GBAS/SBAS Implementation Workshop

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PBN safety studies main principles DSNA France

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CONTENT OF THE PRESENTATION

- Context
- DSNA, French ANSP, methodology
- Generic safety assessment supporting PBN procedures implementation
- Example of Hazard from the RNAV(GNSS) generic safety assessment
- Conclusion

Context

EUROPEAN AND FRENCH LAW

- **European** COMMISSION REGULATION No 1035/2011 requires that hazard identification as well as risk assessment and mitigation are systematically conducted for any **changes to the ATM system (scope)**

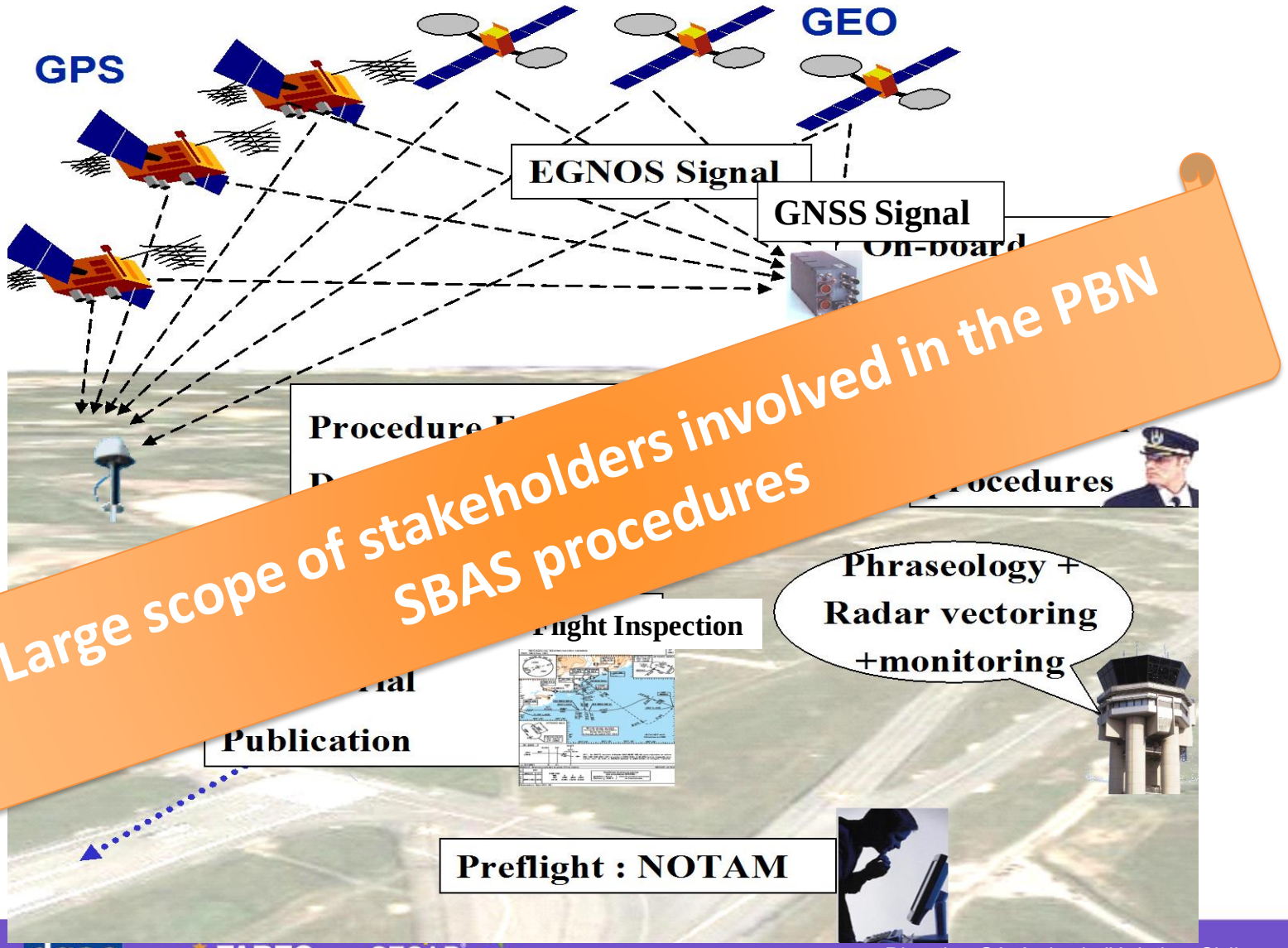
- **ICAO Doc 9906** highlights expectations regarding safety activity related to instrument flight procedure but remains at high level regarding the scope of the safety activities

