



RNP-AR Training & FOSA

(Flight Operational Safety Assessment)



Presented by
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TRI/TRE - Flight Operations Expert

What is RNP-AR in 2015

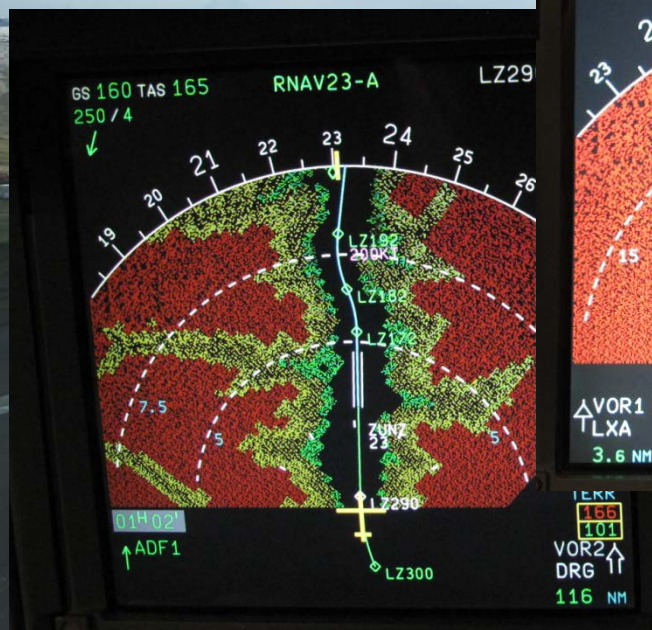




What is RNP-AR in 2015

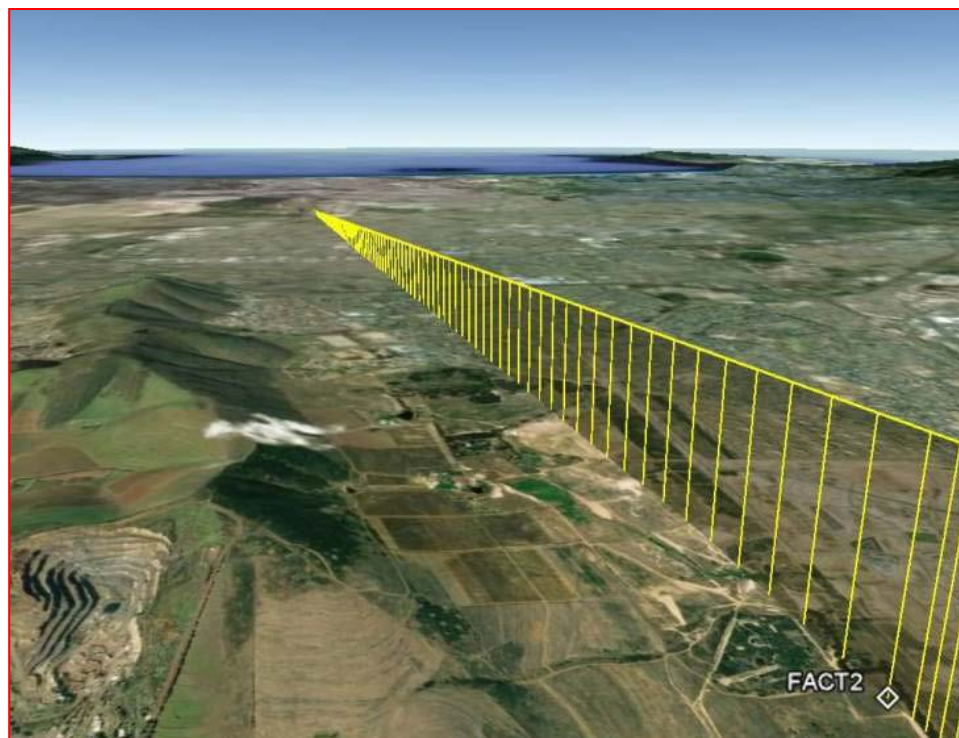
➔ RNP-AR gives access to rich terrain environment airport

- ➔ Safest procedures
- ➔ Better Minimums



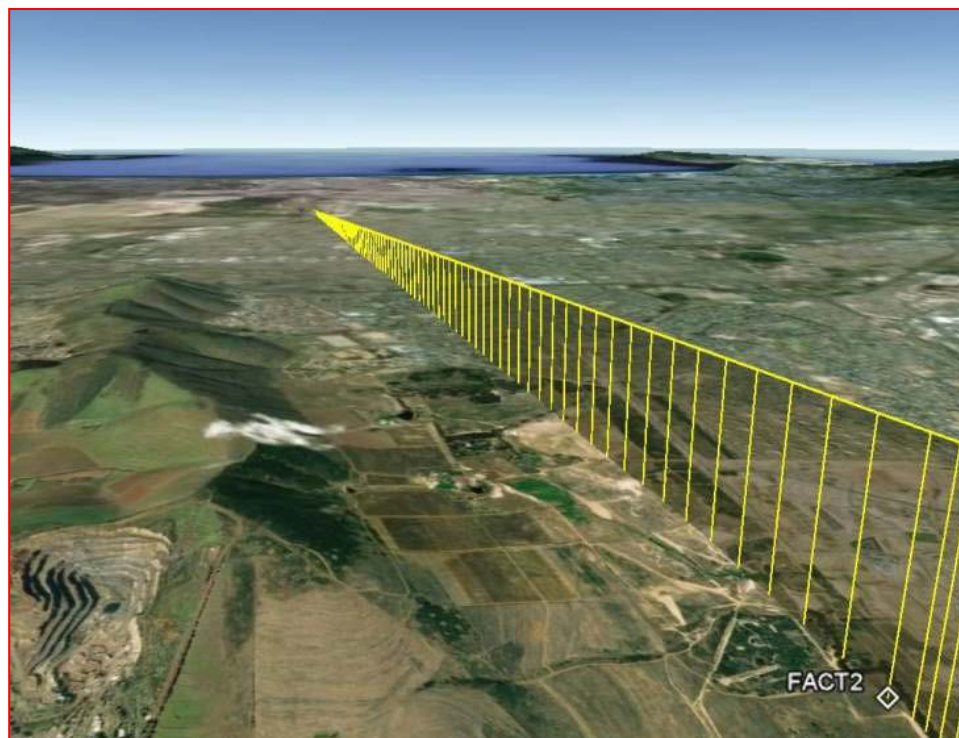
What is RNP-AR in 2015

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What is RNP-AR in 2015

- ➔ RNP-AR gives access to rich terrain environment airport
 - ➔ Safest procedures
 - ➔ Better Minimums
- ➔ RNP-AR used for its benefits in:
 - ➔ Track miles & Fuel saving
 - ➔ Airspace saving & traffic separation
 - ➔ Precision approach overlay
 - ➔ Parallel runways operations



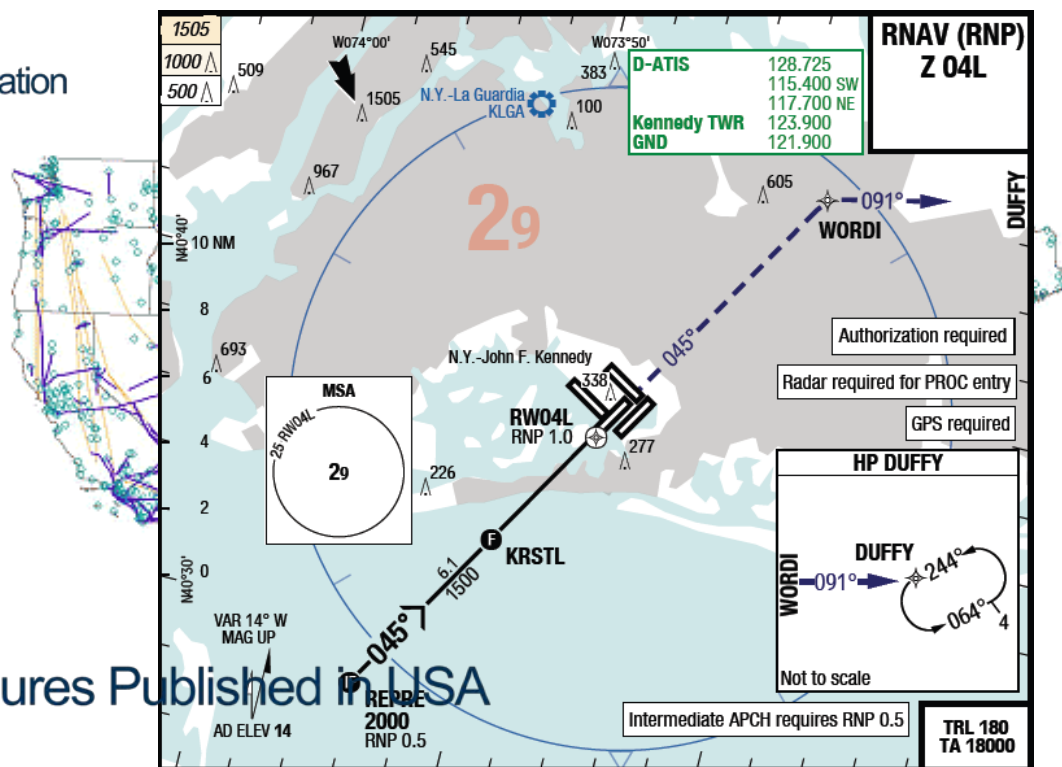
What is RNP-AR in 2015

→ RNP-AR gives access to rich terrain environment airport

- Safest procedures
- Better Minimums

→ RNP-AR used for its benefits in:

- Track miles & Fuel saving
- Airspace saving & traffic separation
- Precision approach overlay
- Parallel runways operations



Over 400 RNP-AR Procedures Published in USA

RNP-AR Training & FOSA

1

Lesson Learned

2

Part of the Approval Process

3

Flight Operational Safety Assessment

4

Training Syllabi

5

Airline RNP-AR Training Concept



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Lessons learned

➔ 44 Airports

- 84 runways
- 634 RNP-AR procedures

➔ 35 Airlines Customers

➔ 17 National Aviation Authorities

➔ More than 200 Type Rating Instructors Trained for RNP-AR Training

➔ More than 12 Aircraft Types...

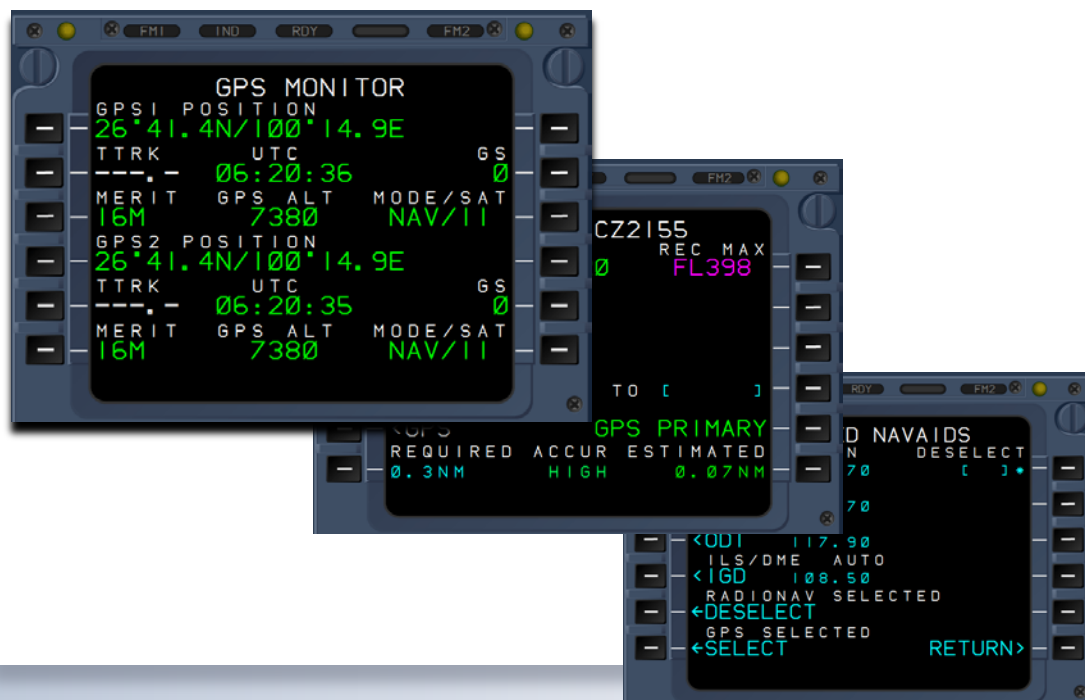
- Airbus, Boeing, Gulfstream,...

Train the Trainer
for RNP-AR



Lessons learned: Training Content

- ➔ All pilots adapted to RNP procedures with no significant problems (Cat C airport).
- ➔ Training issues related to aircraft operation not RNP procedures
 - Crews not familiar with use of FMGS outside narrow daily usage
 - Training directed towards understanding of FMGS capability rather than simply developing new approach technique



- [illegible]

Lessons learned: Simulator (Environment Fidelity)

- ➔ Visual scene (Cat C airport) was regarded as very accurate for airport being trained.
- ➔ Use of generic runway was not an issue



Lessons learned: Simulator (Environment Fidelity)

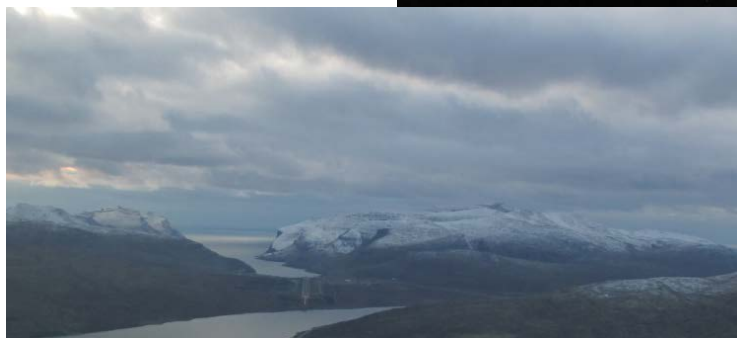
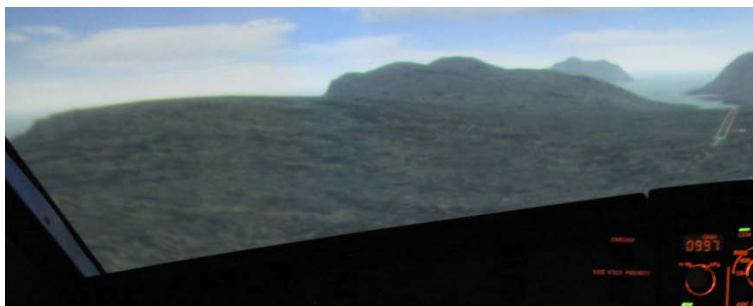


➔ Accurate terrain is more important than accurate visual scene



Lessons learned: Simulator (Environment Fidelity)

- ➔ Visual scene (Cat C airport) was regarded as very accurate for airport being trained.
- ➔ Use of generic runway was not an issue
- ➔ Accurate **TAWS terrain data base** is more important than accurate visual scene



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Airline RNP-AR Training Concept

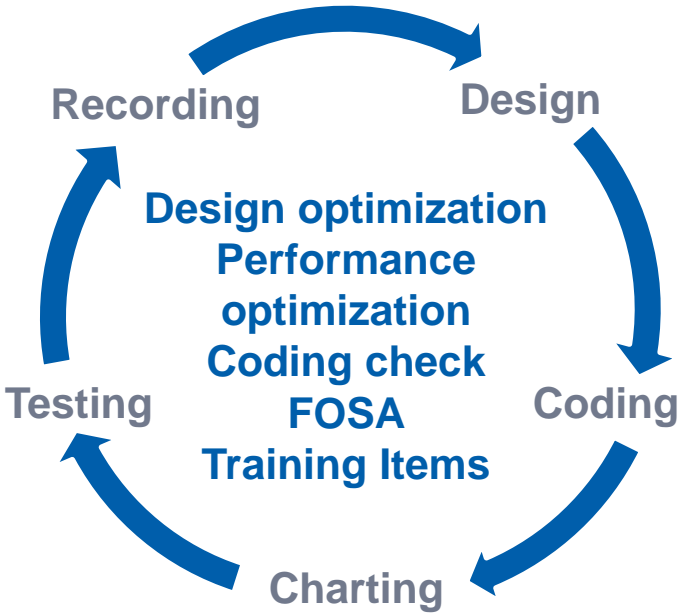


Training, Part of the Approval Process



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

Training package



Training package

Three overlapping screenshots of RNP AR training materials. The leftmost screenshot is titled 'RNP AR OPERATIONS' and shows a list of topics including AC Positioning, Navigation Performance, RasterMap, Procedure Design, AC Performance Considerations, Flying Techniques, SOPs Normal Operation, SOPs Abnormal Operation, and Guide to Final App Mode. The middle screenshot is titled 'REQUIRED NAVIGATION PERFORMANCE' and shows a graph of performance metrics. The rightmost screenshot is titled 'GENERIC RNP AR TRAINING' and shows a table of training items.

