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

29 March -2 April 2021

Validation of Instrument Flight Procedures
Doc. 9906, Vol. 5

Outline

1. Regulatory framework
2. General
3. The validation process
4. Ground validation
5. Flight validation
6. Obstacle assessment methodology

Regulatory framework

Doc. 9905 vol. 5:

- Content:
  - Chapter 1. The validation process;
  - Chapter 2. Step-by-step description of activities within the validation process;
  - Appendix A. Obstacle assessment;
  - Appendix B. Human Factors;
  - Appendix C. Validation templates for fixed-wing aircraft;
  - Appendix D. Validation templates for helicopters.

Objective of flight IFP validation

- Ensure :
  - **Safety, data accuracy and integrity , flyability** of the instrument flight procedure;
  - **Qualitative assessment** including obstacle, terrain, navigation data and the flyability of the procedure as wall as human factor;
- The validation process applies to fixed-wing and helicopter instrument flight procedures:
  - Validation forms provided in Volume 5.

Make a clear difference between **Flight Inspection** and **Flight Validation**

❑**Flight inspection:**

- ☞ Conducted to confirm the ability of the navigation aids/system upon which the procedure is based to support the procedure.

❑Reference documents:

- ☞Annex 10 , Doc. 8071.

❑Actors:

- ☞Qqualified and certified flight inspectors.

❑**Flight validation:**

- ☞ Concerned with factors other than the navaids performances:
  - Data verification, flyability, human factors, obstacles, etc.

❑Reference documents:

- ☞ Doc. 8168, vol. 2, Doc. 9906, vol. 5.

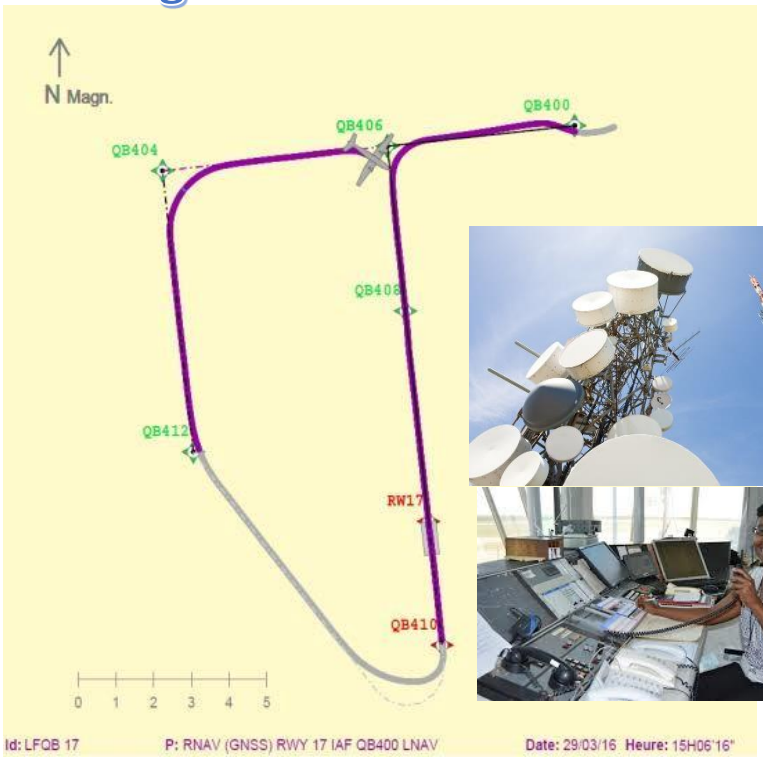
❑Actors:

- ☞ Flight Validation Pilots, Designers.

Make a clear difference between Flight Inspection and Flight Validation

Flight inspection

Flight validation



States responsibilities

- Set up a quality management system:
  - Set up a flight procedure design process;
  - Establish competency requirements for FVP and Designers;
  - take measures to “control” the quality of the processes associated with the construction of instrument flight procedures.
- States assume ultimate responsibility for the procedures published in their national Aeronautical Information Publication (AIP).

Preparation for the validation

- **Activities to be conducted prior to the validation process:**
  - ☞ **Prepare the IFP package (designer);**
  - ☞ **Flight inspection may be required;**
  - ☞ **Data integrity and ARINC encoding requirements:**
    - IFP to be validated should be coded in a navigation data base:
      - Custom navigation data base;
      - Electronic media;
      - Manually.

Preparation for the validation

- **Composition of the IFP package:**
  1. The IFP summary;
  2. Proposed instrument procedure chart/depiction of sufficient detail to safely navigate and identify significant terrain, obstacles and obstructions;
  3. Proposed ARINC 424 coding (for PBN procedures only);
  4. List of relevant obstacles, identification and description of controlling obstacles and obstacles otherwise influencing the design of the procedure, waypoint fix latitude/longitude, procedural tracks/course, distances and altitudes;
  5. Airport infrastructure information, such as visual aids (ALS, VASIS);

Preparation for the validation

- **Composition of the IFP package:**
  6. Information on aerodrome obstacle limitation/safeguarding processes applied;
  7. Any special local operational procedure (e.g. noise abatement, non-standard traffic patterns, lighting activation);
  8. Detailed listing of deviations from design criteria and proposed mitigation;
  9. For a non-standard IFP: training, operational or specific equipment requirements; and
  10. Appropriate validation checklist and report forms.