> **7.7 CONDUCT SAFETY ACTIVITIES (STEP 7)**
>
> This section provides a minimum of information on safety activities. For more detailed information please refer to the *Safety Management Manual* (Doc 9859).

- The French law (Arrêté du 4 Octobre 2017) related to the instrument flight procedure **addressed more precisely safety requirements**:
  - Safety assessment shall determine if the risk is acceptable
  - Safety assessment is under the change manager responsibility
  - Safety assessment is to be provided by the change manager seeking procedure approval to the French ANS.

French ANSP (DSNA) methodology

SCOPE OF THE PBN PROCEDURE SAFETY ASSESSMENT



Large scope of stakeholders involved in the PBN SBAS procedures

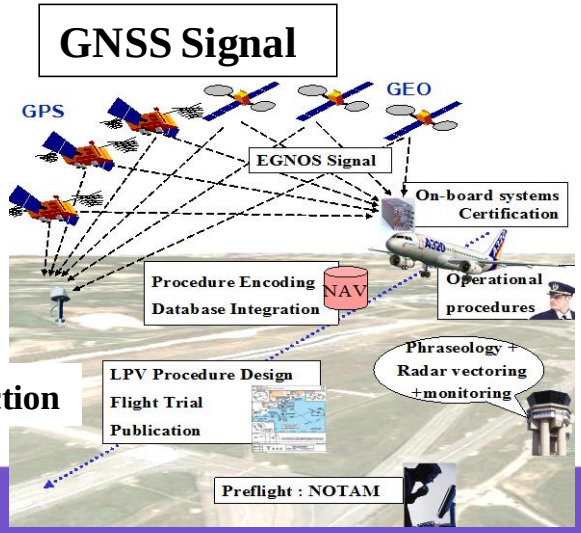
SCOPE OF THE PBN PROCEDURE SAFETY ASSESSMENT

Scope of the safety assessment :

