and RNP_{norm} . In this case it is likely that a detailed FOSA will be needed. Some Aircraft Failures considered in the airworthiness analysis will probably need to be re-investigated to understand their risk in the specific context of the procedure design and the operating environment. In addition all the other elements in Figure 3.1 will probably need to be studied in detail.



FOSA - EOSID evaluation

The Departure Sector is defined in the EU-OPS 1.495.
 The Obstacles are taken into account within a combination of:

- Cone from as defined in EU-OPS 1.495
- Corridor with half-width equal to 2xRNP value



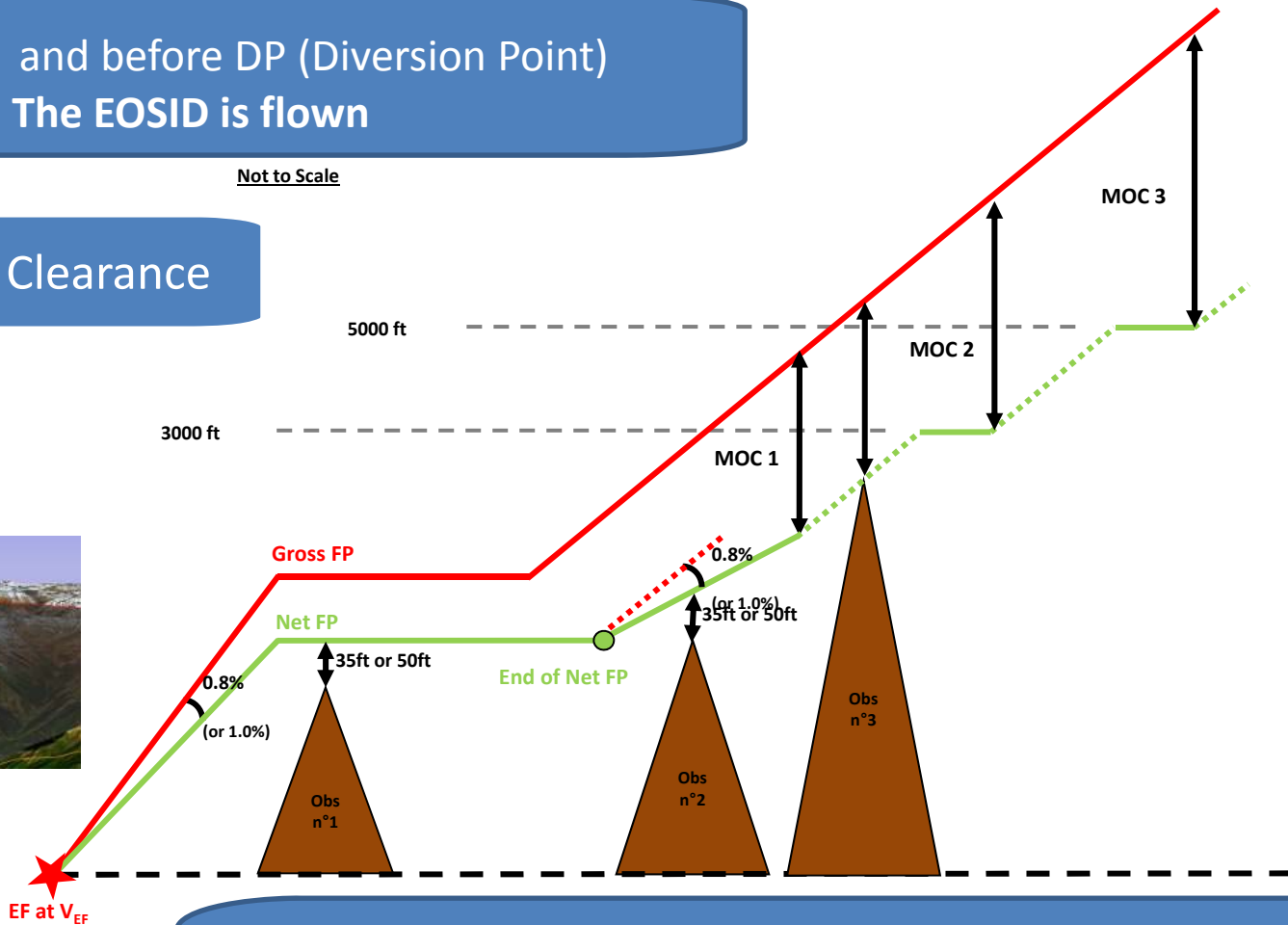
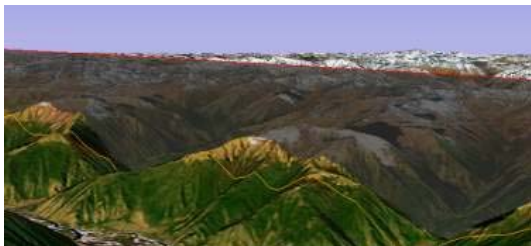