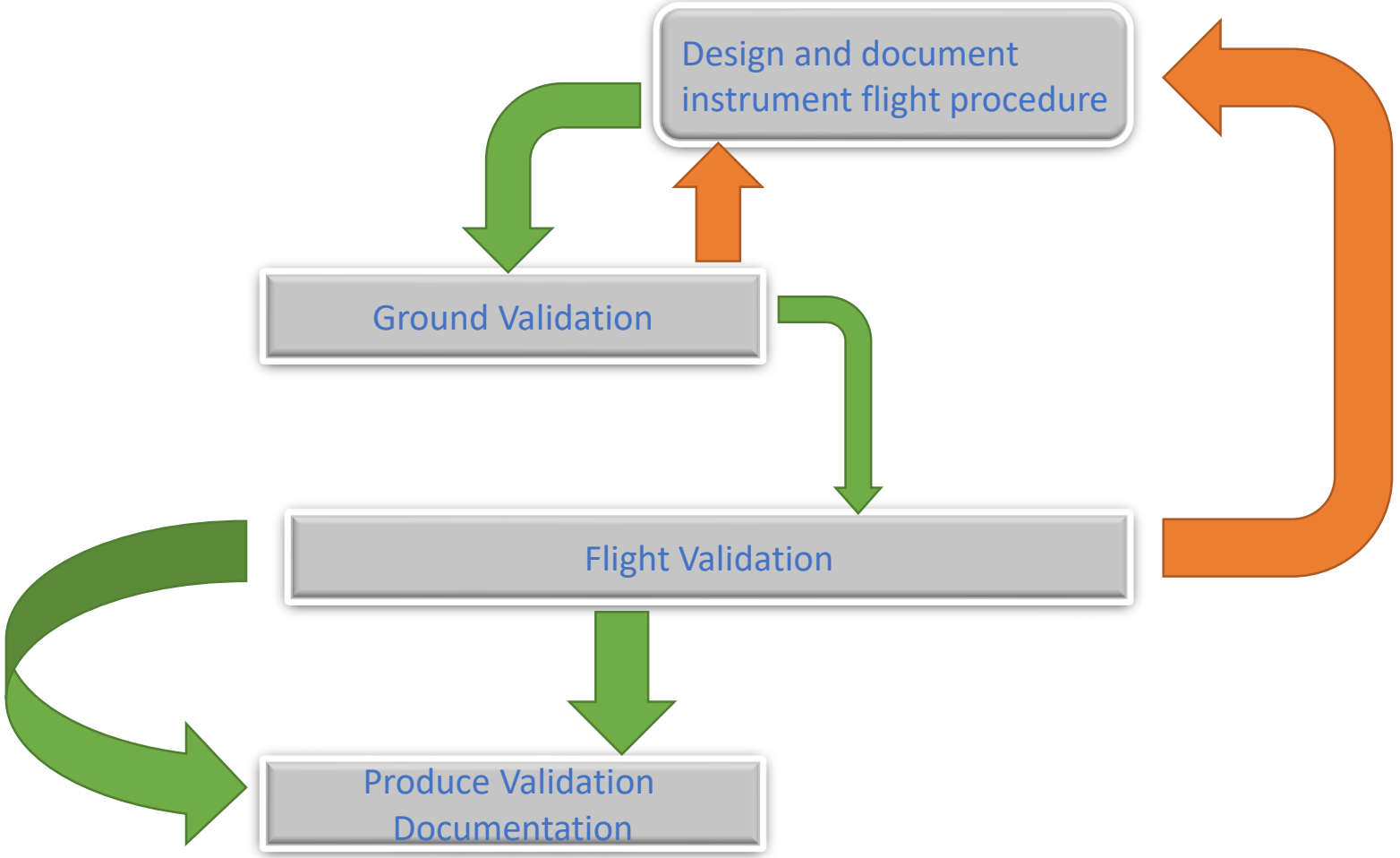
The validation process

- The full validation process includes ground validation and flight validation.
- Ground validation:
  - ☞ Must always be undertaken;
  - ☞ What is it?
    - A systematic review of the steps and calculations involved in the procedure design as well as the impact of the procedure on flight operations.