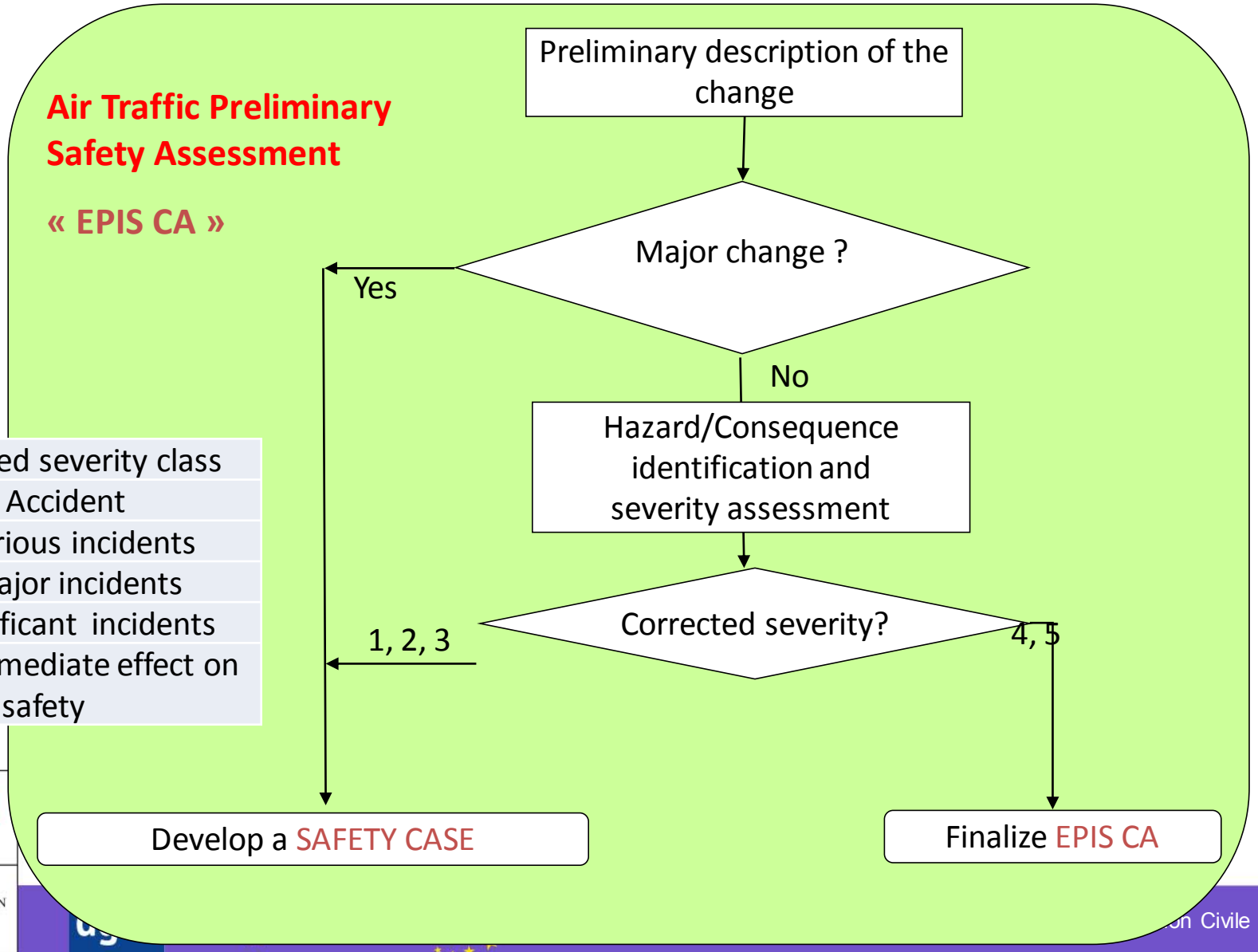
- **ATM operational perspective (ATM)**

Out of scope of the safety assessment

- **Procedure design** related hazard as supported by specific **quality assurance process**
- **On-board** related hazard as endorsed by **aircraft certification process and airline approval**.



GENERAL DSNA SAFETY METHODOLOGY



Corrected severity class
1 - Accident
2 – Serious incidents
3 - Major incidents
4 - Significant incidents
5 – no immediate effect on safety

