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Workshop on quality assurance for the implementation of an instrument flight procedure

29 March -2 April 2021

Flight Procedure Design Software validation

Doc. 9906, Vol. 3

Outline

1. Regulatory framework
2. General
3. Procedure design tools
4. Implementing a validation programme

Structure of the Manual

- Doc. 9906, vol. 3 organization:
  - Chap. 1 – Introduction
  - Chap. 2 – Scope
  - Chap. 3 – Overview of procedure design tools
  - Chap. 4 - Implementing a validation programme
  - Chap. 5 – Environment of procedure design
  - Chap. 6 – Tools inputs
  - Chap. 7 – Procedure design functions
- Five Appendixes dealing with calculations, data transformation and basic validation are provided.

Scope of the Manual

- One mean among others for validation of the functions of procedure design tools;
- Provide guidelines for the validation of flight procedure design tools in compliance with criteria;
- *The scope excludes the **certification** of procedure design tools and functional validation.*
- Two type of validations:
  - **Functional validation:** Confirmation of the correct implementation of automation functions and of the compliance of the human machine interface with the user requirements;
  - ***Validation with reference to criteria:*** Confirmation through a series of tests of the compliance of the results with reference to applicable criteria.

Key definitions

- **Procedure design tool: A**ny numerical automation system that provides calculations and/or Layouts in the field of FPD;
- **Validation:** Confirmation, through the provision of objective evidence, that the requirements for a specific intended use or application have been fulfilled
- **Software validation:** Acknowledgement, derived from a series of tests, of the compliance of an automation system with the applicable standards:
- **Test:** A basis for critical evaluation
- **Certification:** An official acknowledgement that the standards derived from a given procedure (**certification procedure**) have been complied with, and implies the delivery of a certificate of compliance.

State responsibilities

- The implementation of procedures is the responsibility of contracting States;
- The procedure design may be carried out by States or by State delegation to third parties;
- States shall ensure that automation functions have been validated;
- Implementation of the validation can be carried out by States or by State delegation to third parties.

Needs for procedure design tools

- Procedure design tools is used for the design of RNAV or PBN procedures:
  - ☞Departures, arrival, en-route, approaches.
- Benefits of procedure design tools:
  - ☞Useful for quality control and integrity enhancement;
  - ☞Facilitate the design;
  - ☞Time save.

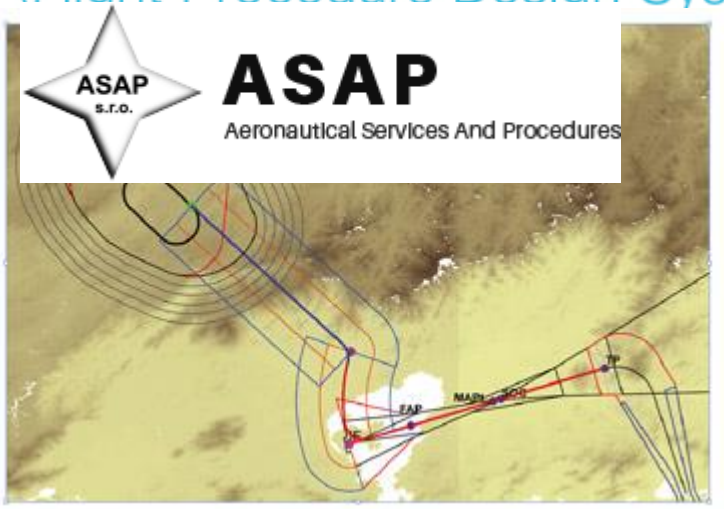
Use of automation is not intended to replace the procedure designer's expertise
They can be misleading in case of errors.
States are encouraged to use software packages to design IFPs.

Procedure design tools

- **Two main types of procedure design tools :**
  - ☞**The Aiding tools:** The level of automation is not exhaustive as well as the restrictions for the criteria.
  - ☞ **The Expert tools:**
    - The level of Automation here is high;
    - Optimum compliance with the criteria.