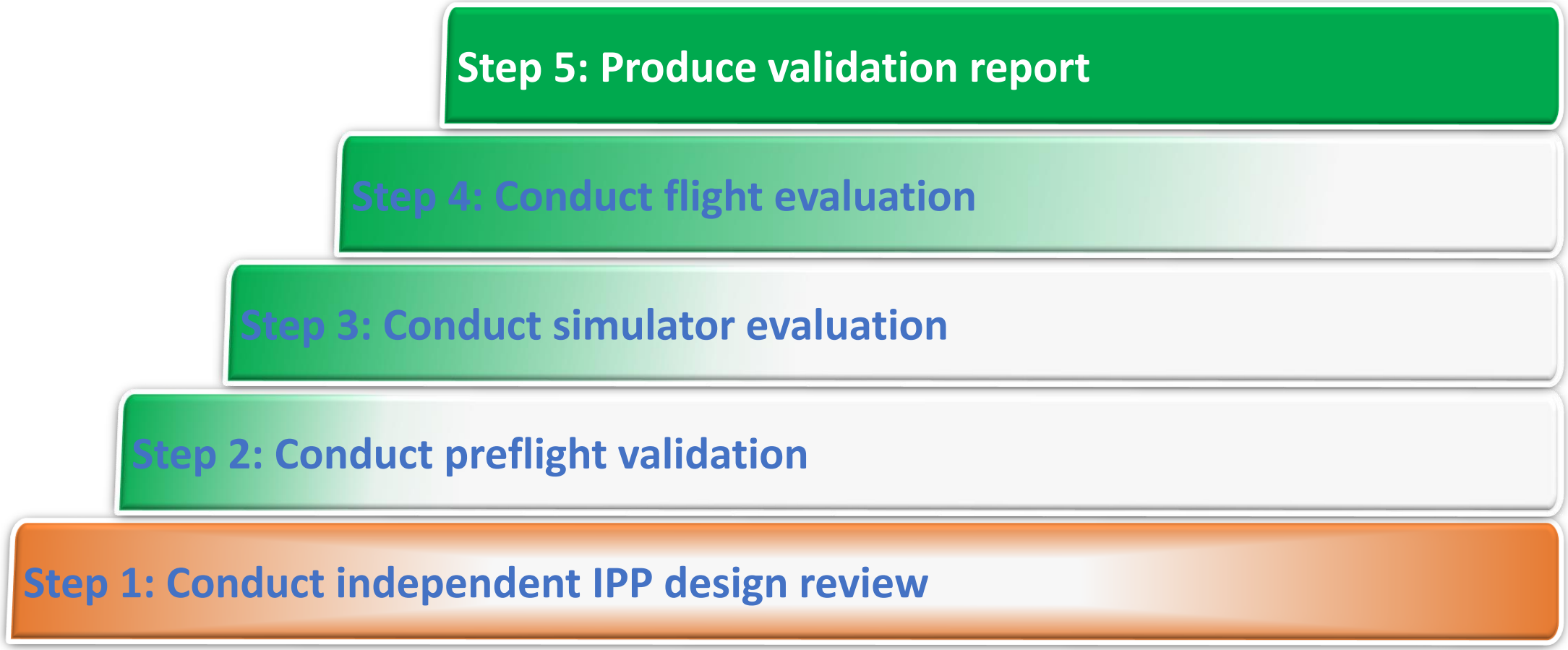
The validation process

- Flight **validation** consists of:
  - Flight simulator **evaluation**
  - Evaluation flown in an aircraft referred as Flight evaluation.
- Flight validation requirement may be dispensed with.
  - 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.