RISK CLASSIFICATION SCHEME

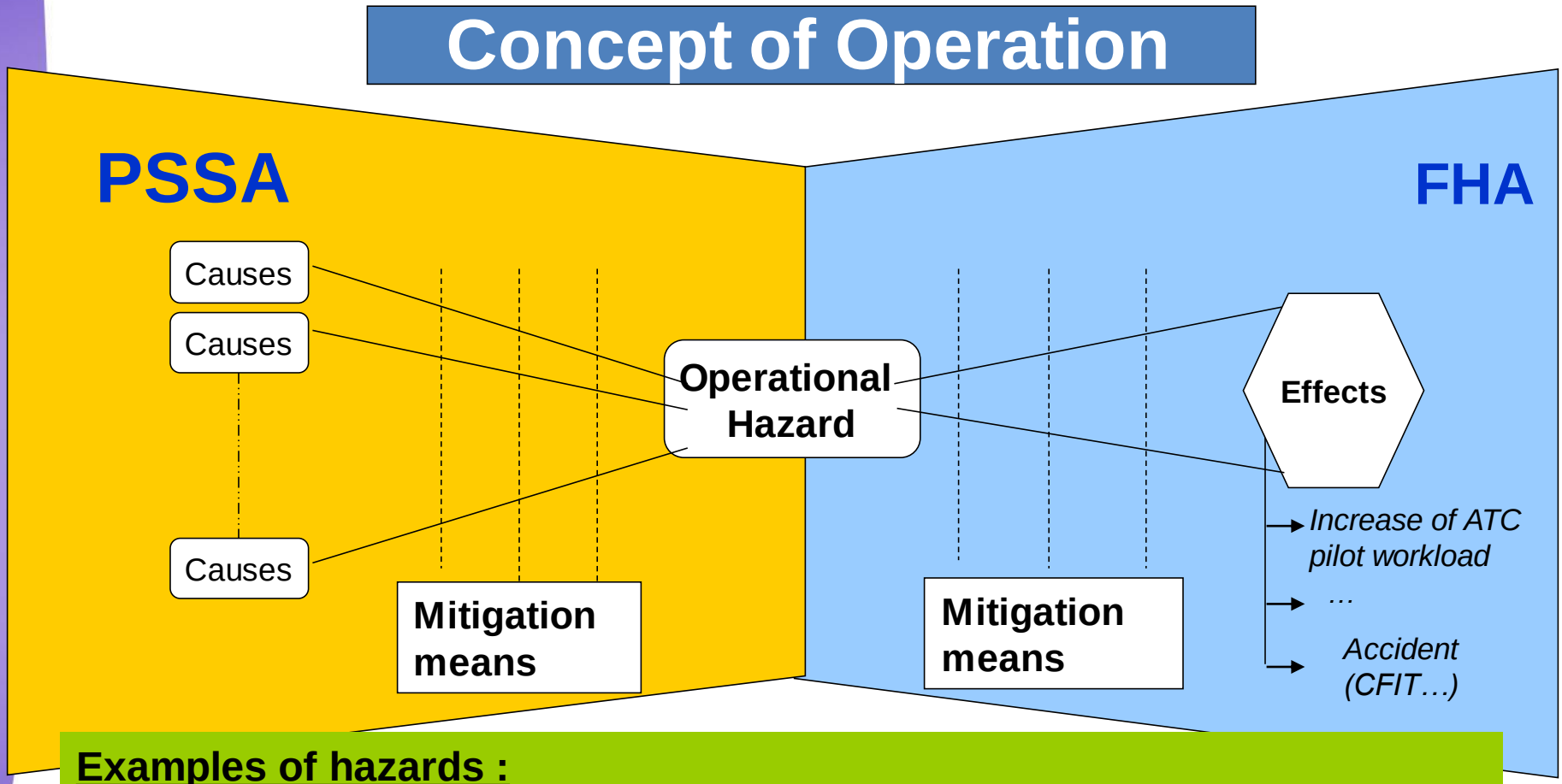
Occurrence / Corrected severity class	Numerous	Likely	Occasional	rare	Extremely rare
1 - Accident					
2 – Serious incidents					
3 - Major incidents					
4 - Significant incidents					
5 – no immediate effect on safety					

No acceptable risk

Detailed safety case required

Occurrence	Explanations – order of magnitude
Extremely rare	Never occurred from the organism point of view
rare	May happen once every 5 to 10 years within the entity.
Occasional	May happen once to twice a year within the entity
Likely	May happen several times a year within the entity
Numerous	May happen several times a month within the entity

ATM RISK ASSESSMENT AND MITIGATION



Examples of hazards :

- The aircraft significantly deviates from the RNAV trajectory
- The aircraft fails to intercept the final segment
- Several aircraft deviate from their RNAV trajectories (Loss of GNSS signal)

Generic safety assessment supporting PBN and SBAS procedures implementation

GENERIC VS LOCAL SAFETY ASSESSMENT

Generic DSNA PBN safety assessment materials to support local implementation of PBN procedures :

- Describe the change (PBN implementation of NPA, SBAS procedure, BaroVNAV procedure, arrival, departure)
- Summarize Assumptions, Requirements and Recommendations from DSNA PBN safety assessments
- Provide a list of hazards, with frequency of occurrence and severity proposals (based on generic assumptions)