RNP-AR Training & FOSA

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Training Syllabi

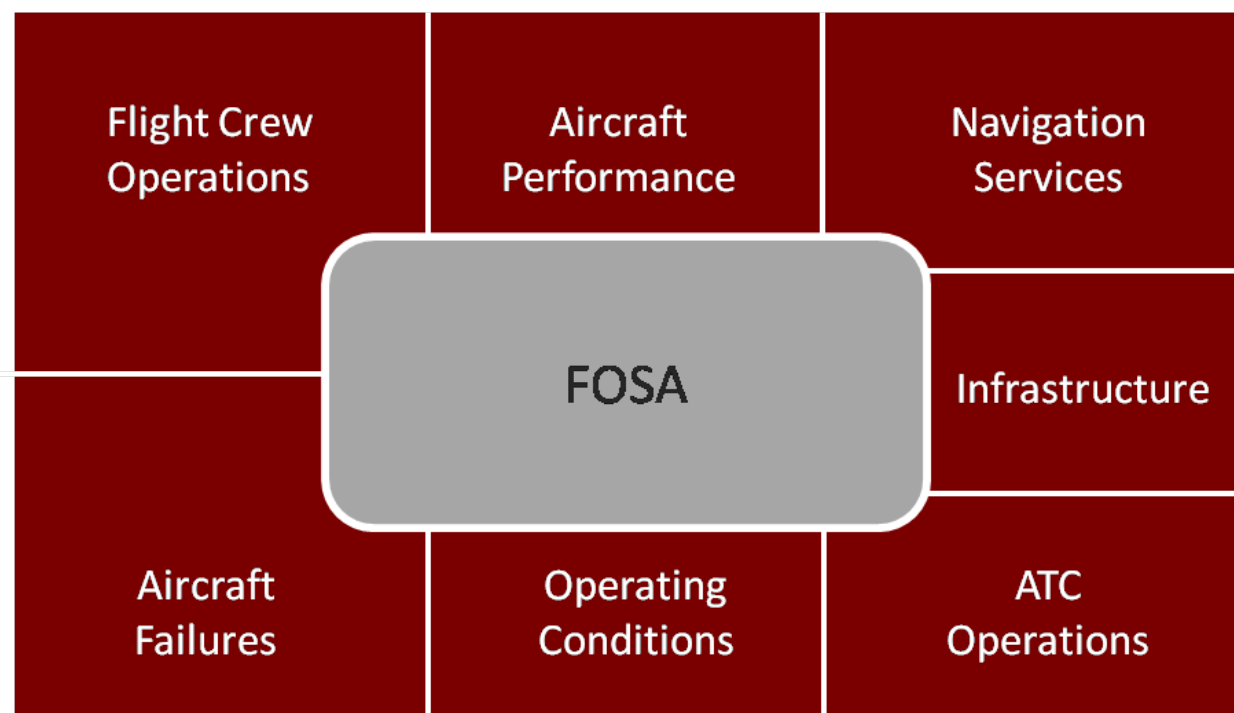
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Airline RNP-AR Training Concept




How should a FOSA be conducted?

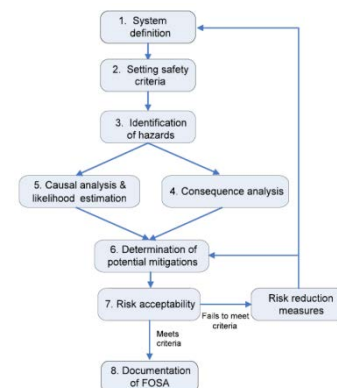
The FOSA should integrate components from the various domains of flight operations affecting the **safe** conduct of an RNP procedure:



How should a FOSA be conducted? - Checklist

For each particular FOSA aspect, the following flow should be followed:

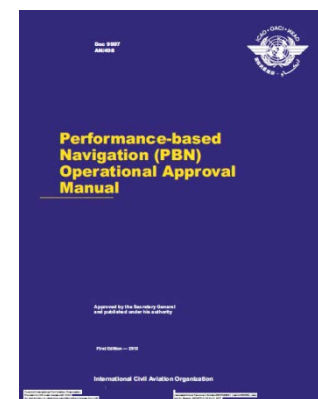
- 
- 1) System analysis and definition criteria;
 - 2) Identification of hazards;
 - 3) Estimation of the consequences of hazards;
 - 4) Estimation of the probability / severity of the consequences;
 - 5) Estimation of risk;
 - 6) Acceptance / risk mitigation;
 - 7) Documentation of the evaluation.



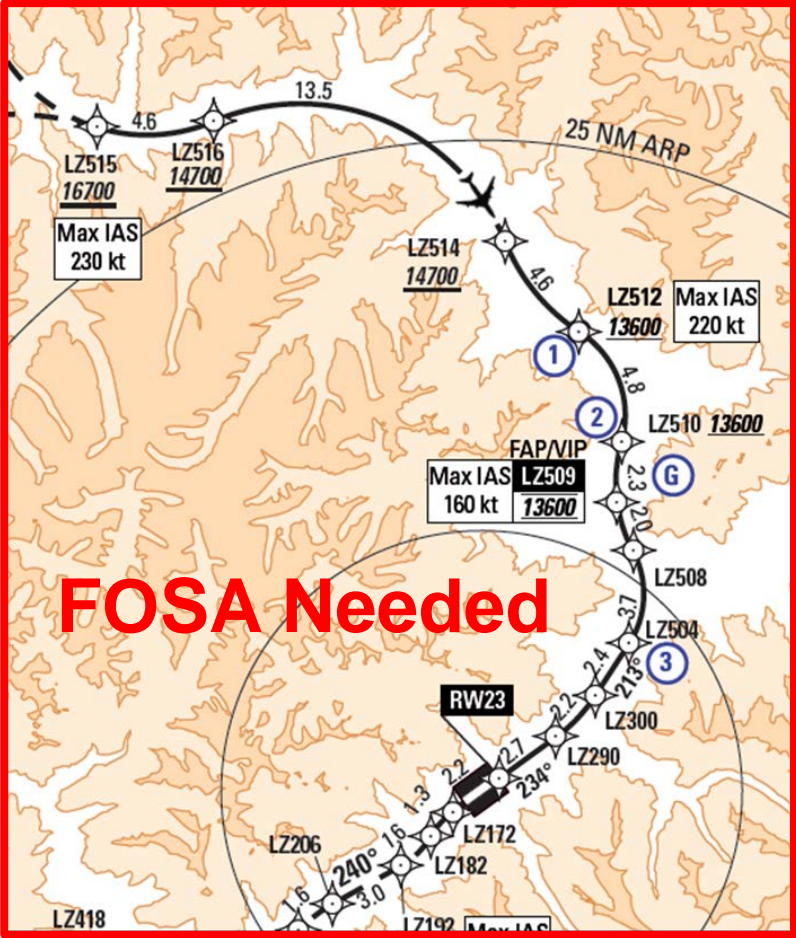
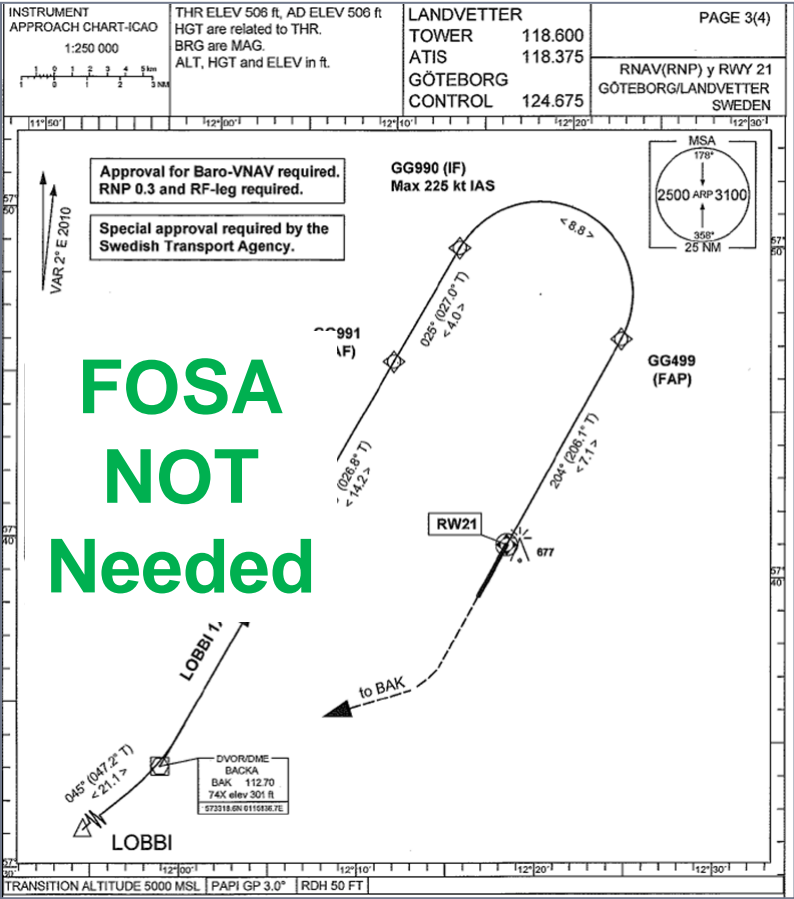
When should a FOSA be conducted ?