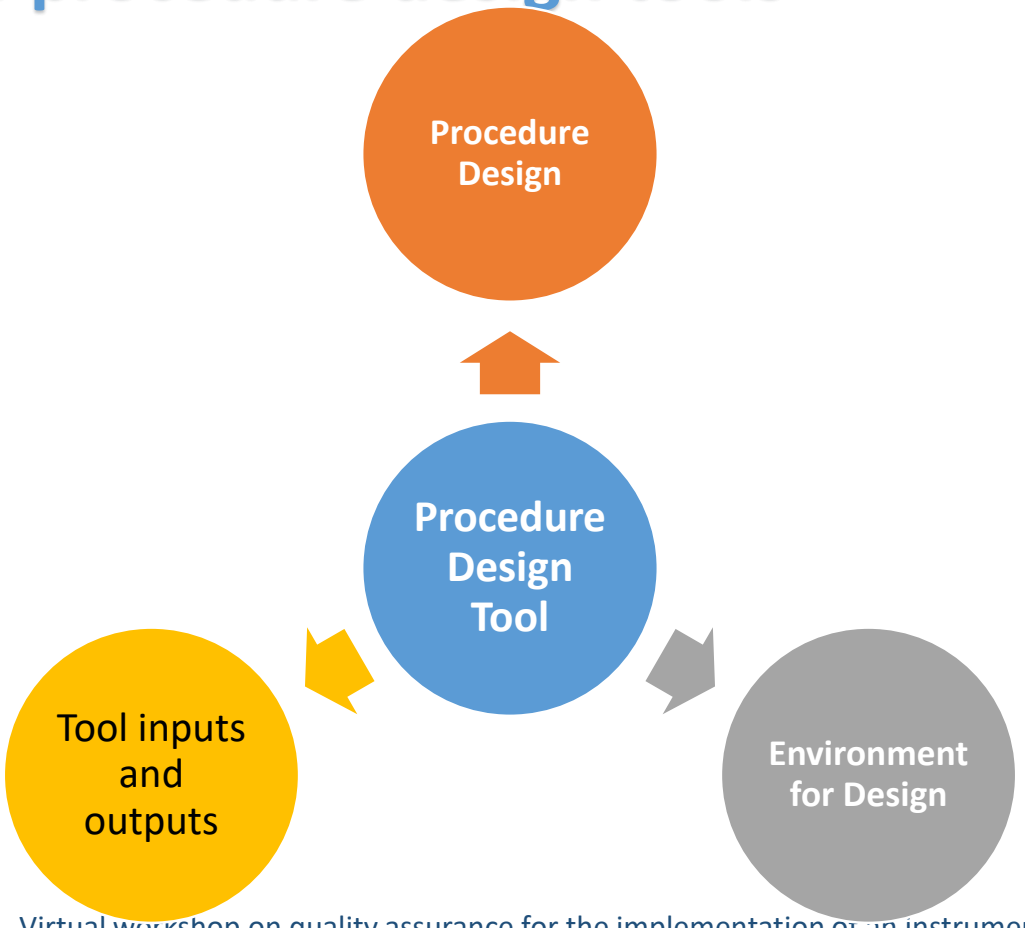
PANADES

(Flight Procedure Design System)



RISK COMPANY

Main functions of procedure design tools

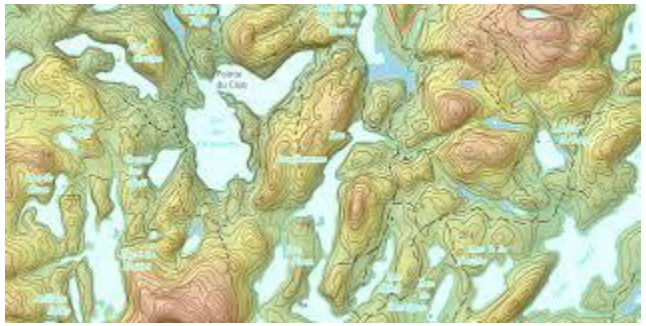


The environment for design

- Set of general aspects to be accounted but that not specifically standard criteria related:
  - Geographical information: coordinate reference system integration, WGS-84 calculations, conversion between various reference systems, charting projections, etc.;
  - Graphical tools: creation and management of graphical objects (segments, curves, texts, etc.), 2-D or 3-D display of geographical information;
  - Reference material: direct access to reference criteria and documentation used for design;
  - Recording and archiving the work of the designer for subsequent studies; and
  - Reports of procedure design studies.