Local safety assessment

- Created from the generic elements consolidated through local context like conflict with other trajectories (helicopter…) or airspaces
- Lists actions to be done by local air navigation service : ATCO training, operational manual update, information of local users, …

→ **Validation of the PBN safety assessment by local operational staff (controllers, pilots, procedure designers, flight inspector…) is necessary**

GENERIC PBN SAFETY ASSESSMENT MATERIALS

- **6 PBN DSNA generic safety assessment available**

RNAV 1 STAR & initial Approach
Radar environment

RNAV 1 STAR & initial Approach
Non radar environment

RNAV 1 SID
Radar environment

RNAV 1 SID
Non radar environment

RNAV(GNSS) – LNAV, LNAV/VNAV, LPV
Radar environment

RNAV(GNSS) – LNAV, LNAV/VNAV, LPV
Non radar environment

Example of Hazard from the RNAV(GNSS) safety assessment

EXAMPLE OF GUIDANCE TO DESCRIBE THE CHANGE

Description of the modification introduced by the RNAV GNSS procedure

Note: This description corresponds to the generic case and shall be modified with respect to the local context

Description of the modification introduced by the RNAV GNSS procedure

The means of surveillance available are :

- ☐ Radar environment: guidance and overall radar coverage along the final segment. Guidance and holding maintenance of the separations ensured thanks to the radar.
- ☐ Non radar environment: procedures control methods holding of the separations from the positioning reports made by the pilot at significant points.

Note: These two cases are analyzed in this study. In radar environment, indicate if parts of the trajectory are below the MRVA.

The link between the arrival phase of flight and the initial approach is realized via *[Tick the applicable case(s)]* :

- ☐ an RNAV STAR
- ☐ a conventional STAR
- ☐ An ATC instruction: the controller vectors the aircraft or asks the pilot to perform a « direct to » toward

The intermediate approach is :

- ☐ aligned with the runway (required for APV SBAS and for APV Baro-VNAV)
- ☐ not aligned with the runway (possible in LNAV).

Note:

- *Give the name of the initial significant point: IAF and any other significant point of the initial…;*
- *Explain the reasons behind the design of the initial segment*

The intermediate approach is :

- ☐ aligned with the runway (required for APV SBAS and for APV Baro-VNAV)
- ☐ not aligned with the runway (possible in LNAV).

EXAMPLE OF RELEVANT ASSUMPTIONS

Environmental assumptions

- Considered configuration of runways : either single or dedicated dependant runway (no simultaneous approaches);
- Runway approved for the NPA or for precision approach;
- Low or medium obstacles density ;
- Areas in the terminal airspace that controllers could use to free the aircraft in case of problem.
- The commissioning of RNAV GNSS approaches does not have any significant influence on the traffic capacity.
- ATC Service available
- Publication on the alternate airfield of a conventional procedure usable in case of dysfunction of the GNSS system.
- RNAV GNSS missed approach
- The APV Baro-VNAV is published with an NPA procedure on the same runway end:
  - Common initial and intermediate approach segments

The APV SBAS is published with an NPA procedure on the same runway end:
- Common initial and intermediate approach segments

Same trajectory to be followed in case of missed approach

- The final segment of the APV Baro-VNAV procedure corresponds to the recommendations of the Doc 8168-OPS/611 :
  - Aligned with the runway
  - Follows a glide path between 3° and 3.5°

The final segment of the APV SBAS procedure corresponds to the recommendations of the Doc 8168-OPS/611 :
- Is aligned with the runway
- Follows a descent path between 3° and 3.5°
- Is preceded by an intermediate segment equally aligned with the runway.

