ICAO WACAF Workshop

1st – 4th September 2015

ICAO DOC 9906 IFP Validation & Approval

RNP Procedure Design, Validation and Approval

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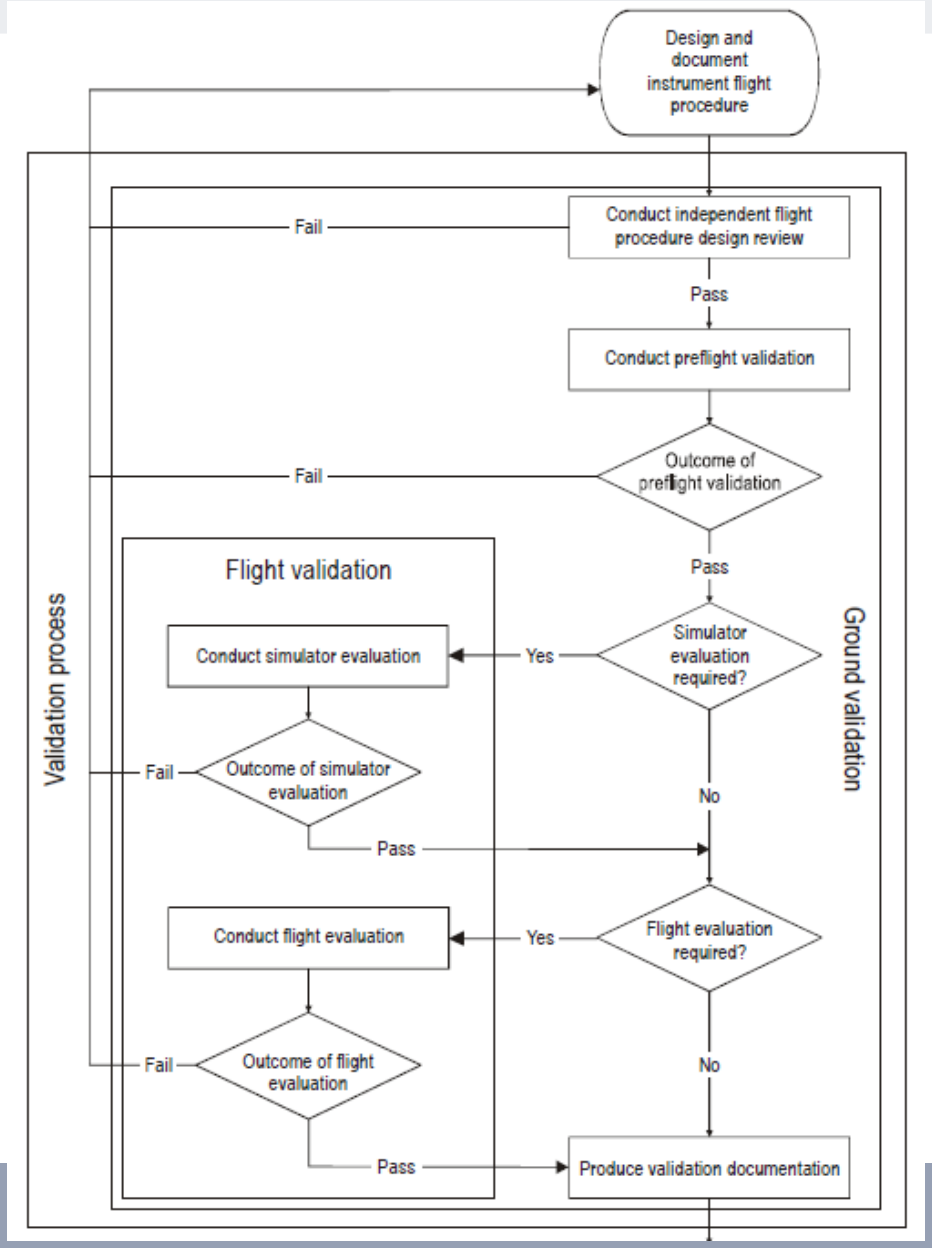

Validation Process Flow Chart

Objective is to give the green light to implement procedure

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RNP Procedure Design, Validation and Approval

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- independent FPD Review
- Pre flight validation
- Simulator evaluation
- Flight Evaluation
- Validation Documentation

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Ground Validation

Independent FPD Review

Ground Validation

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A flight procedure designer other than the one who designed the procedure must perform this step. The designer can be assisted by specialists in other fields of expertise as necessary.