The environment for design

- The function contributes to the correct functioning of the tools;
- Shall therefore be validated!



Tool inputs and outputs

- Tool inputs/Outputs i/o:
  - ☞Integration and release of digital information and data to/from the software tools;
  - ☞Include management of various (aeronautical, terrain) i/o data format: CRM, Obstacles, AIXM, ARINC 424, etc.:
    - Integration of raster data: “bitmap” charts, images, digital terrain models (DTM), etc.;
    - Integration of vector files: vector DTM, topographical data, etc.;
    - Integration, management and update of aeronautical information: navaids, aerodromes, obstacles, airspace, etc.

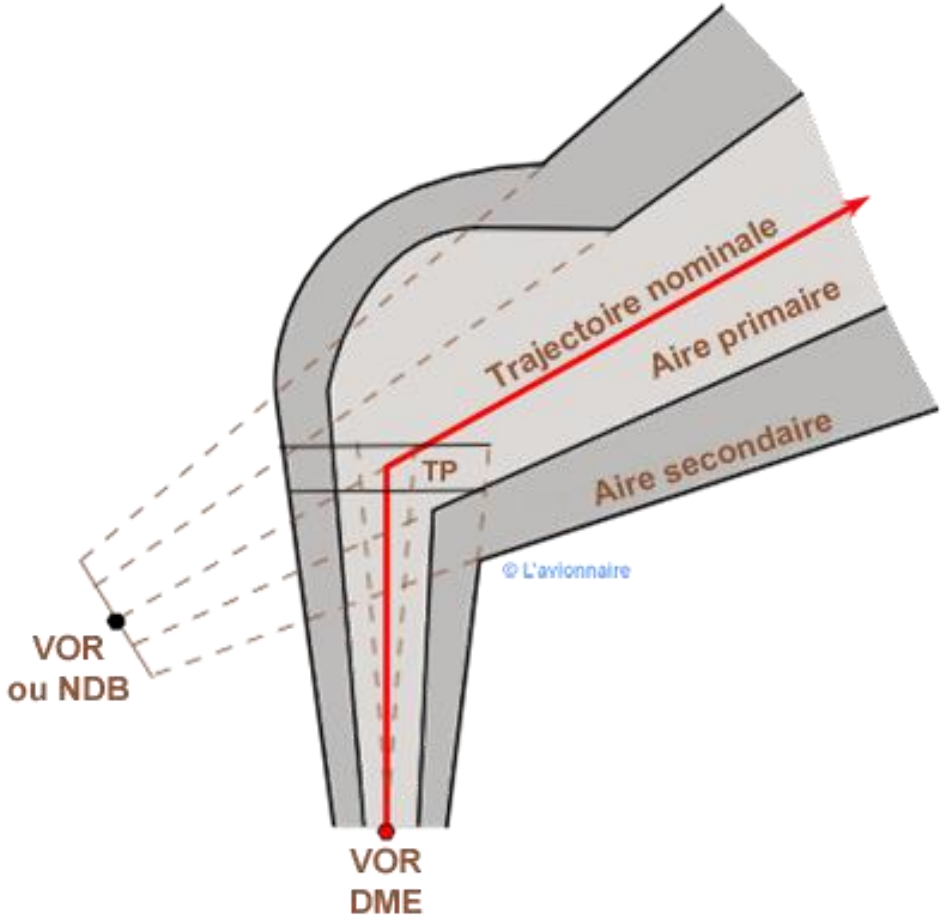
Tool inputs and outputs

- For the inputs:
  - Inputs may be done manually or automatically:
    - Ensuring imported data integrity is very important!
  - Input functions are critical for the correct operation of the software tools.
- For the outputs:
  - Provide output results (layout, files) of the design: calculation results, IFP coding, etc.
  - Results include:
    - 2-D or 3-D procedure design layout display;
    - Output file including all the calculation results;
    - Graphical representation of the procedures (from the design mode to an aeronautical chart); and
    - Procedure coding (ARINC 424, AIXM, etc.).