EXAMPLE OF LIST OF HAZARD

Operational Hazards : *[MUST be updated for the local study]*

Title	Corrected severity class	Corrected frequency of occurrence
[insertion of new OH depending on the local context]		
OH1 : An aircraft diverts significantly from the RNAV GNSS trajectory	*4*	*Rare*
OH 2 : Loss of the GNSS signal	*4*	*Rare*
OH 3 (radar) : Problem of transition between radar vectoring and final	*4*	*Rare*
OH 4 (APV SBAS) : Interception of the final approach segment from above the glide path plan		
OH 5 (APV SBAS) : Loss of the SBAS signal		
OH 6 (radar): Loss of the radar coverage during the radar vectoring or monitoring toward the IAF when there is no designed STAR associated.	*4*	*Occasional*
OH 7 : Interference with other trajectories or airspace		

EXAMPLE OF HAZARD ASSESSMENT (2/3)

External mitigation means of the ANSP	Action	Responsible
1. Surveillance and radar vectoring (**ASSUMP**)	*no action*	
1b. Procedure control method (**ASSUMP**)	*no action*	
2. **Distance/altitude check at 1000ft**, distance/altitude table and the table of ground speed/vertical speed (**ASSUMP**)	*no action*	
3. ATC Standard Operating Procedures (SOP) about working method broadcast to the controllers, Controllers briefing prior to the commissioning and use of the embedded GNSS procedure in the continuing education. (**REQ**)	Lead a coordination with the other organism impacted by this new procedure Update the SOP, the education briefing, the education booklet with the new procedure.	*[To complete]*
4. Education for unusual situations (**REQ**)	Integrate the contingency procedures in the ATC education plan.	*[To complete]*
Protective mitigation means		
Specific phraseology for an APV SBAS or APV Baro-VNAV (**REC**)	Update the ATC education briefing with the specific phraseology.	
7. GNSS WGS 84 (IAF, TP, IF, FAF) points and TAA on IAF (static chart to be provided on the radar display) (**REC**)	Input elements of the RNAV GNSS procedure in the radar visualization.	*[To complete]*
8. MRVA modification (**REC**)	Bring the MRVA down around the airfield	*[To complete]*
9. Contingency procedures coordinated between the local air traffic control service and the users (**REC**)	Coordination of the local air traffic control service and the users about the contingency procedures at the moment of the users' consultation. After the procedure publication, ask for information at the users of the contingency procedures.	*[To complete]*
10. Position reporting at the runway end in non radar environment only (**REC**)	Update the ATC education briefing in order to give notice to the controllers that the distance to the runway end is not always displayed onboard.	*[To complete]*

EXAMPLE OF HAZARD ASSESSMENT (3/3)

Preventive Mi me

Internal mitigation means of the ANSP	Action	Responsible
11. Quality process of the procedure design process: Check by a second designer, traceability dossier to ensure the chart/proposal coding consistency (**ASSUMP**)	*no action*	
12. Quality process of the aeronautical information service so as to validate the publication project. (**ASSUMP**)		
13. Respect of the design rules (right interception angle, sufficient stabilization distance, compliant reductions in speed) (**ASSUMP**)	Implementation an education monitoring of the procedures designers.	
14. FAS Datablock protected by a CRC mechanism (ASSUMP)	In Europe the generation tool developed by Eurocontrol is used. Outside Europe, ensure to have a validated and approved tool to realize the FAS DB.	
15. Flight inspection of the procedure before the commissioning. (**ASSUMP**)		
16. NOTAM publications (**ASSUMP**)		
17. Proposal of coding tables provided in the AIP (**ASSUMP**)		
18. 28 days of delay between publication and		
	of the FAS DB	
24. Transmission of the FAS DB in an electronic format from the aeronautical information service to the data packers (REQ)	Set up a tool/working method enabling to pass on the FAS DB file to the electronic format.	
25. Reinforce the quality process of the Aeronautical Information Service so as to validate the publication project including the use of a geo reference tool (the waypoints position is checked thanks to their coordinates). (REC)	Give geo-reference to the aeronautical information service and to the service in charge of the software design.	