Tasks:

- Confirm correct application of Criteria
- Confirm data accuracy and integrity
- Verify mitigations for deviations from design criteria
- Verify draft chart is provided and correct
- Confirm correct FMS behaviour
- Perform obstacle assessment

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Independent procedure review

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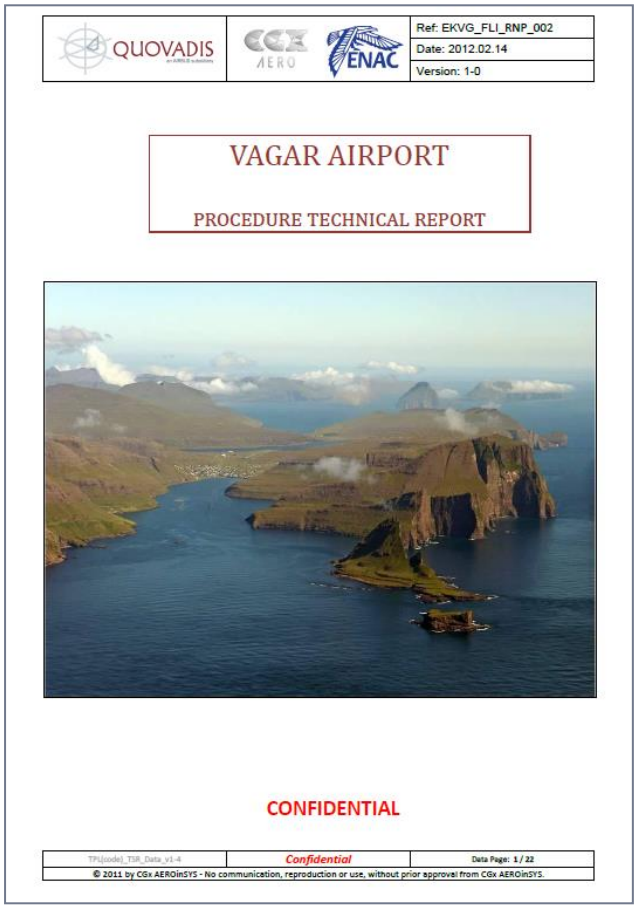
- Technical Report : the document describing the procedure design



QUOVADIS | CGX AERO | ENAC

Ref: EKVG_FLI_RNP_002
Date: 2012.02.14
Version: 1-0

VAGAR AIRPORT

PROCEDURE TECHNICAL REPORT

CONFIDENTIAL

TPL(code)_TSR_Data_v1-4 | *Confidential* | Data Page: 1 / 22

The Technical Report contains:

- References of Obstacle Data
- Minimum Safety Altitude (MSA) construction details
- Holding construction details
- Approach contruction details, including Vertical Error Budget (VEB) and minima calculation .
- Departure construction details