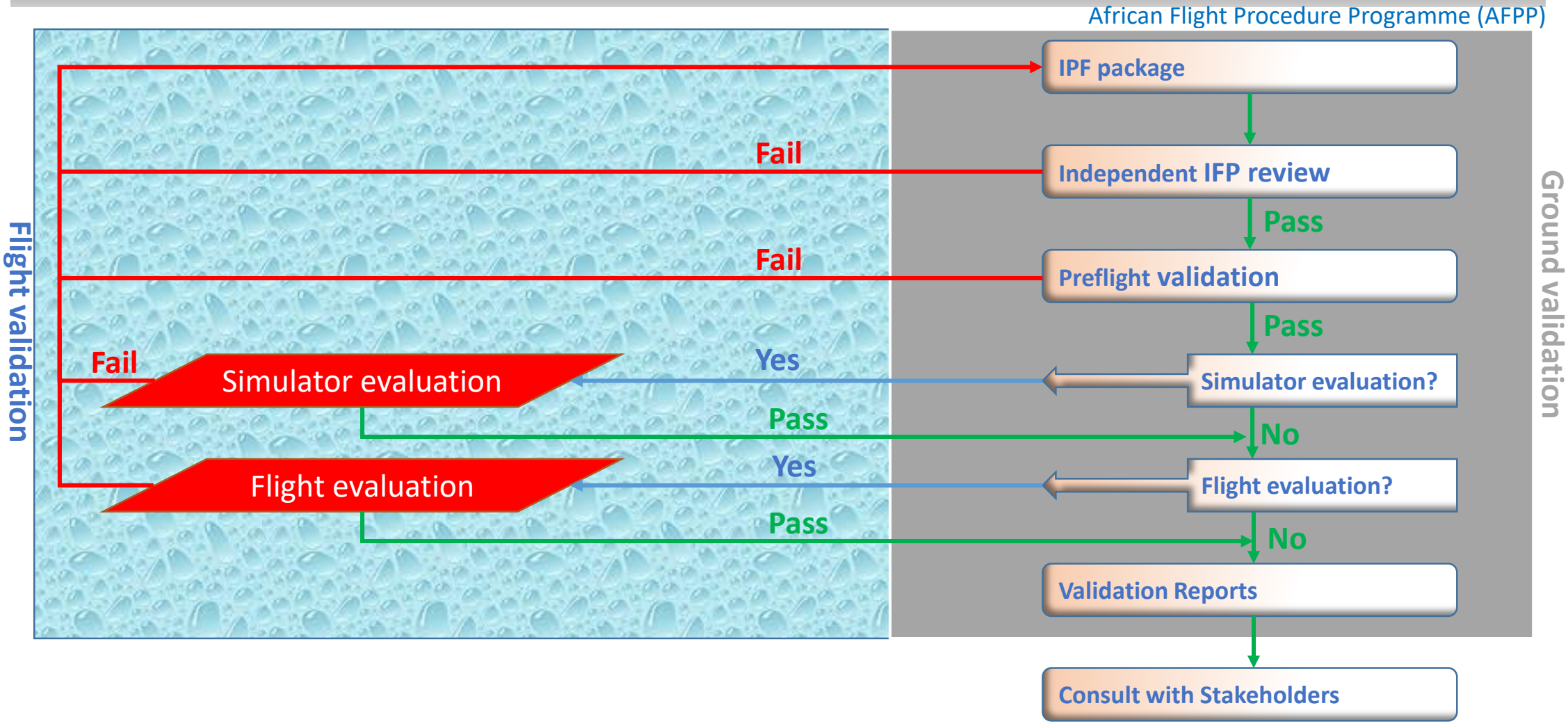
The validation process



The validation process



The validation process



Ground validation

- Ground validation is **mandatory**:
  - ☞ independent review + preflight validation,
- Inputs:
  - ☞IFP design package.
- Actors:
  - ☞Designer(s), appropriate experts: airspace designers, FVP, coders, Airport authorities, ATC, flight inspectors.
- Outputs:
  - ☞GO/No go forward approval.
- Quality records:
  - ☞Ground validation report.

Flight validation

- Flight validation : ± Simulator evaluation ± Flight evaluation
- Flight validation is **not mandatory**!
  - ☞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.
  - ☞**Therefore, set up a good QMS for the obstacles!**

Flight validation

- Flight validation only required under the following cases:
  - The flyability of a procedure cannot be determined by other means;
  - The procedure requires mitigation for deviations from design criteria;
  - The accuracy and/or integrity of obstacle and terrain data cannot be determined by other means;
  - New procedures differ significantly from existing procedures; and
  - Or helicopter PinS procedures.
- *Flight validation is mandatory for new procedures in some States.*

Step 1 – Conduct independent IFP design review

- Conducted by an independent designer:
  - An IFP designer other than the one who designed the IFP;
  - He can be assisted experts in other domains

- Goal:
  - Confirm the right application of the criteria (Doc. 8168, Doc. 9905);
  - Confirm data accuracy;
  - Verify mitigation for deviations from procedure design criteria;
  - Verify the correctness of the draft charts;
  - Confirm correct FMS behavior (Desktop simulation tools);
  - Perform obstacle assessment with State-approved ground-based methods (if required):
    - Such method should be approved.

Step 2 – Conduct preflight validation

- Actors:
  - ☞Designer(s) with good knowledge of flight validation issues;
  - ☞Possible assistance of designers and FVP.
- Purpose: identify:
  - ☞The impact of the IFP on flight operations and any other issues.
- Preflight validation determine the need for simulator evaluation.

- Goal:
  - ☞ Conduct the inventory and review of the IFP package;
  - ☞ Evaluate data and coding;
  - ☞ Review special operational and training requirements;
  - ☞ Document the results of preflight validation;
  - ☞ Coordinate operational issues (if flight evaluation is required).

Conduct inventory and review of the IFP package

- Tasks:
  - ☞Ensure the completeness of the IFP package;
  - ☞Ensure that charts and maps are available in sufficient detail for assessment of the IFP during the FV;
  - ☞Familiarize with the target population of the procedure (e.g. aircraft categories, type of operation);
  - ☞Discuss the IFP package with the procedure designer, as necessary.
  - ☞Verify that the IFP procedure graphics and data match.

Conduct inventory and review of the IFP package

- Tasks:
  - ☞Compare the IFP design, coding and relevant charting information against the navigation database used for flight validation;
  - ☞Verify that controlling obstacles and obstacles otherwise influencing the design of the procedure are properly identified;
  - ☞Review the airport infrastructure and special airport regulations;
  - ☞Review the navigation infrastructure used by the procedure;
  - ☞Review pertinent flight inspection documentation, if required.

Step 2 – Conduct preflight validation

Evaluate data and coding

- Tasks:
  - Prepare loadable data and coding.
  - Compare true courses and distances for segments between the data file and the procedural data.
  - Compare ARINC 424 coding for legs and path terminators between the data file and the procedural data.