Procedure design tools

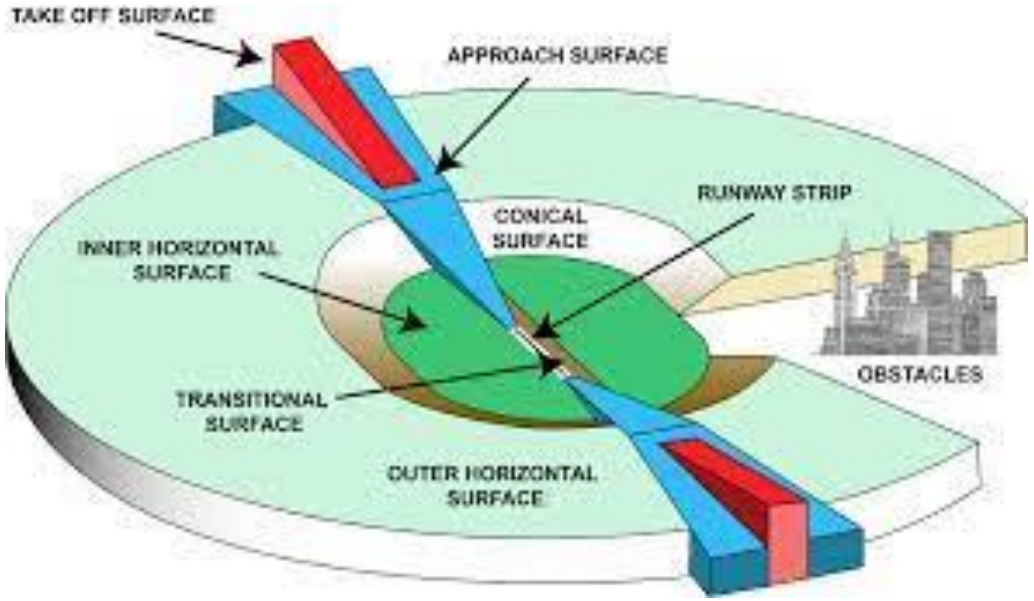
Procedure design

- Correspond to the core of the design process (Apply criteria), nominal trajectories and protection area, procedures calculations, etc.
- Available functions depend on the type of tool;
- Functions include:
  - Integration of ICAO parameters for calculations;
  - Modelling of the considered criteria (if applicable):
  - RNAV/conventional, en-route/terminal/approach procedure layouts, with protection areas, for all the procedure elements;



Procedure design

- Functions include:
  - RNAV/conventional, en-route, terminal, approach procedure calculations;
  - Protections areas;
  - CRM calculations;
  - Annex 14 surfaces.
- Correct implementation of the design functions in the part of the validation process.



Implementing a validation programme

- A Flight Procedure Design tool validation should follow the following steps:
  - ☞Preparation phase;
  - ☞Definition of the validation coverage;
  - ☞The tool testing requirements;
  - ☞The validation methodology and the production of the validation documentations.

Preparation step

- Develop a work plan defining:
  - The software validation coverage;
  - The overall objective schedule;
  - The available resources;
  - The validation team for the validation process, including the expertise according to the validation coverage;
  - The tasks to be carried out;
  - The roles and responsibilities of each team member for each task;
  - A tentative detailed work programme (work items and timeframe).

Software validation coverage and tool testing requirements

- The software validation coverage:
  - Work programme of the tool validation:
    - All the tool's functions
- The tool testing requirements:
  - First confirm the correct installation and configuration of the software;
  - Validation to take account of the tests performed by the tool developer (tests data sets);
  - Tests are to be carried out partially of totally at the user location;
  - Knowledge of test planning, definition of expected test results, and recording of all test outputs required:
    - Support needed from the software provider/developer.

Validation methodology

- The validation process will prior consider :
  - ☞The units of measurements and rounding considerations;
  - ☞The basic parameters validation: basic drawings, calculations methods, etc. to be checked; e.g., earth radius.
  - ☞The modelling of criteria validation: methodology for the modelling of criteria validation through assessment in four (04) domains:
    - Methods and concepts;
    - Input data;
    - Output data;
    - Graphical checks.