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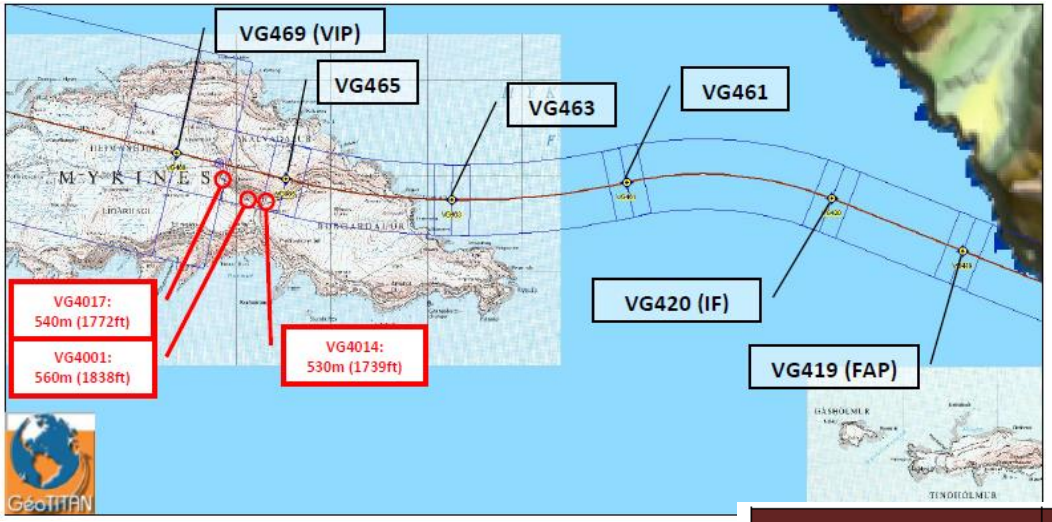
Independent procedure review

- Example : Final approach procedure description



	VG465 RF (L) VG463	VG463 RF (L) VG461	VG461 RF (R) VG420 (IF)
RNP required (NM)	0.1	0.1	0.1
Initial Orientation (°)	104.8207	92.2008	78.8643
Length (NM)	0.9460	1.0001	1.1865
Radius (NM)	4.2851	4.2851	1.9998
Angular amplitude (°)	12.6492	13.3725	33.9951
Max IAS (Kt)	160	160	160
Wind Speed (Kt)	60	50	50
Max TAS (Kt)/ (Altitude (ft))	170 / 3700	168 / 3200	167 / 2800
Max bank angle (°)	11	10	19
Significant obstacle	VG4014	Boat on the sea	Boat on the sea
Obstacle elevation (m)	530	50	50
MOC (m)	300	300	300
MOCA (m/ft)	830 / 2724	350 / 1149	350 / 1149
Safety altitude (ft)	2800	1500 [5]	1500 [5]
Procedure altitude (ft)	3110 [3]	2730 [6]	2000 [4]

Independent procedure review

- Example : Final approach Vertical Error Budget and Obstacle Clearance Altitude calculation

FAP Calculations

Min Intermediate Segment Alt (a):	2 000.00	ft
LTP MSL Elevation (b):	264.00	ft
RDH:	50.00	ft
Vertical Path Angle (VPA):	3.50°	
Distance from LTP to FAP (D):	27 564.33	ft
	4.54	NM

VEB OAS Origin & Gradient

Min Intermediate Segment Altitude:	2000.00	ft
LTP Elevation:	264.00	ft
Vertical Path Angle:	3.50°	
RDH:	50.00	ft
RNP Value:	0.10	NM
Δ ISA:	-24.45°	
Straight In Segment		
(*Wingspan =<262*) **LTP to Origin:**	2142.07	ft
OAS Gradient :	0.055157	
RF Turn Segment | **Bank angle:**	25.00°	
(*Wingspan =<262*) **LTP to Origin:**	2700.21	ft
OAS Gradient :	0.055157	