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**.

Performance-based
Navigation (PBN)
Operational Approval
Manual
ICAO DOC 9997



When should a FOSA be conducted ?



When should a FOSA be conducted ?

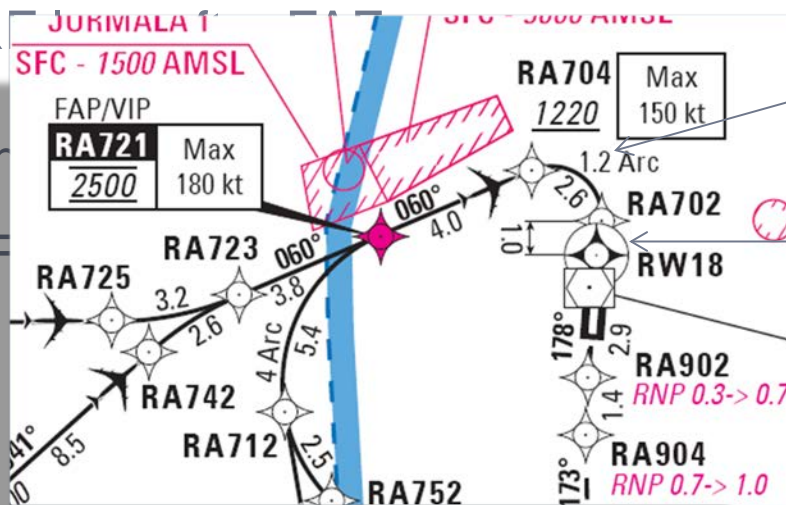
Examples of conditions that may require an assessment:

- Special airport (e.g.. CAT C) or special environmental conditions (e.g.. terrain, complex location of the airport...);
- Use of low RNP values (below 0.3);
- Use of RF legs after FAF;
- Deviations from ICAO nominal criteria (e.g. steeper bank angles, reduced FROP distance).

When should a FOSA be conducted ?

Examples of conditions that may require an assessment:

- Special airport (e.g.. CAT C) or special environmental conditions (e.g.. terrain, complex location of the airport...);
- Use of low RNP values (below 0.3);
- Use of RNP 0.3 or below in the final approach segment;
- Deviation from the standard final approach path (FAP) or reduced FAP length;
- Steeper bank angles, short stabilization in final

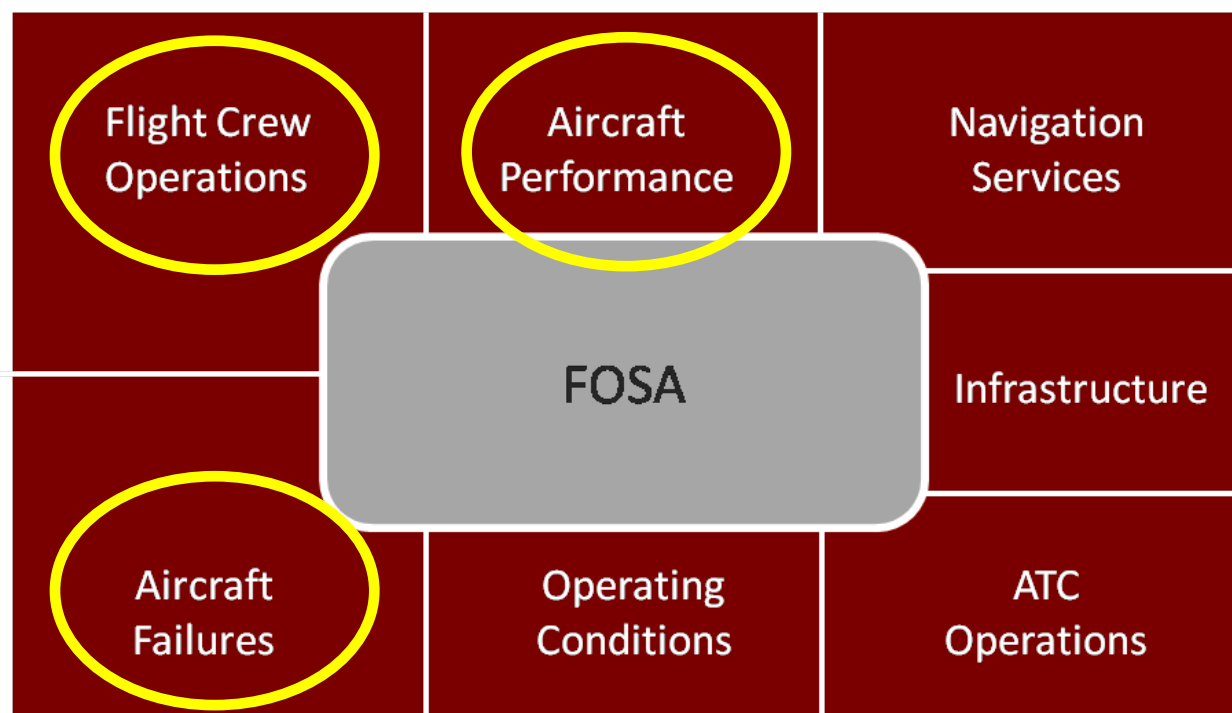


RF leg in final after FAP
Small Arc radius

Short stabilization in final

How should a FOSA be conducted?

The FOSA should integrate components from the various domains of flight operations affecting the **safe** conduct of an RNP procedure:



How should a FOSA be conducted? – Flight Crew Ops.

- Are there any deviations from ICAO and what are their impact on the aircraft?

Examples: bank angles, FROP, TOGA to NAV...

- Have the more stringent criteria been used and what is the impact ?

Examples: Steep slope (descent and/or final), higher than usual climb gradient, close terrain (TAWS system impact), overall complexity of the procedure (capability of the NAV mode guidance), tight RF legs, multiple speed restrictions (not automatic on some aircraft), RF in final, high MSA etc...

- Evaluation of normal SOPs, and need for specific procedures to be applied (eg : use of SPD BRK, unusual L/G extension, ...)

Responsibility: Operator, with inputs of procedure design

Flight Crew
Operations

How should a FOSA be conducted? – Aircraft Performance

- What are the performance limits of the procedure?
- Dedicated TOW assessment;
- Dedicated Missed Approach assessment;
- Need for dedicated Engine Out track, and positioning of Diversion Point;
- Need for specific operating procedures (EO ACC ALT...).

Responsibility : Operator, with inputs of procedure design

Aircraft
Performance

How should a FOSA be conducted? – Aircraft Failures

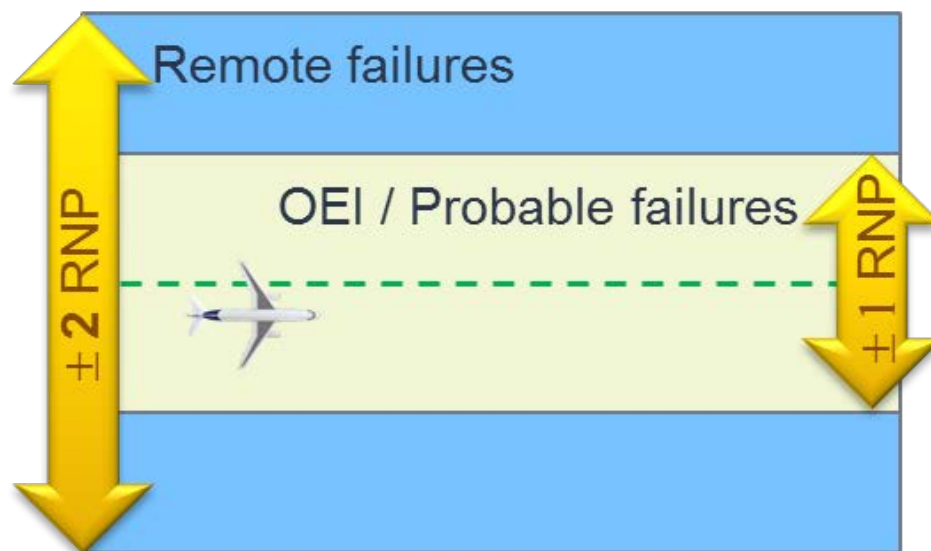
- Engine failure;
- Failure affecting guidance systems (AP, FD..);
- Loss of GNSS signal;
- Assessment of failures effect on RNP capability (below demonstrated value);
- Minimum equipment required.