Units of measurement and rounding considerations;

Table 7-1. Common conversion factors

Conversion factor	*Value*	*Source*
Nm to Metre (m)	1 852.0	Annex 5, Table 3.3
* Foot (ft) to Metre (m)	0.3048	Annex 5, Table 3.3
Metre (m) to Foot (ft)	= 1 / 0.3048	
Knot (kt) to m/s	0.514444	Annex 5, Table 3.3

(*) Attention must be paid to the foot-to-metre conversion factor which was changed in Amendment 13 to PANS-OPS, Volume II (Doc 8168).

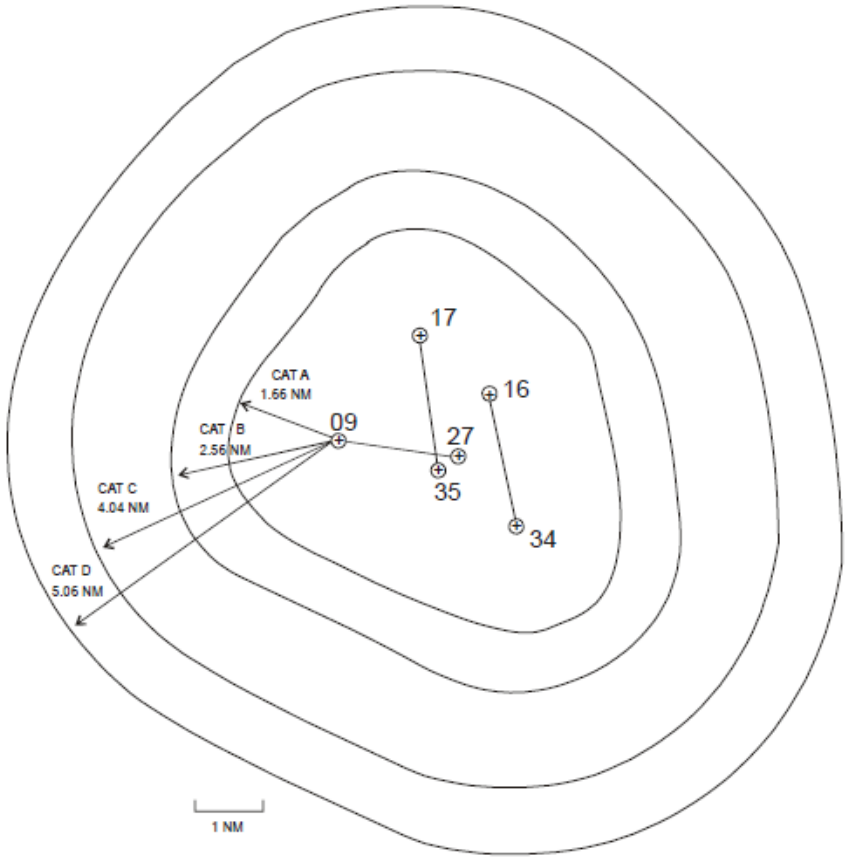
Implementing a validation programme

❑ Input data

Input data					
THR 16 coordinates	41° 55' 45".8883 N	012° 25' 40".1264 E			
THR 34 coordinates	41° 53' 44".6216 N	012° 26' 17".9834 E			
THR 35 coordinates	41° 54' 31".7435 N	012° 24' 40".2610 E			
THR 17 coordinates	41° 56' 36".7320 N	012° 24' 11".6239 E			
THR 09 coordinates	41° 54' 58".2541 N	012° 22' 35".0575 E			
THR 27 coordinates	41° 54' 46".3514 N	012° 25' 03".2384 E			
Temperature	ISA + 15				
IAS (kt)	100	135	180	205	250
AD ELEV (ft)	313				
Bank Angle (°)	19.3	20	20	20	20
Aircraft CAT	A	B	C	D	E

Implementing a validation programme

❑ Graphical check



Validation documentation

- The following requirements apply to the validation documentation:
  - Detailed documentation of the tests to be compiled;
  - Documentation should include:
    - The history of the tests: including the input data and test results;
  - Recommended to share the validation documentation with the software provider/developer.