NON SI UNITS Version 2.2 3/17/09

VPA Temperature Limits

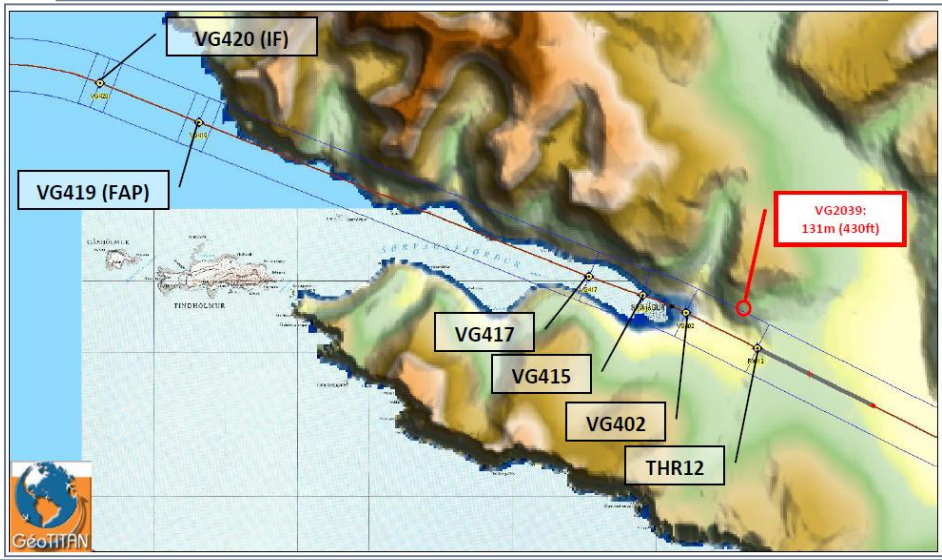
Vertical Path Angle:	3.50°	
Max Vertical Path Angle:	4.00°	
FAP Elevation:	2000.00 ft	
LTP Elevation:	264.00 ft	
ACT:	-10.00°C	
Min Vertical Path Angle	3.29°	
NA Below	-10.00°C	14.00°F
NA Above	42.22°C	108.00°F
NA Below (2.5°)	-67.62°C	-89.72°F

VEB MOC

Vertical Path Angle	3.50°	
LTP MSL Elevation	264.00	ft
RDH	50.00	ft
Tangent of VPA	0.061163	
OAS Gradient	0.055157	
OAS Origin Distance (*measured along-track from LTP*)	2 142.07	ft
Obstacle Distance (*measured along-track from LTP*)	27 564.33	ft
VEB MOC (*at obstacle*)	**334**	ft
OAS_{HGT} (*at obstacle*)	**1402**	ft

IAS: 160kt
TAS: 160.6kt
Vertical path angle: 3.5°
OAS gradient: 5.5157%
Distance origin VEB to threshold:
For straight in segment: 652.9m
For RF turn segment: 823.02m

Controlling obstacle: VG2039
Obstacle elevation: 131m
Distance obstacle (before) threshold: (+) 417.7m (between the threshold and VEB origin)
HL : 150ft
OCA_{final} : 580ft
OCH_{final} : 316ft



Independent procedure review

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- Catch errors in criteria and documentation
  - Skilled procedure designer
  - Good knowledge of design criteria

- ***If the procedure documentation is not compliant with requirements : no validation step is possible***

- DOC 9906 contains a description of what an IFP package should contain (vol5, paragraph 1.5.1). States should either endorse that list or publish their own.

- Independent reviewer should sign off IFP package or an equivalent document

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Ground Validation

Pre flight validation

Pre flight Validation

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This may be a joint activity by flight procedure designers and pilots

Persons performing preflight validation must ensure that the IFP documentation is complete and that all necessary charts, data and forms are available. As a minimum, the following tasks must be performed:

a) Ensure the completeness of the IFP package (i.e. that all forms, files and data are included) as described in Chapter 1, 1.5.1, of this manual.

b) Ensure that charts and maps are available in sufficient detail for assessment of the IFP during the FV.

c) Familiarize with the target population of the procedure (e.g. aircraft categories, type of operation).

d) Discuss the IFP package with the procedure designer, as necessary.

e) Verify that the IFP procedure graphics and data match.

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Pre flight Validation

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Persons performing preflight validation must ensure that the IFP documentation is complete and that all necessary charts, data and forms are available. As a minimum, the following tasks must be performed:

f) Compare the IFP design, coding and relevant charting information against the navigation database used for flight validation.

g) Verify that controlling obstacles and obstacles otherwise influencing the design of the procedure are properly identified.

h) Review the airport infrastructure and special airport regulations.

i) Review the navigation infrastructure used by the procedure.

j) Review pertinent flight inspection documentation, if required.

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Pre flight Validation

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Outcomes:

a) Determine if a flight inspection is necessary.
b) Determine the need for flight simulator evaluation, especially where there are special or unique design considerations.
c) Determine the need for flight evaluation in the aircraft,
d) Record specific additional actions required in a flight validation (if required).
e) Provide a detailed written report of the results of pre-flight validation.