Step 2 – Conduct preflight validation

Review special operational and training requirements

- Tasks:
  - Review deviation form criteria to ensure that safety is not compromised;
  - Review the safety case;
  - Assess restricted procedures for special training and equipment requirements.

Step 2 – Conduct preflight validation

Document the results of preflight validation

- Tasks:
  - Determine the need for flight inspection, simulator evaluation and/or flight evaluation;
  - Record specific additional actions required in a flight validation;
  - Provide a detailed written report (Templates provided in Appendices C and D.

- Flight validation is required in the following cases:
  - Flyability of the IFP cannot be determined by other means;
  - The procedure contains **non-standard** design elements;
  - The **accuracy and integrity of obstacles** is not well known;
  - **New procedures** differ significantly from existing ones;
  - For helicopters PinS procedures

Document the results of preflight validation

Flight evaluation is mandatory in the following cases:

- For procedures where runways or landing location infrastructure has never been flight assessed;
- As determined by State Authority.

Step 2 – Conduct preflight validation

Coordinate operational issues (if flight evaluation required)

- Temperature and wind limitations, air speeds, bank, angles, climb/descent gradients, etc.
- Determine:
  - ☞The aircraft and equipment required to complete flight validation of the IFP;
  - ☞Airport infrastructure and navigation aid/sensor availability.
- Check weather minima and visibility required for flight validation. Conduct the initial assessment in daylight conditions in VMC in each segment with visibility requirements sufficient to perform obstacle assessment.

Step 2 – Conduct preflight validation

Coordinate operational issues (if flight evaluation required)

- Assess the need for a night evaluation in the case of at least one of the following circumstances:
  - IFP developed for an airport with no prior IFR procedures;
  - IFP to newly constructed runways or to runways lengthened or shortened;
  - addition of lights to, or reconfiguration of lights in, an existing system already approved for IFR operations; and
  - Circling procedures intended for night use.
- Coordinate with ATS and other stakeholders.

Step 3 – Conduct simulator evaluation

- Requirements:
  - ☞Conducted by a **qualified and experienced FVP, certified or approved by the State**.
  - ☞RNP AR to be simulator evaluated;
- Goal:
  - ☞Provide initial evaluation of data base, flyability and provide feedback to designers;
  - ☞Recommended for complex or special procedures .

Step 3 – Conduct simulator evaluation

General rules

- The simulator used should be compliant with tasks to be performed;
- The IFP should be flown using the IFP parameters: speeds, slopes, altitudes, etc.
  - Final approach flown with its parameters and with **TAWS** (Terrain Awareness Warning System) **active**.
- Goal:
  - Evaluate flyability;
  - Evaluate database coding and accuracy;
  - Verify that waivers/mitigations for deviations from design criteria do not compromise safety;
  - Evaluate any other factors as much as possible (wind, temperature and barometric pressure).
- Document the results of simulator evaluation:
  - Assess whether the IFP is ready for further processing in the validation process;
  - Provide a detailed written report of the results of simulator evaluation (template provided in appendices C and D).

Assess flyability and human factors

- Objectives of flyability assessment:
  - ☞Evaluate aircraft maneuvring areas for each relevant category of aircraft.
- Human factor – Assess the IFP:
  - ☞Practicality: no too much maneuvers, etc.;
  - ☞Complexity: IFP should be simple;
  - ☞Interpretability: clear and easy to understand ;
  - ☞Other considerations:
    - Pilots must be able to extract the information quickly and accurately.

Flyability assessment methodology

1. Fly each segment of the IFP on-course and on-path;
2. Validate the intended use of the IFP as defined by stakeholders and described in the conceptual design;
3. Evaluate other operational factors, such as charting, required infrastructure, visibility and intended aircraft categories;
4. Evaluate :
   a. The aircraft maneuvering area for safe operations for each category of aircraft to use the IFP;
   b. Turn anticipation and the relationship to standard rate turns and bank angle limits;
   c. The IFP complexity, required cockpit workload and any unique requirements;
5. Check that waypoint spacing and segment length are suitable for aircraft performance;
6. Check the distance to runway at decision altitude/height or minimum descent altitude/height that is likely to be applied by operators and evaluate the ability to execute a landing with normal maneuvering;
7. Evaluate required climb or descent gradients, if any;
8. Evaluate the proposed charting for correctness, clarity and ease of interpretation;
9. Evaluate TAWS warnings.

Step 4 – Conduct flight evaluation

- Stakeholders:
  - ☞Qualified and experienced FVP certified or approved by the State;
  - ☞Procedure designer as appropriate.
- Objectives:
  - ☞Validate the intended use of the IFP.
- Concept of operation:
  - ☞FVP take a seat in the cockpit providing good visibility;
  - ☞Only task-related persons are allowed on the flight;
  - ☞Couple autopilot and flight director;
  - ☞The procedure must be flown using the correct sensor.