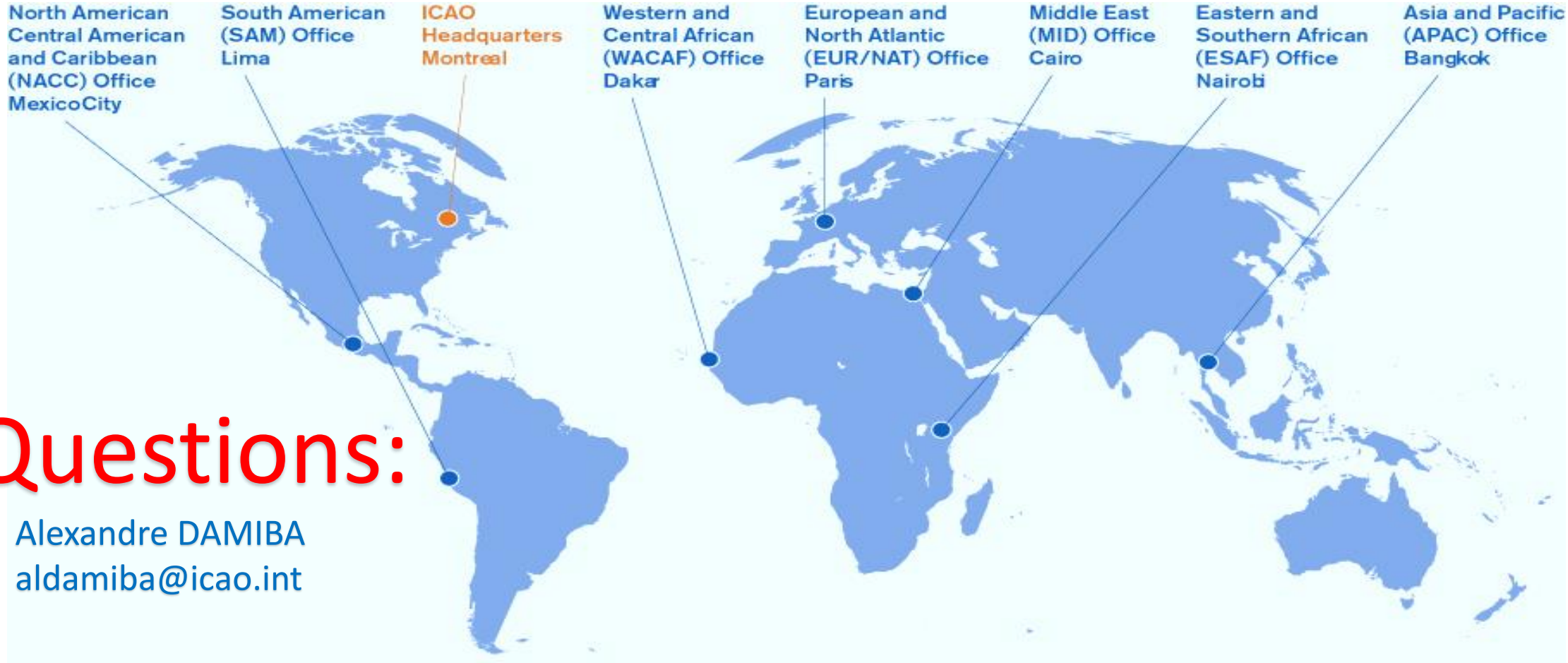
A sample of validation documentation is provided in Appendix E

Implementing a validation programme

- Tool documentation:
  - ☞ The tool documentation should follow from the technical reference criteria and material.
- Geographical information:
  - ☞ The validation of geographical information aims at verifying (if applicable) that the geographical data are correctly processed in the tool.
- Wgs-84 calculations;
- Magnetic variation.

Comprehension questions

1. How many types of validation of flight procedure design tools do you know:
   - ☞Functional validation and
   - ☞Validation with reference to criteria
2. Are the tools validated or certified?
   - ☞Validated
3. Who is responsible for the validation of the tools?
   - ☞State directly or by delegation
4. How many types of procedure design tools?
   - ☞Aiding tools and expert tools.



Questions:

Alexandre DAMIBA
aldamiba@icao.int