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Testing and Validation : NavDB Coding Check

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Coding check is carried out prior to any testing to, proactively preparing for expected behaviour or coding problems, and take full advantage of the testing slots.

Geodetic System : WGS84 (ITRF08)
Ellipsoïd : WGS84
Elevation System : EGM08

General layout

LP THR07

CODE	THR07
LATITUDE WGS84	13°26'09.5554"N
LONGITUDE WGS84	89°04'10.6794"W
Ellipsoid Height WGS84	21.03 m
Altitude above Mean Sea Level (EGM08)	21.25 m

Threshold 07

Description : Iron circle in the concrete

Photographs

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TQVSP MSLPMSFR07-X ARELTA 010RELTAMSEA0E  A 101IF                    + 09200                          U
TQVSP MSLPMSFR07-X ARELTA 020LP664MSPC0E    101TF                                                   U
TQVSP MSLPMSFR07-X ARELTA 030LP578MSPC0E   L101RF      0065001749    14490020                          U
TQVSP MSLPMSFR07-X ARELTA 040LP574MSPC0E    302TF                    14310036                LPC63 MSPCU
TQVSP MSLPMSFR07-X ARELTA 050LP570MSPC0E   R302RF      0085001431    14310026                          U
TQVSP MSLPMSFR07-X ARELTA 060LP568MSPC0E    302TF                    19500077    + 03900     LPC62 MSPCU
TQVSP MSLPMSFR07-X ARELTA 070LP564MSPC0E    302TF                    19500014                          U
TQVSP MSLPMSFR07-X ARELTA 080LP562MSPC0E    302TF                    19500066    + 03700               U
TQVSP MSLPMSFR07-X ARELTA 090LP560MSPC0E  B 302TF                    19500024                          U
TQVSP MSLPMSFR07-X ARELTA 100LP526MSPC0EE   302TF                    19500020                          U
TQVSP MSLPMSFR07-X R      010LP526MSPC0E  F 302IF                    19500100      03500               U
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TQVSP MSLPMSFR07-X Z      060LP590MSPC0E   R101RF      0050000690    06890047                          U
TQVSP MSLPMSFR07-X Z      070LP533MSPC0E    101TF                    18070097                LPC05 MSPCU
TQVSP MSLPMSFR07-X Z      080LP533MSPC0EE HL   HM                    18070228    + 03000               U
                                                                      3600T010      03000   230         U
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ICAO DOC 9906 vol 5
2.2.2 Evaluate data and coding

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Determine the need for flight simulator evaluation

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A flight validation (simulator and/or aircraft as required) is required in the following cases:

a) if the flyability of a procedure cannot be determined by other means;
b) if the procedure contains non-standard design elements (deviations from criteria, e.g. non-standard approach angles/gradients, non-standard segment lengths, speeds, bank angles);
c) if the accuracy and/or integrity of obstacle and terrain data cannot be determined by other means;
d) if new procedures differ significantly from existing procedures; and
e) for helicopter PinS procedures.

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Determine the need for flight evaluation in the aircraft

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Flight evaluation is required in the following cases:

a) for procedures where runway or landing location infrastructure has not been previously assessed in flight for instrument operations; and

b) as determined by the State Authority.

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Flight Validation

Simulator Evaluation

Procedure Testing and Validation: Objectives

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1.1 The need for validation

The purpose of validation is to obtain a qualitative assessment of procedure design including obstacle, terrain and navigation data, and provides an assessment of flyability of the procedure.

The validation is one of the final quality assurance steps in the procedure design process for instrument flight procedures (IFP) and is essential before the procedure design documentation is issued as part of the integrated aeronautical information package.

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PROCEDURE VALIDATION OBJECTIVES:

1) Terrain and Obstacle data validation

2) Fly-ability check

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Procedure Validation Process (ICAO)

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1.2 Validation process

The full validation process includes ground validation and flight validation.