Step 4 – Conduct flight evaluation

- Tasks:
  - ☞Assess flyability to determine that the procedure can be safely flown;
  - ☞Provide the final assurance that adequate terrain and obstacle clearance have been provided;
  - ☞Verify that the navigation data to be published are correct;
  - ☞Verify that all required infrastructure, such as runway markings, lighting, and communications and navigation sources are in place and operative;
  - ☞Ensure the navigation system's documentation confirms that the applicable navigation systems (navigation aid/sensor, GNSS, radar, etc.) support the procedure;
  - ☞Evaluate other operational factors, such as charting, required infrastructure, visibility and intended aircraft category;
  - ☞Verify that waivers/mitigations for deviations from design criteria do not compromise safety.

Step 4 – Conduct flight evaluation

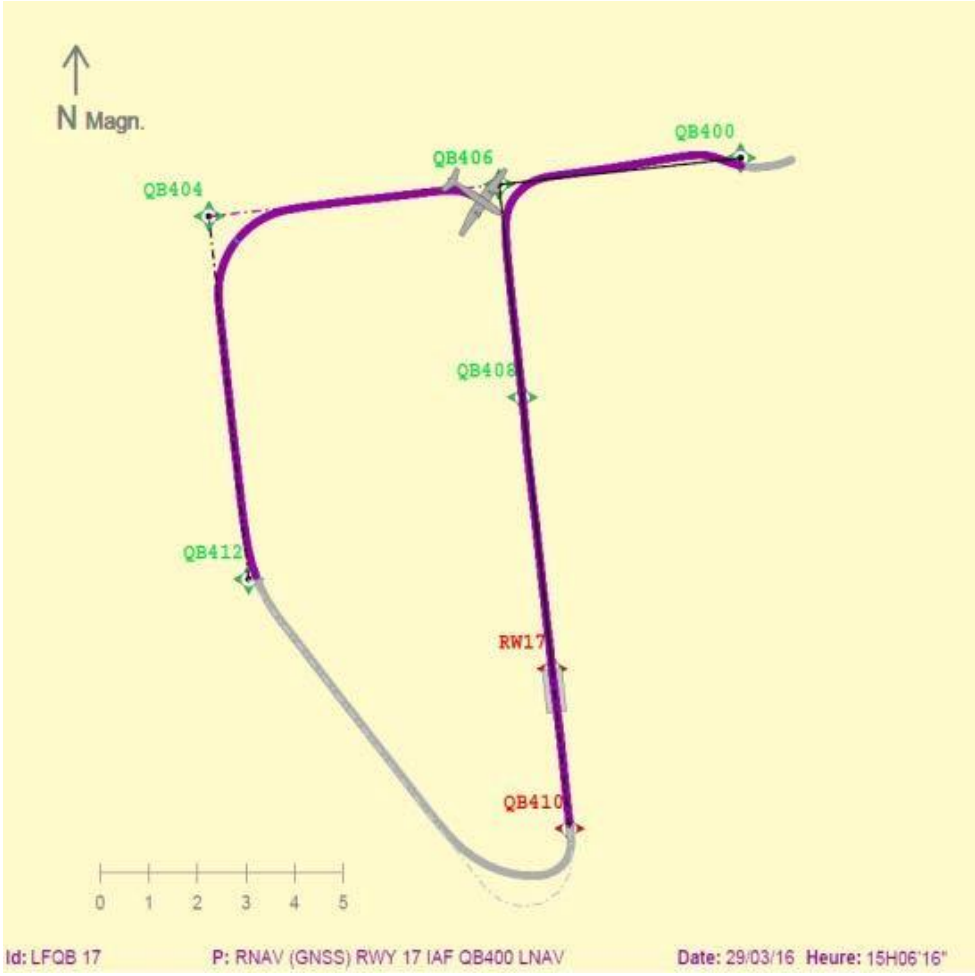
- *Note:*
  - *Additional guidance provided for specific procedures: GBAS and SBAS.*
- Goal of flight evaluation:
  - Verify data;
  - Assess obstacles:
    - The controlling obstacle should be verified for each segment;
    - Obstacles assessment methodology is developed in section 6.
  - Assess flyability and human factors;
  - Conduct associated validation tasks;
  - Verify charts depiction and details;
  - Record flight validation.

Step 4 – Conduct flight evaluation

- The following data shall be saved as a minimum:
  - Processing date and time;
  - Number of satellites in view;
  - Minimum number of satellites;
  - Average PDOP;
  - Maximum observed HDOP (SBAS procedures only);
  - VPL (SBAS/GBAS procedures only);
  - HPL (SBAS/GBAS procedures only);
  - Maximum observed VDOP (SBAS procedures only);
  - For each segment, the maximum and minimum altitude, ground speed, climb rate and climb gradient; and
  - A printed graphic or an electronic file of sufficient detail that depicts the horizontal (and the vertical for VNAV procedures) flight track flown, referenced to the desired track of the approach procedure, including procedure fixes.