FOSA – Performance assessment

Engine Failure at V_{EF} and before DP (Diversion Point)
=> The EOSID is flown

EOSID and Obstacle Clearance

Not to Scale



- As per:
- Certification Specifications (CS/FAR 25.111 & CS/FAR 25.115)
 - Operating Rules (EU-OPS 1.495)
 - ICAO PANS-OPS Chap. II.3.1.2 – Minimum Obstacle Clearance
 - AC 120.91 – 9 (Termination of Takeoff segment)



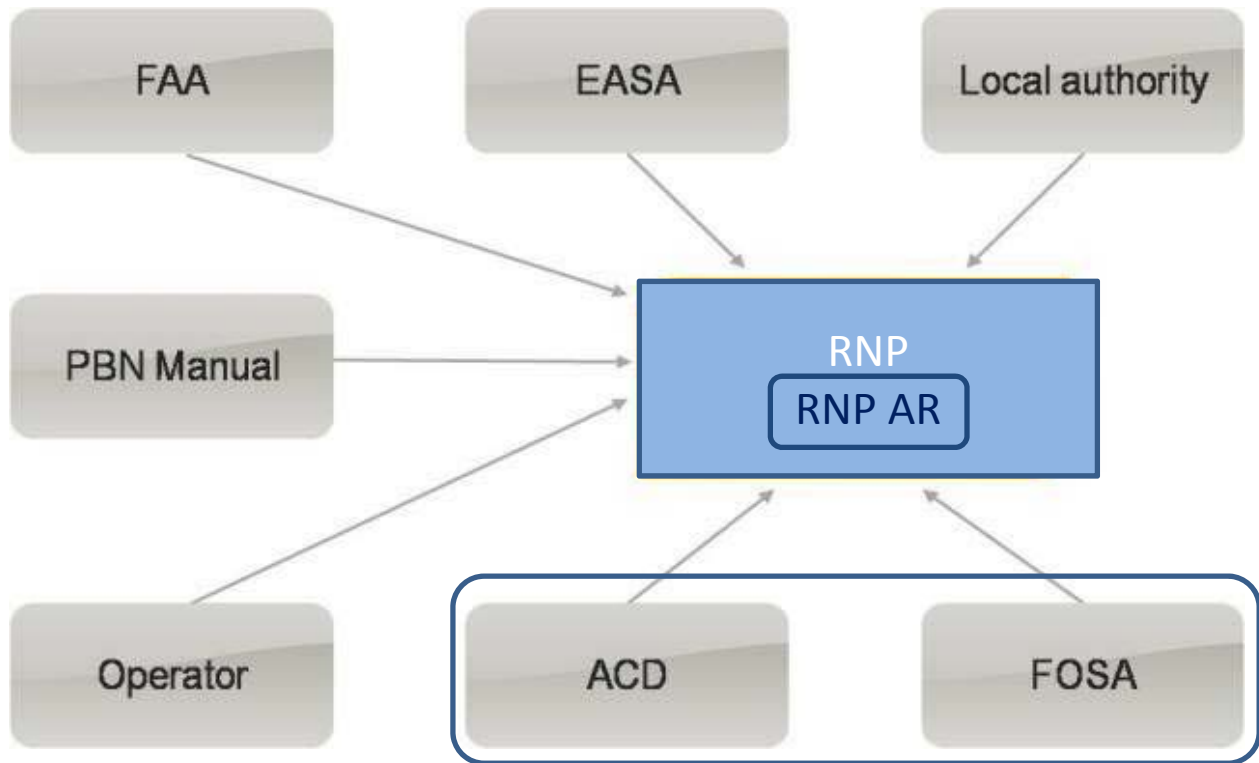
Training



- PBN Operations Approval Process
 - ✓ Different requirements in existing PBN regulation
 - ✦ Training



Training requirements for RNP AR APCH





RNP-APCH versus RNP-AR: Requirements

	RNP APCH	RNP-AR
Aircraft equipment SA/LR	1 FMS + 1 GPS	Aircraft Modification
MEL	1 FM 1 GPS	2 FM 2 GPS + RA /flight control computers / EFIS /MCDU/ AP / FD / FCU TAWS
AFM / FCOM	/	Additional sections (Mod Package)

Note: The operators holding an RNP AR operational approval according to EASA AMC 20 -26 or FAA AC 90-101A also meet RNP approach requirements.