Ground validation consists of an independent IFP design review and a pre-flight validation. Flight validation consists of a flight simulator evaluation and an evaluation flown in an aircraft. An overview of the necessary steps in the validation process can be found in Figure 1-1. The validation process of IFP(s) must be carried out as part of the initial IFP design as well as an amendment to an existing IFP.

If the State can verify through ground validation the accuracy and completeness of all obstacle and navigation data considered in the procedure design, and any other factors normally considered in the flight validation, then the flight validation requirement may be dispensed with.

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- ✓ Ground testing is required.
- ✓ Flight testing and validation may be dispensed if validation activities can be fully conducted during the ground testing.

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Validation Process (ICAO)

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Benefits of simulator validation compared to flight validation:

4.3.4.3 Many of these factors can be evaluated, entirely or in part, during ground validation. Initial flyability checks should be conducted with software tools allowing the flyability of the procedure to be confirmed for a range of aircraft and in a full range of conditions (wind/temperature, etc.) for which the procedure is designed. The verification of the flyability of an RNAV or RNP procedure can also include independent assessments by procedure designers and other experts using specialized software or full-flight simulators. Flyability tests using flight inspection aircraft can be considered, but it must be borne in mind that this only proves that the particular aircraft used for the test can execute the procedure correctly. This is probably acceptable for the majority of less complex procedures. The size and speed of flight test aircraft can seldom fully represent the performance of a fully loaded B747 or A340 and therefore simulation is considered the most appropriate way to carry out the flyability test. Flight simulator tests should be conducted for those more complex procedures, such as RNP AR APCH, when there is any indication that flyability may be an issue. Software tools that use digital terrain data (typically digital terrain elevation data (DTED) level 1 being required) are available to confirm appropriate theoretical navaid coverage.

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Unique testing capabilities provided by simulator are fully recognized for RNP APCH and RNP AR operations

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Flight Validation – Simulator evaluation

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6.2.4.4 *State ground and flight validation*

6.2.4.4.1 As RNP AR APCH procedures do not have a specific underlying navigation facility, there is no requirement for flight inspection of navigation signals. Due to the importance of publishing correct data, validation (ground and flight) of the procedure must be conducted in accordance with PANS-OPS (Volume II, Part I, Section 2, Chapter 4, 4.6). The validation process prior to publication should confirm obstacle data, basic flyability, track lengths, bank angles, descent gradients and compatibility with aircraft predictive terrain hazard warning functions (e.g. TAWS) as well as the other factors listed in PANS-OPS. When the State can verify, by ground validation, the accuracy and completeness of all obstacle data considered in the procedure design, and any other factors normally considered in the flight validation, then the flight validation requirement may be dispensed with regarding those particular factors.

6.2.4.4.2 Because of the unique nature of RNP AR APCH procedures, simulator assessment of each procedure should be accomplished during ground validation to evaluate the factors, including basic flyability, to be considered in the flight validation, to the extent possible, prior to flight validation. To the maximum extent possible, this simulator assessment should evaluate the factors considered in the flight validation, including basic flyability.

Note.— The evaluation of procedure flyability, and the performance of navigation and flight control systems, including speeds, aircraft weights and other operational variables, is the responsibility of the operator.

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Flight Validation – Simulator evaluation

- The simulator used should be suitable for the validation tasks to be performed. For complex or special procedures where simulator evaluation is desired, the evaluation should be flown in a simulator which matches the procedure requirements.
- When the procedure is designed for a specific aircraft model or series and specific FMS and software, simulator evaluation should be flown in a simulator with the same configuration used by the operator in daily operations.

Consideration should be given to what should / will be part of an Operational Approval

From the initiation of the project, simulation means availability and necessity to include an air operator should be considered

Testing: Conclusion

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Simulator testing is the only means allowing evaluation of:

- ✓ Failure cases.
- ✓ Wide range of temperature, wind, pressure, weight conditions to assess fly-ability, TAWS warnings, track keeping and bank angle limitations.

Flight test aircraft are not representative of operator's aircraft systems behavior, fly ability, and performance.

Demonstration flight could be conducted to check the integration with ATC, and is recommended as part of the operator ops approval process.

- ✓ Can be performed during a revenue flight.