Step 4 – Conduct flight evaluation

HDOP : Horizontal Dilution Of Precision
HPL : Horizontal Protection Level
PDOP : Position Dilution Of Precision
VDOP : Vertical dilution of precision
VPL : Vertical protection level



Step 5 – Produce a validation report

- For the production of the report, process as follows:
  - ☞Review all aspects of the validation process to complete the assessment.
  - ☞Determine satisfactory or unsatisfactory results, based on criteria established by the State.
- For satisfactory results:
  - ☞Ensure the completeness and correctness of the IFP package to be forwarded.
  - ☞Propose suggestions for improved operation of the procedure when such factors are outside the scope of the procedure design (e.g. ATC issues).

Step 5 – Produce a validation report

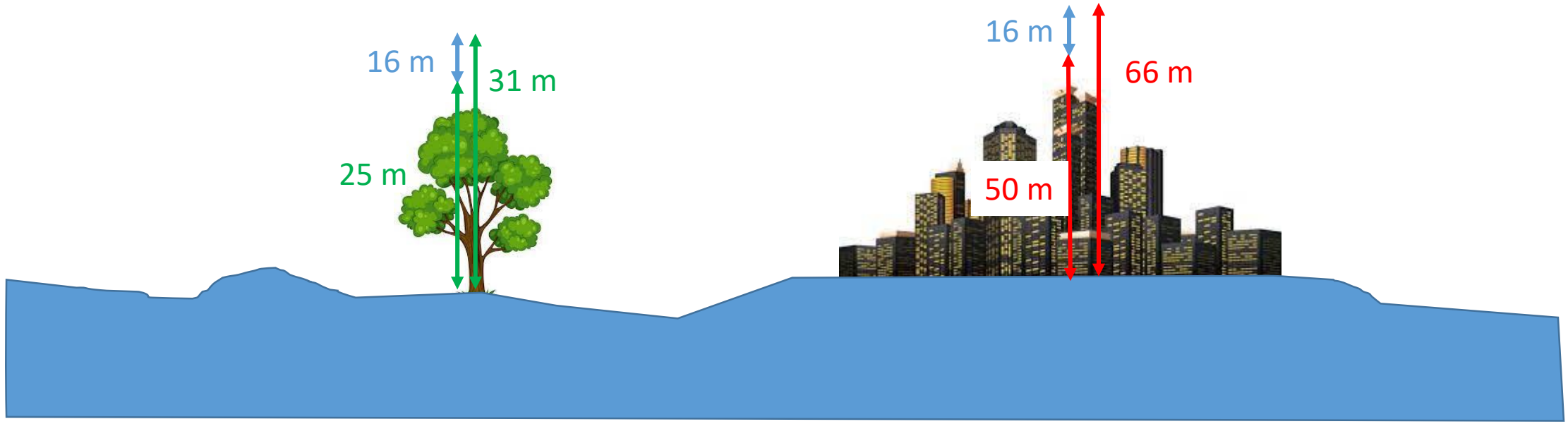
- For unsatisfactory results, return the IFP for corrections by:
  - ☞Providing detailed feedback to the procedure designer and other stakeholders.
  - ☞Suggesting mitigation and/or corrections for unsatisfactory results.
- Provide a final validation report:
  - ☞Templates and checklists are provided in the appendices.

Obstacle assessment methodology

- Obstacles can be assessed at two level of the validation process:
  - ☞During the ground validation and/or,
  - ☞During the flight evaluation.
- Two cases during the ground validation:
  - ☞The obstacles and/or Terrain data accuracy and integrity are granted:
    - Account them in the design.
  - ☞The accuracy and/or integrity cannot be granted:
    - Set up a ground-based obstacle assessment method
    - Get a State approval for the method.

Obstacle assessment methodology

Examples



Free DTM with 16 m vertical accuracy is used

Maximum vegetation allowance not know (Agree on a value: e.g. 25 m

Hight of the higher building not know (agree on a max value, e.g. 50 m)

Obstacle assessment methodology

- Obstacles assessment methods using flight evaluation:
  - ☞Some flight evaluation aircrafts are fitted with features which assess automatically the obstacles in the protection area during the evaluation:
    - For such aircrafts no additional job!
  - ☞However, most the aircrafts doesn't have this features, so:
    - Manual assessment:
      - The assessment is done in VMC;
      - The pilot is positioned in the aircraft so as to have good visibility;
      - Often required to fly the lateral limits of the protection area.

Obstacle assessment methodology

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      - The pilot is positioned in the aircraft so as to have good visibility;
      - Often required to fly the lateral limits of the protection area.