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RNP-APCH versus RNP-AR: Requirements

	RNP APCH	RNP-AR
RAIM prediction	Yes	Yes
Procedure	Public	Private / Public Procedure to be validated by Aircraft model, and FMS version
Navigation DATABASE	Public	Restricted / Public
Control of NDB process	Yes	Yes

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RNP-APCH versus RNP-AR: Requirements

	RNP APCH	RNP-AR
Dispatcher Training	Approved generic training	Approved training <i>Note: Credit may be given for existing RNP training</i>
Maintenance training	Approved generic training	Approved Training <i>Note: Credit may be given for existing RNP training</i>

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Note: The operators holding an RNP AR operational approval according to EASA AMC 20 -26 or FAA AC 90-101A also meet RNP approach requirements.



RNP-APCH versus RNP-AR: Requirements

	RNP APCH	RNP-AR
Crew Training	<p>Approved generic training</p> <p><i>(May be integrated in the current training program)</i></p>	<p>Approved Training + <i>(Specific Training if Category C Airport)</i></p> <p><i>Note: Credit may be given for existing RNP training</i></p>

(2) RNP AR Recurrent Training. Each pilot must complete at least two RNP AR approach procedures: one as pilot flying and one as pilot monitoring. These two RNP AR approaches shall employ the unique AR characteristics of the operator’s approved procedures (i.e., RF legs, RNP missed). You must fly one approach to the DA and one approach must result in an RNP missed approach procedure. One of the above approaches will include either an interrupted approach resulting in vectors to resume the approach or a hold at an IAF or transition fix.

NOTE: An RNP AR procedure may be substituted for any required precision or nonprecision approach.

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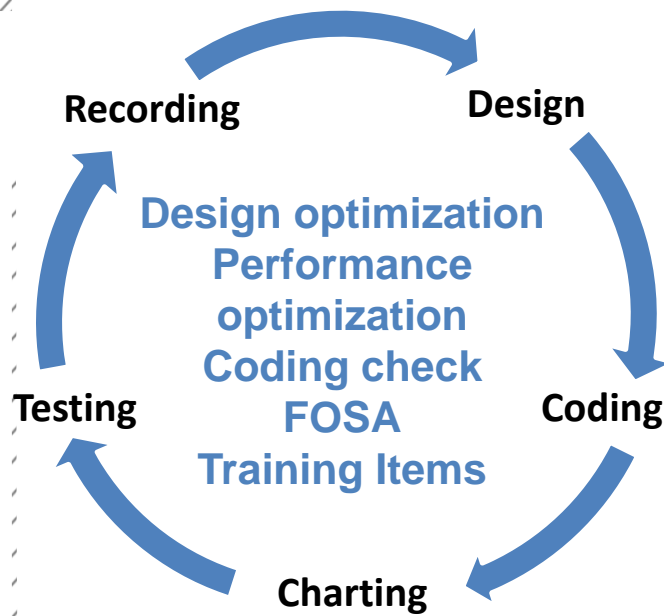


Training - part of the approval process



- Crew
- Dispatcher
- ATC (according to authorities needs)

Training package



Training package

The screenshots show various components of the training package software, including a main menu for RNP AR OPERATIONS, a graph for REQUIRED NAVIGATION PERFORMANCE, and a detailed training matrix for GENERIC RNP AR TRAINING.