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Flight Validation

Flight Evaluation

Flight Validation

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- If it has been declared necessary!

- Mandatory in some cases:
  - for procedures where runway or landing location infrastructure has not been previously assessed in flight for instrument operations; and
  - as determined by the State Authority.

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Flight inspection for RNP procedures

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The terms "flight validation" and "flight inspection" are often misinterpreted as the same concept. Flight validation and flight inspection are separate activities that, if required, may or may not be undertaken by the same entity.

a) Flight validation is concerned with factors other than the performance of the navigation aid or system that may affect the suitability of the procedure for publication, as detailed in PANS-OPS, Volume II, Part I, Section 2, Chapter 4, Quality Assurance.

b) Flight inspection is conducted with the purpose of confirming the ability of the navigation aid(s)/system upon which the procedure is based, to support the procedure, in accordance with the Standards in Annex 10 — *Aeronautical Telecommunications* and guidance in the *Manual on the Testing of Radio Navigation Aids* (Doc 8071). Personnel performing flight inspection duties should be qualified and certified in accordance with Doc 8071, Volume I, *Testing of Ground-Based Radio Navigation Systems*.

As RNP AR approaches do not have a specific underlying navigation facility, there is no requirement for flight inspection of navigation signals.

EASA AMC 20-26

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Validation Documentation

Validation conclusion

Assess the results of the validation process as follows:

a) Review all aspects of the validation process to complete the assessment.
b) Make a determination of satisfactory or unsatisfactory results, based on criteria established by the State.

For satisfactory validation, complete the IFP processing as follows:

a) Ensure the completeness and correctness of the IFP package to be forwarded.
b) Propose suggestions for improved operation of the procedure when such factors are outside the scope of the procedure design (e.g. ATC issues).

For unsatisfactory validation, return the IFP to the procedure designer for corrections:

a) Provide detailed feedback to the procedure designer and other stakeholders.
b) Suggest mitigation and/or corrections for unsatisfactory results.

Validation Documentation

Document the results of the validation process as follows:

a) Complete a detailed written report of the results of the validation process including justification for any steps in the validation process deemed not required. This involves a compilation of reports provided by the individual steps in the validation process.

b) Ensure that any findings and operational mitigations are documented.

c) Forward uncharted controlling obstacle position and elevation data to the procedure designer.

d) Ensure that recorded data are processed and archived together with the IFP and validation documentation.

Note.— Templates of checklists and reports are available in DOC 9906, vol 5 appendices

Approval

Procedure Approval

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- Once Validation accomplished
- Once reviewed by stakeholders
- Clear organisation = Clear responsible and efficient process
- Procedure approval is different from Operational Approval

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Example of organisation – in France