Responsibility : Operator

Aircraft
Failures

Aircraft Navigation Performance

EASA regulation for aircraft manufacturer

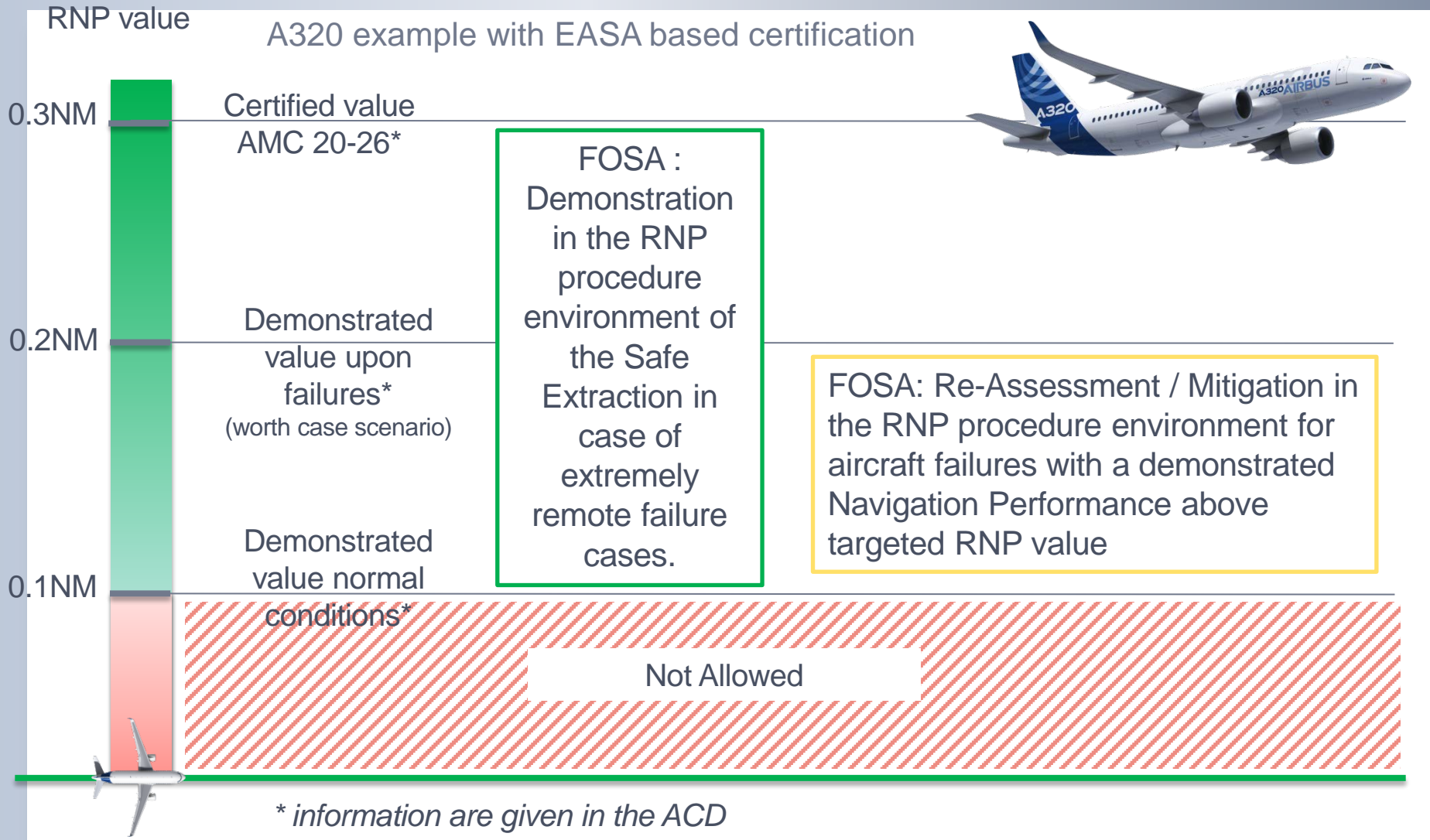


Safe extraction for extremely remote failures

Aircraft Navigation Performance

OEM Certification Process	Operator Operational Approval
Flight and simulator test demonstrations	Assessment value:
RNP values: <ul style="list-style-type: none"> • Normal Conditions • Non-Normal Condition 	Certified RNP values to be considered may indeed depends on the local operational risk assessment (FOSA)
Performance assessment based on the max observed XTK during Flight Test, with a large sampling of: <ul style="list-style-type: none"> • Procedure type (approach, missed approach, and SID) • Legs type (RF radius – transitions) • A/C weight and CG • Weather • All engine and engine out conditions 	Based on the given procedure design Operational approval may be conditioned to an operational / environmental envelop” Operational “mitigation” consideration
Extremely remote failure cases	Contingency procedures are needed in rich obstacle environment, tailored to the procedure (Safe Extraction)

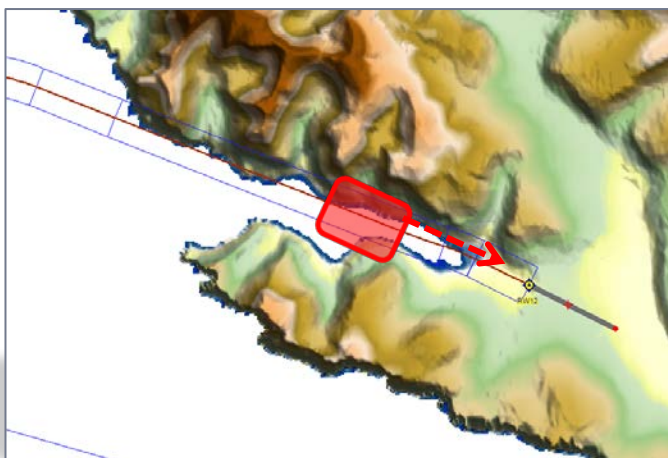
FOSA: Aircraft Navigation Performance aspects



FOSA: Aircraft Navigation Performance aspects

Example of remote failure and associated risk assessment: **Loss of NAV mode**

- ✓ This failure will result in reversion to HDG mode on this current aircraft heading.
- ✓ The criticality of this failure is much more severe in steep turn (RF) than straight line (TF).



Designed in RNP 0.1
Failures less critical



Designed in RNP 0.2
Failures have more effect
on track deviation

FOSA: Aircraft Navigation Performance aspects

Example of remote failure and associated risk assessment: **Loss of NAV mode**

Objectives of the detailed FOSA: To show that the containment of critical failures is within the **safety objectives defined by AMC 20-26**, and to determine which specific procedures should be implemented to train flight crews.