Obstacle assessment methodology

Obstacles assessment methods using flight evaluation:

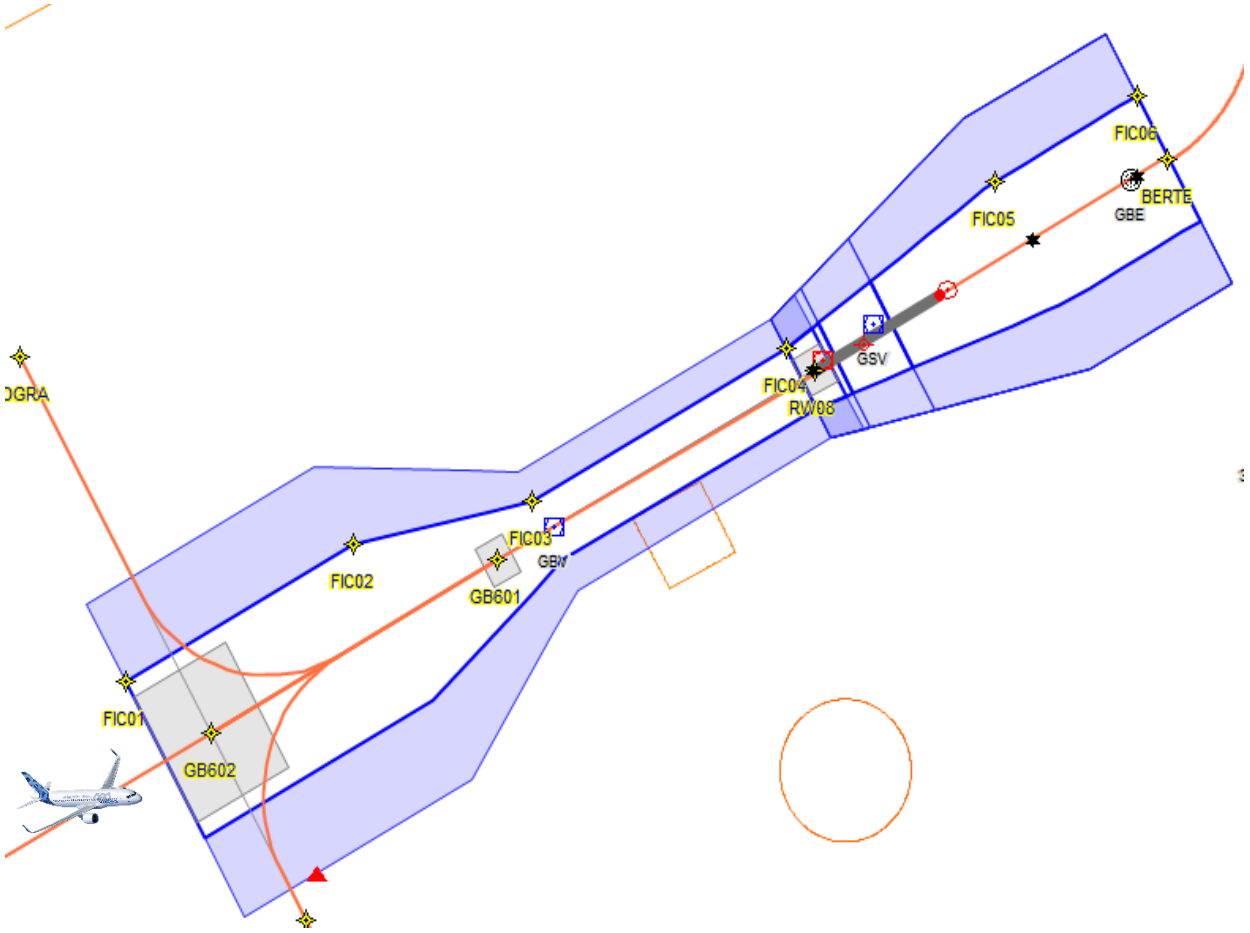
- Designer to report doubtful controlling obstacle to the FVP for consideration:
  - Approximative location and elevation;
  - For terrain/trees or adverse assumption obstacles, no need to verify; just check that no higher obstacle is reported in the vicinities.
- FVP to place special emphasis on :
  - Newly discovered obstacles;
    - If new controlling obstacle is found, the result of the validation is “Failed”;
    - Emphasis is given to power lines, man-made obstacles, windfarms, chimneys, etc.

Obstacle assessment methodology

Obstacles assessment methods using flight evaluation:

- FVP to place special emphasis on :
  - ☞Newly discovered obstacles:
    - If new controlling obstacle is found, the result of the validation is “Failed”;
    - Emphasis is given to power lines, man-made obstacles, windfarms, chimneys, etc.
    - Obstacles GNSS altitude and locations to be noted using latitude/longitude or radial/distance:
      - On site survey is needed after.

Obstacle assessment methodology



Example method to check intermediate, final and missed approach segments:

1. Fly the nominal trajectory and then,
2. Fly the limits of the primary protection areas.

Comprehension checks

1. What are the components of an IFP validation?
   - ☞Ground validation and flight validation.
2. Is flight validation mandatory?
   - ☞No! if a State If the State can verify, through ground validation, the accuracy and completeness of all obstacle and navigation data considered in the procedure design etc.
3. What are the steps of a validation?
   a. Independent review;
   b. Preflight validation;
   c. Simulator evaluation;
   d. Flight evaluation.
4. Can flight evaluation be performed using a desktop simulator?
   - ☞Flight evaluation aircraft with a certified/approved and experienced FVP

Questions:

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