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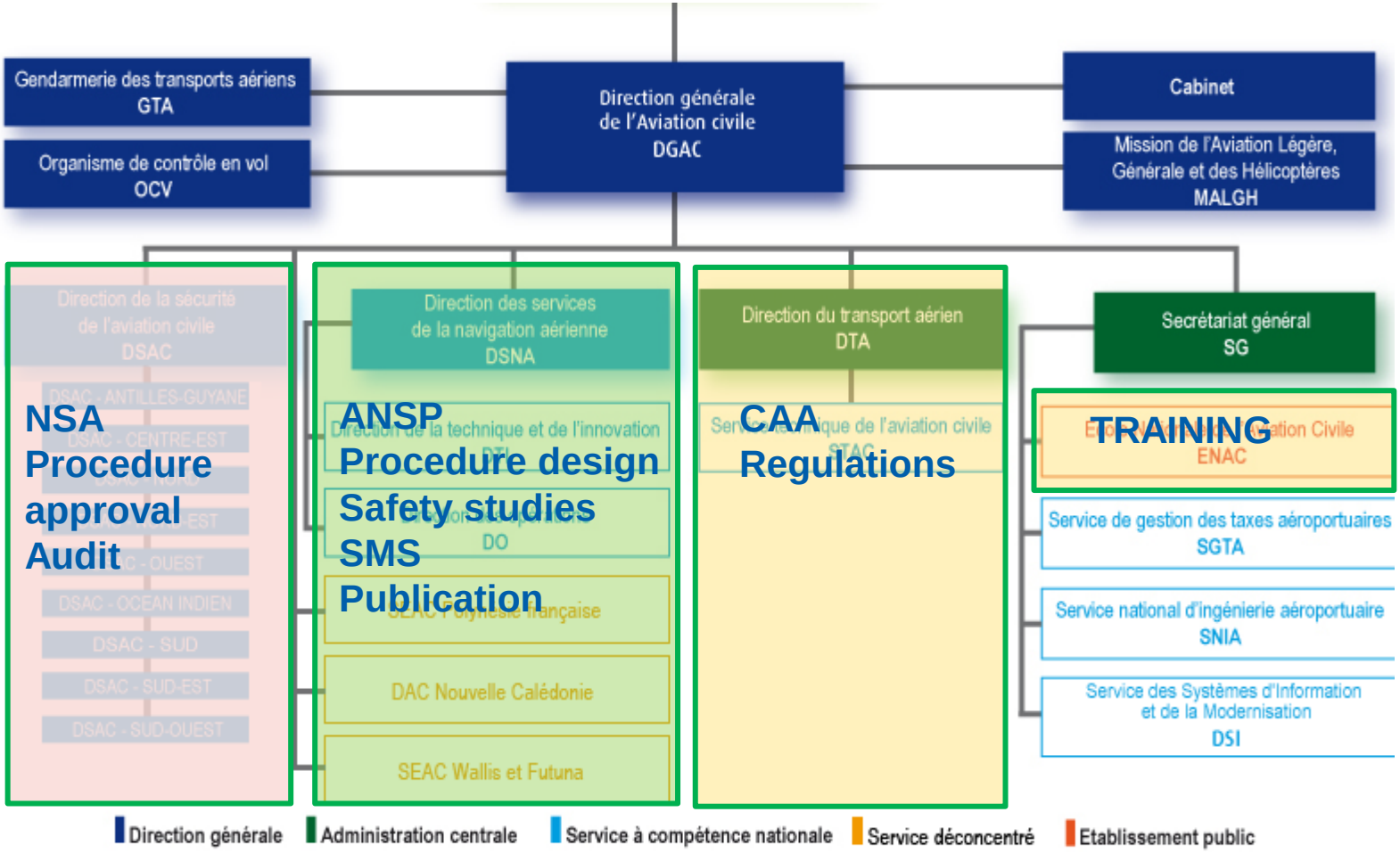

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Procedure Approval is different from Operational approval

Recommendations & Regulations

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Applicable recommendations & regulations used for design are the base for the validation requirements:

PROCEDURE APPROVAL		
Procedure Design	ICAO	DOC 9905 & 8168
Procedure Validation	ICAO	DOC 9906 volume 5 *Validation of Instrument Flight Procedures*

OPERATIONAL APPROVAL

Local Regulations – (where applicable)

Operational Approval	FAA	AC90-101A *Approval Guidance for RNP Procedures with AR*
	EASA	AMC 20-26 *for RNP AR Operations* *AMC 20-27 for RNP APCH*

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OPS APPROVAL: FAA AC90-101

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b. Flyability Check. An initial flyability check is required for all 14 CFR non-part 97 U.S. RNP AR procedures, as well as all foreign RNP AR procedures the operator is authorized to fly. Using either the actual aircraft in visual meteorological conditions (VMC), a flight simulation training device (FSTD) approved for RNP AR, or appropriately configured desktop/laptop computer, validate the RNP AR procedure contained in the NDB to ensure it matches the published procedure. An FSTD or desktop/laptop computer must utilize software identical to that used by the aircraft (e.g., FMS software) and use an aerodynamic model of the aircraft's flight characteristics. You must use a map display in the aircraft, FSTD, or computer to compare the database procedure with that published. This validation process requires flying the

FAA AC90-101A

Fly-ability check can be accomplished through ground evaluation (simulator)

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Performance Based Navigation (**PBN)** solutions

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Any Questions?

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