7.2.6.2 Loss of NAV mode

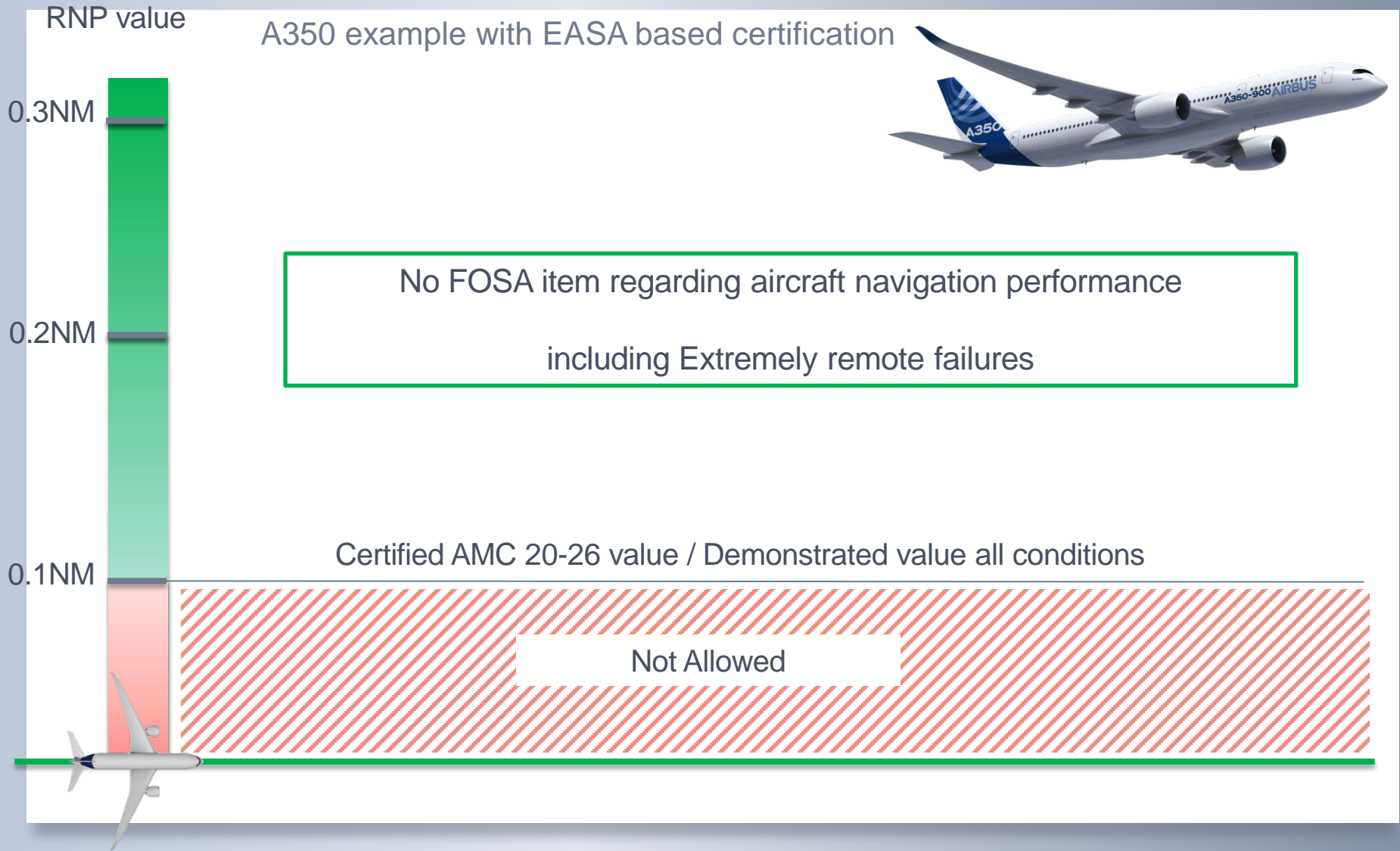
Containment objective: **2xRNP**

SIM Ref	RNP track	RNP level	Location of failure	Description of failure	Max XTK	Max VDEV
SIM8 – Item 6	RNV30X	0.20	Passing 1000 ft	Loss of NAV mode	0.05L	Not signif. (1)
SIM8 – Item 11	RW30 – 1N Dep	0.15	At liftoff	Loss of NAV mode	0.07L	N/A
SIM9 – Item 1	RW12 – 1T Dep	0.15	At liftoff	Loss of NAV mode	Not signif. (1)	N/A
SIM9 – Item 3	RNV12Y	0.10	At VG417	Loss of NAV mode	0.04L	N/A

(1) Not significant means less than 0.03nm (LDEV) or not less than -10 ft (VDEV)

*Failure testing matches safety objective :
containment with 2xRNP*

FOSA: Aircraft Navigation Performance aspects



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Airline RNP-AR Training Concept



RNP-AR Training Syllabi

Initial Crew training:

➔ Generic training

- 4h00 CBT



GENERAL

A/C PERFORMANCE
CONSIDERATIONS

A/C POSITIONING

FLYING
TECHNIQUES

NAVIGATION
PERFORMANCE

NORMAL
OPERATION

BaroVNAV

ABNORMAL
OPERATION

PROCEDURE
DESIGN

GUIDE TO FINAL
APP MODE

RNP-AR Training Syllabi

Initial Crew training:

➔ Generic training

- 4h00 CBT

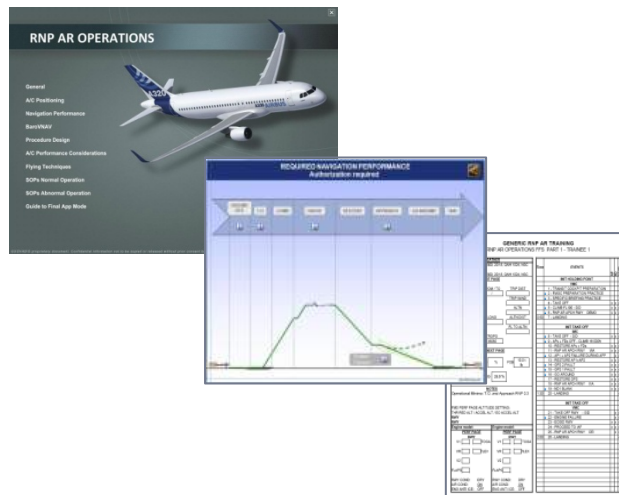


RNP-AR Training Syllabi

Initial Crew training:

➔ Generic training

- 4h00 CBT
- Chart study
- 1h30 FFS Briefing
- 4H00 FFS session



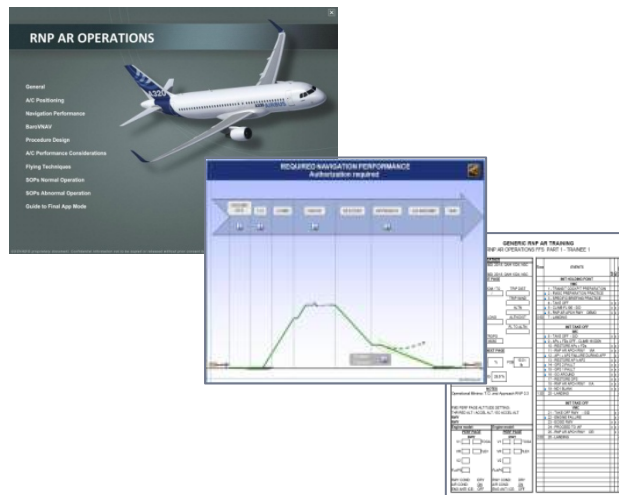
May satisfy RNP-AR training requirement
for all non-limitative environments

RNP-AR Training Syllabi

Initial Crew training:

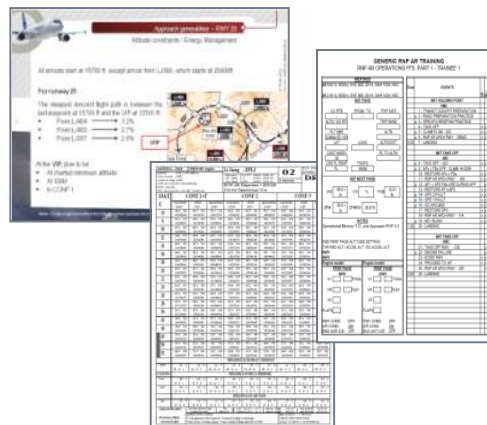
➔ Generic training

- 4h00 CBT
- Chart study
- 1h30 FFS Briefing
- 4H00 FFS session



➔ Specific training (Non-Standard Airport)

- Procedure design
- Normal procedures
- Non-normal procedures (FOSA)
- 1h30 FFS briefing
- 4H00 FFS session



RNP-AR Training Syllabi

GEN

Ground Training Segment

- 4 CBT modules
- Charts general

Flight Training Segment

01:30 Briefing
Briefing guide

Simulator
Generic
04:00

Defined list of failures:

- Autopilot
- GPS / Position
- FMGC
- Engine

SPEC

Ground Training Segment

- Proc Design
- Normal Ops
- Abnormal Ops
- FCOM Review

Flight Training Segment

01:30 Briefing
Performance
EOSID, DP
Energy Mngt

Simulator
Specific
04:00 1st A/P

Contingency procedures
Engine failure cases

RNP-AR Training Syllabi

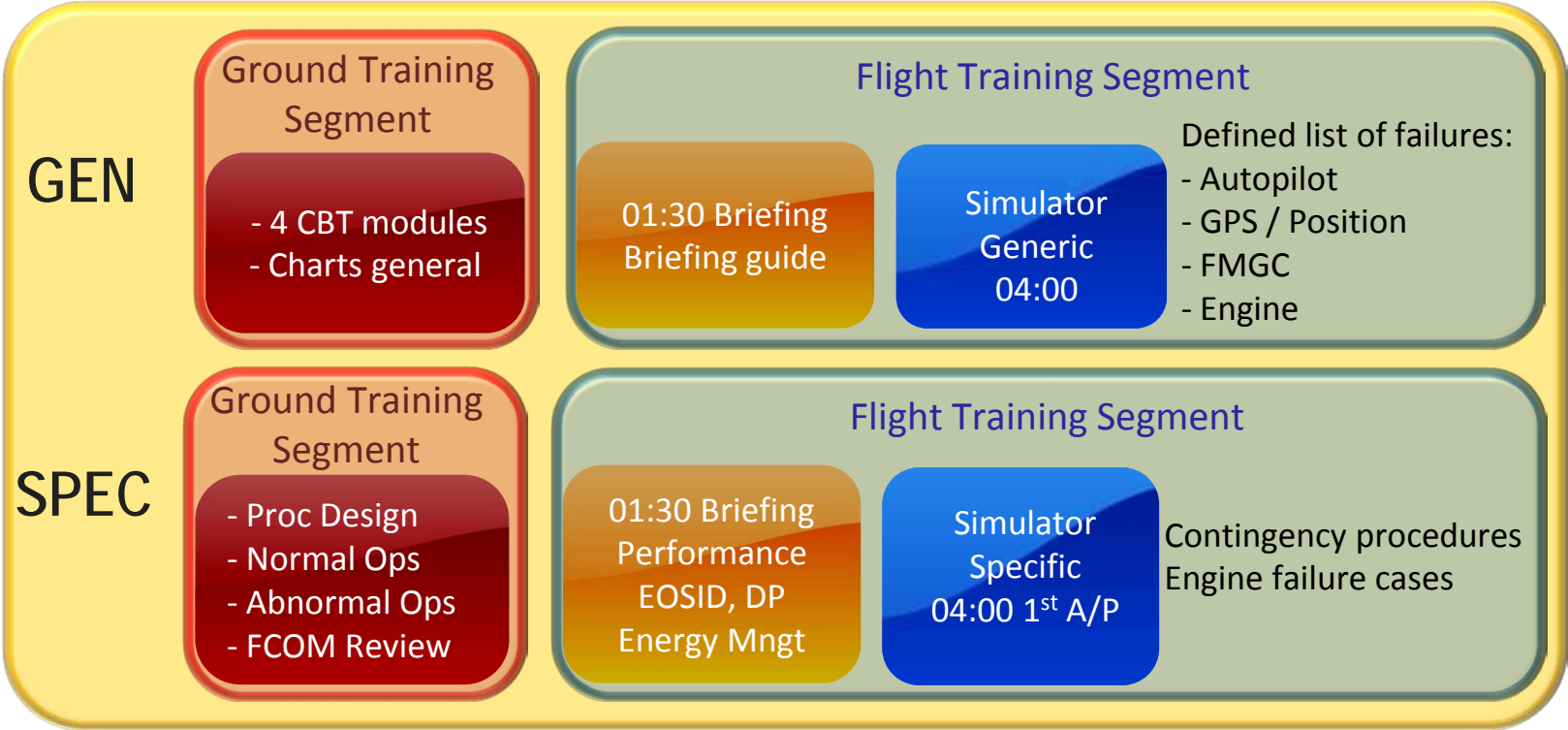
GEN



SPEC

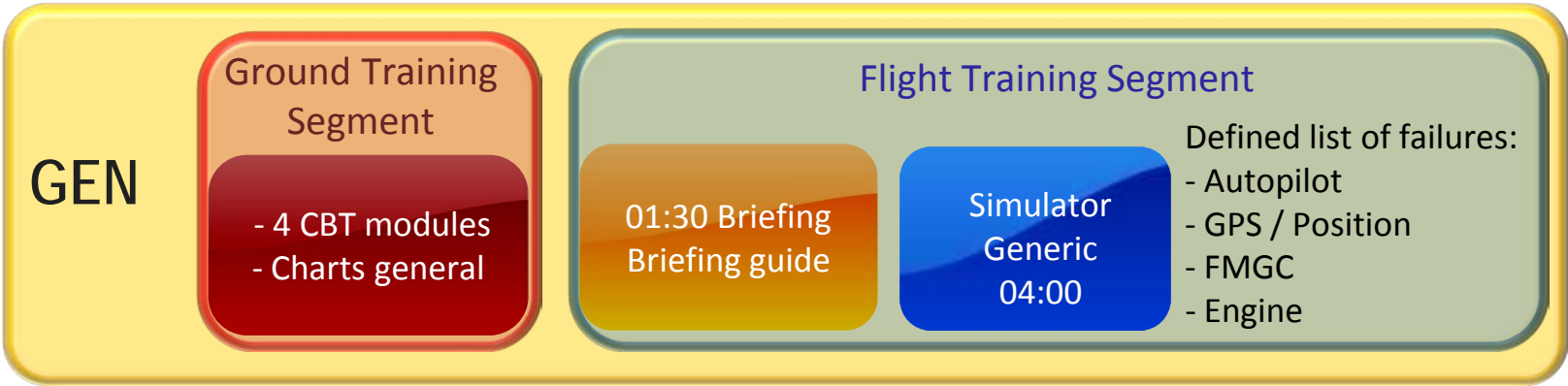


RNP-AR Training Syllabi

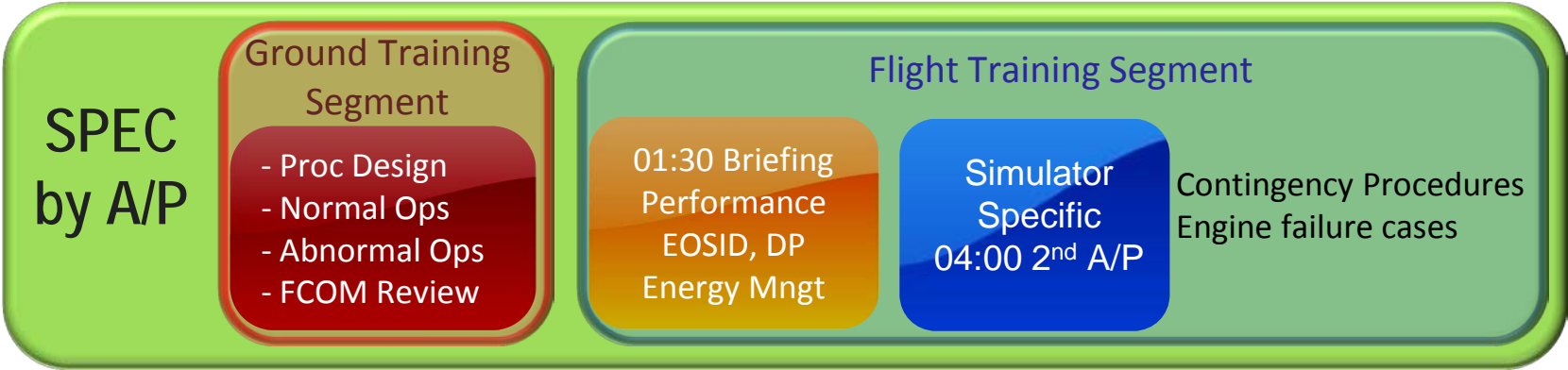


RNP-AR Training Syllabi

All Standard Airports



Additional Specific Training by Non-Standard Airports



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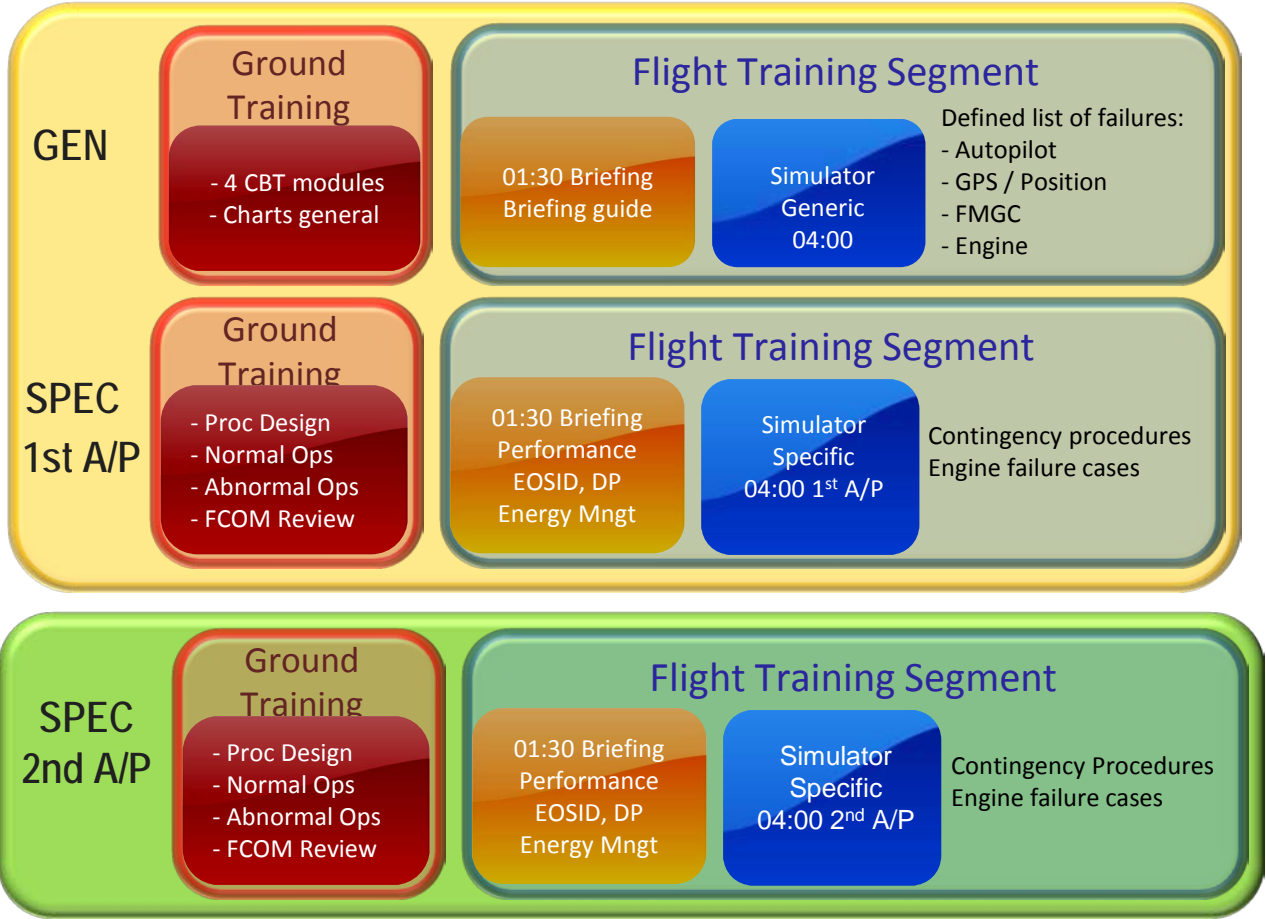
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Airline RNP-AR Training Concept