FAS validation Process (REQ)

Transmission of the FAS DB in an electronic format from the aeronautical information service to the data packers (REQ)

ADDITIONAL SAFETY ASSURANCE MEANS

The safety is also guaranteed:

- By the process already in place in the SMS of the local entity responsible for the procedure implementation,
- By the monitoring of the RNAV GNSS procedure during its operational use
- Thanks to the realization of the Event Notification Form (ENF) enabling to evaluate the efficiency of mitigation means.
    - We have an expert team in place analysing all event reports and providing additional recommendations

Conclusion

CONCLUSION

- **For PBN procedures, the main changes are on-board (airborne database integration and pilot training)**

→ To address safety on such a wide subject, it is wise to set up a working group to gather all expertise and work together.

- **Providing generic PBN Safety assessment material is helpful for the local implementation as PBN is a complex subject**

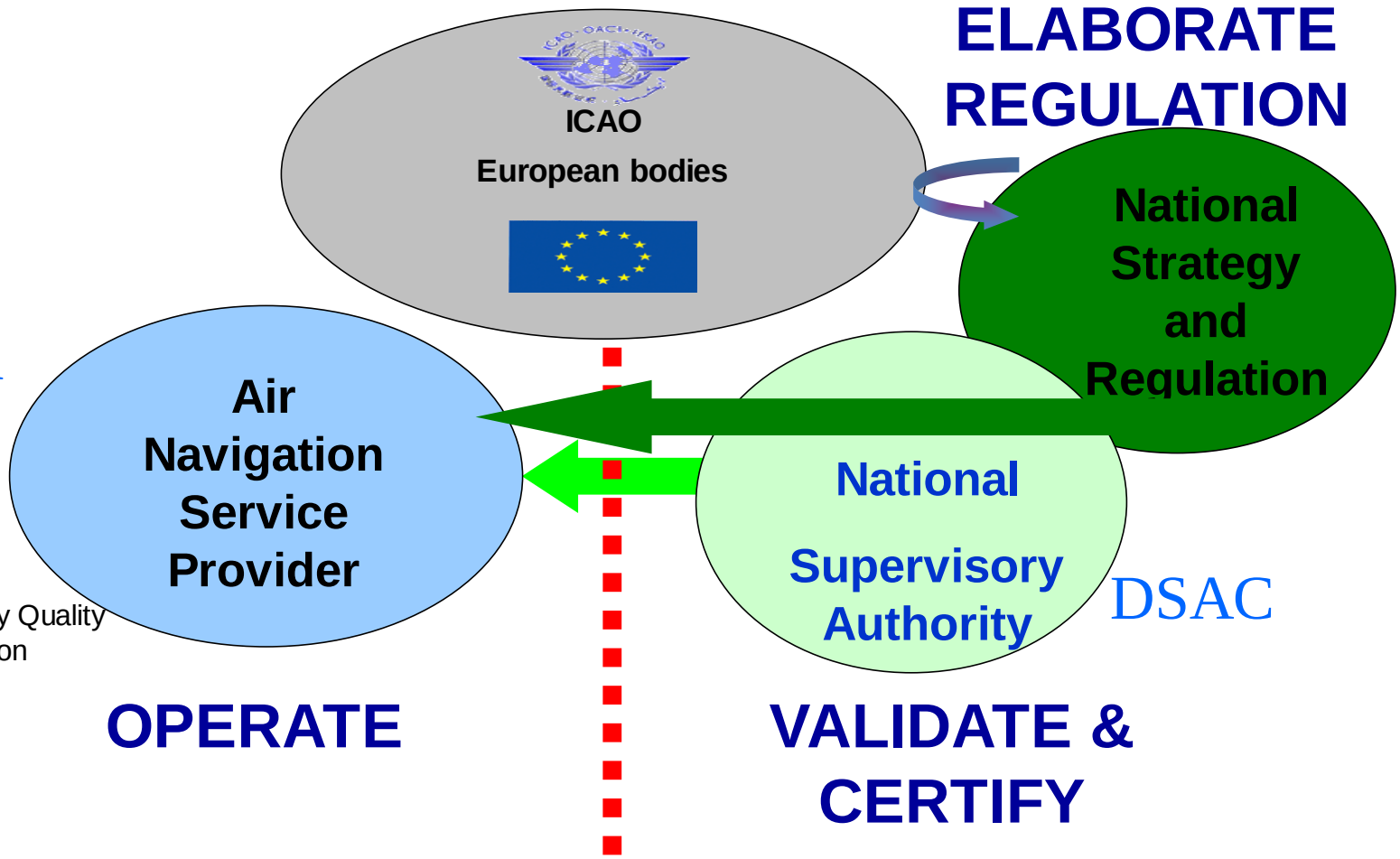
→ Local implementation shall also be supported by local operational people (controller, pilot, procedure designer, flight inspection...)