Training - part of the approval process

Application Package

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	CHINA SOUTHERN AIRLINES LI JIANG RNP AR - Application package		中国南方航空 CHINA SOUTHERN		Ref: ZPLJ_RNP_CSN_001 Date: 09th September 2010 Version: 1 Revision: 0
TABLE OF CONTENTS					
1	INTRODUCTION	6			
1.1	ACRONYMS AND DEFINITIONS	7			
1.1.1	Acronyms	7			
1.1.2	Definition of terms and expressions	10			
1.2	REFERENCE DOCUMENTS	12			
2	AIRCRAFT QUALIFICATION	15			
3	PROCEDURES DESIGN	16			
3.1	PROCEDURE DESIGN SUMMARY	16			
3.2	AIRPORT DATA	16			
3.2.1	Airport	16			
3.2.2	Runway 02/20	16			
3.2.3	Declared distances	17			
3.3	MINIMUM SECTOR ALTITUDE	17			
3.4	RUNWAY 02	18			
3.4.1	Runway 02 – Approaches	18			
3.4.2	Runway 02 – Departures	19			
3.4.3	Runway 02 EOSID	20			
3.5	RUNWAY 20	21			
3.5.1	Runway 20 – Approaches	21			
3.5.2	Runway 20 – Departures	22			
3.5.3	Runway 20 – EOSID	23			
3.6	LI JIANG PROCEDURES CHARACTERISTICS	24			
3.6.1	Path terminators	24			
3.6.2	Minimas	24			
3.6.3	Missed approach	24			
3.6.4	Temperature limits	24			
3.7	CHARTS - RWY 02	25			
3.7.1	RWY 02 – SID chart	25			
3.7.2	RWY 02 – EOSID chart	26			
3.7.3	RWY 02 – Initial Approach chart	27			
3.7.4	RWY 02 – Final Approach chart	28			
3.8	CHARTS - RWY20	29			
3.8.1	RWY 20 – SID/EOSID chart	29			
3.8.2	RWY 20 – Initial Approach chart	30			
3.8.3	RWY 20 – Final Approach chart	31			
4	OPERATING PROCEDURES AND CONSIDERATIONS	32			
4.1	PREFLIGHT CONSIDERATIONS	32			
4.1.1	Minimum Equipment List	32			
4.1.2	Sataflight®: GPS Prediction service	32			
5	NAVIGATION DATABASE VALIDATION PROGRAM	39			
5.1	DATA PROCESS	39			

NAVIGATION PROGRAM





Training - part of the approval process

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5.1.1 Aircraft NavDB loading.....39

6 TRAINING.....

6.1 FLIGHT CREW TRAINING PROGRAM..... T

6.2 INITIAL TRAINING

6.2.1 *Ground training program*

6.2.2 *Flight training segments*.....

6.2.3 *Evaluation module*.....

6.3 FLIGHT DISPATCHER TRAINING.....

6.4 RECURRENT TRAINING

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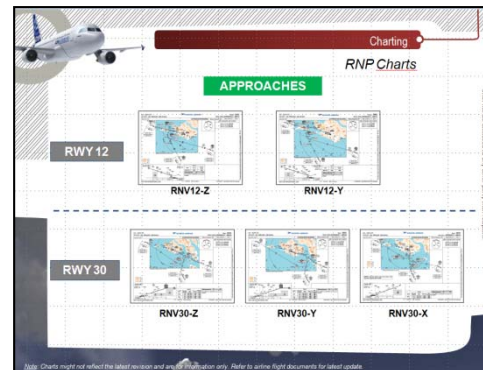


Training concept

A customized solution for Flight Crew Training

Generic training

- CBT
- Chart presentation
- FFS session



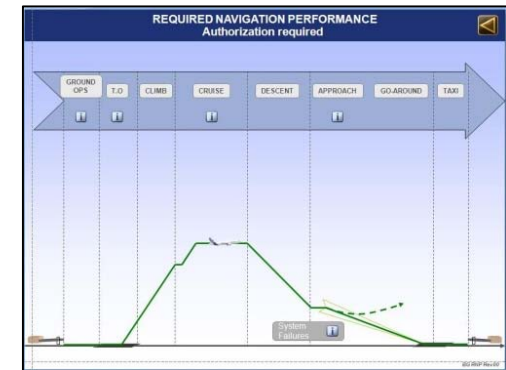


Training concept

A customized solution for Flight Crew Training

Specific training

- Procedure design presentation
- Normal procedures presentation
- Non-normal procedures presentation
- FFS session





Training concept

Multiple Airports

Airlines may have several RNP-AR approaches in their network:
RNP-AR training based on the most demanding airport covers skill and knowledge for less demanding airports.



Conclusions

- PBN Operations Approval Process
 - ✓ Different requirements in existing PBN regulation
 - ✦ Conclusions



Conclusions

- Aircraft eligibility can be easily assessed through Aircraft Flight Manual (AFM)
- An Ops approval Check List / Compliance Matrix should be considered by Flight Inspectors
- FOSA should be considered
- Operational Approval is not a one shot exercise and should be continuously monitored



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