Airlines RNP-AR Training Concept

➔ What if: Airlines have several RNP-AR approaches in their network:



Airlines RNP-AR Training Concept

➔ What if: Airlines have several RNP-AR approaches in their network:
Solution:

Identify what shall be trained due to:

- RNP-AR procedures
 - Navigation Data Base Check
 - Flyability Check
 - Operator FOSA *(when needed)*
- AIRPORT specificities → Airport AIP

“Operators intending to receive credit for RNP training, when their proposed programme relies on previous training must receive specific authorisation from their approving authority.”

Airlines RNP-AR Training Concept

→ Airport Categorization (AMC1 ORO.FC.105)

Category "A"	Category "B"	Category "C"
Day and Night OPS + Approved IFR procedures + One non limitative RWY + Circling not above 1000ft	Performance limitations or Non standard APP or Obstruction / Terrain or Special physical layout	Additional consideration to Cat "B"
NIL	Briefing or Self briefing	Briefing + Flight (Observation or under supervision) or FFS training

Airlines RNP-AR Training Concept

➔ What if: Airlines have several RNP-AR approaches in their network:
Solution:

RNP-AR training based on the most demanding one
Covers skill and knowledge for less demanding ones.



Airlines RNP-AR Training Concept

➔ RNP-AR Training Versus Airport Categorization

Category "A"	Category "B"	Category "C"
RNP-AR Generic training		RNP-AR Specific training
Customized to AIRLINE SOP's		Customized to AIRLINE SOP's
Valid for all cat A and B airports <i>(within operator network, upon OPS approval)</i>		Based on FOSA recommendations
		Satisfies CAT C airport requirements

Airlines RNP-AR Training Concept

- ➔ Maintain existing concept of cat A, B, C airfields,
- ➔ Training requirements for RNP AR approaches where terrain is not an issue is straight forward,
- ➔ Cat A and B airports - train to most restrictive airport,
- ➔ Cat C airports – maintain current requirements for specific airport training including RNP AR,
- ➔ RNP-AR Recurrent Training: Train to most representative case. (A, B, C).

Airlines RNP-AR Training Concept

➔ RNP-AR Recurrent Training: Train to most representative case. (A, B, C).

EASA AMC 20-26

4 RNP-AR approaches (2 PF + 2 PM)
1 Missed Approach
1 Full Stop Landing
may be substituted for any required
“precision like” approach

FAA AC 90-101A

2 RNP-AR approaches (1 PF + 1 PM)
1 Missed Approach
1 to DA
may be substituted for any required
precision or non-precision approach.

➔ *Note: Training and recurrent training for RNP-AR are valid for RNP-APCH.*

RNP-AR Training & FOSA

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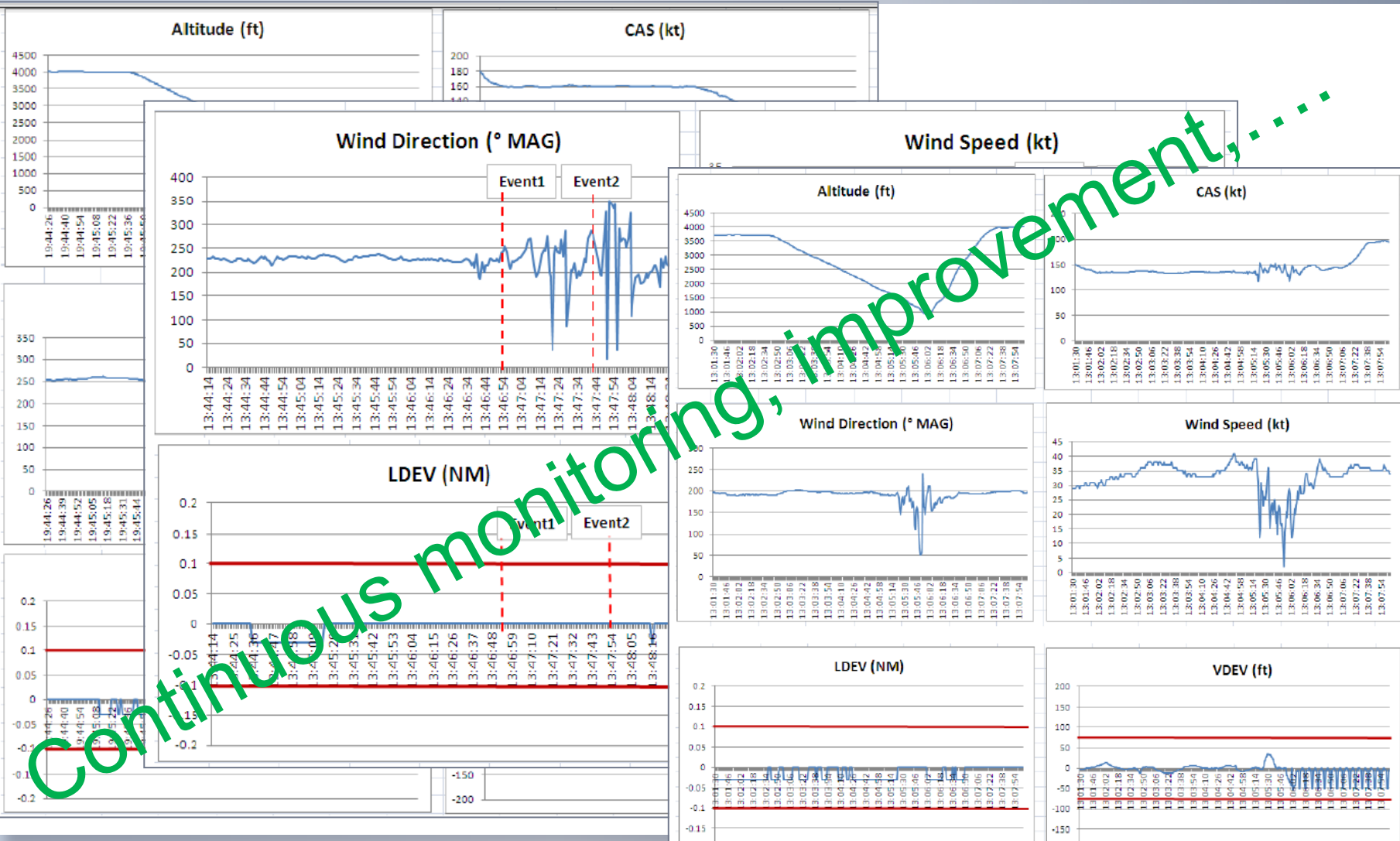
Training Syllabi

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Airline RNP-AR Training Concept



RNP-AR Flight Data Monitoring





- Check Navigation Data Base
 - Check Flyability
 - Maintain existing concept of cat A, B, C airfields
 - train RNP AR items to most restrictive airport
- (Training and recurrent training for RNP-AR are valid for RNP-APCH)*



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