- **For SBAS procedures implementation , the main specific element regarding safety is the FAS DB.**

--> National methodology to validate FAS DB and to keep FAS DB integrity through FAS DB publication

Complementary slides

FRENCH DGAC ORGANIZATION



ORIGIN OF THE GENERIC PBN MATERIALS

- In order to support the implementation of the first PBN procedures, first safety assessment were performed at national level
- The development of each PBN safety assessment was supported by:
  - A group of PBN, procedure designer and safety experts
  - The development of a generic concept of operations
  - A local implementation (workshop with ATCO, pilots, procedure designer….)

LPV Approach
2008-2009 in **Clermont Ferrand**

RNAV 1 STAR/SID
2009 in **Bordeaux/Nice**

LNAV/VNAV Approach
2011 in **Brest**

RNAV 1 STAR/SID
2013 in **New Caledonia**

EXAMPLE OF HAZARD ASSESSMENT

HAZARD DESCRIPTION AND RELATED FREQUENCY/ GRAVITY

Operational Hazard (OH) :				
Identification of the OH : OH1	**OH definition:** An aircraft significantly diverts from its RNAV GNSS trajectory.			
Initial estimated severity without external mitigation means				
☐ 1	☐ 2	☒ 3	☐ 4	☐ 5
Estimated frequency of occurrence without internal mitigation means				
☐ Ext. rare	☐ Rare	☒ Occasional	☐ Likely	☐ Numerous
Estimated frequency of occurrence taking into account the internal mitigation means				
☐ 1	☐ 2	☐ 3	☒ 4	☐ 5
Corrected estimated severity taking into account the external mitigation means				
☐ Ext. rare	☒ Rare	☐ Occasional	☐ Likely	☐ Numerous
Detailed description of the operational hazard				

Note: This OH is applicable to all RNAV GNSS approach segments (initial, intermediate and final segments and missed approach).

The aircraft performing an RNAV GNSS procedure diverts from the trajectory expected by the controller and flies out from the lateral and/or vertical protection area(s) toward the terrain without detection by the pilot with his CDI visualization means **(and VDI for the APV procedures)**.

Consequences:
If the aircraft diverts laterally from its trajectory, the most likely effect is that the aircraft comes closer to another aircraft or to the terrain.
If the aircraft diverts from its trajectory toward the terrain, the consequences are more severe because the aircraft may come closer to the high areas. If the MOC (Minimum Obstacle Clearance) is no longer met, the operational consequence has an initial severity of at least 3 (worst credible case).

Causes due to the ANSP context:

- Incorrect design of the procedure (waypoints coordinates error, error concerning altitude constraints, speed limitation, interception angles, error concerning vertical design, incorrect survey/knowledge of the obstacles);
- Introduction of an error in the procedure publication in the Aeronautical Information Publication: wrong points coordinates, wrong descent altitude and waypoints);
- Unawareness of the new RNAV GNSS procedure by the approach controller.
- Incorrect parameters in the meteorological data used to feed ATIS message and controllers.
- Incorrect QNH value transmitted by the ATIS to the pilot (error at the moment of ATIS message creation or ATIS message out of date);
- Incorrect QNH value transmitted at the first altitude clearance provided by the Approach control.

Causes not due to the ANSP context:

- Incorrect coding of the procedure (misunderstanding of the designed/protected trajectory) by the data packer: use of incorrect Path Terminator (PT)…;
- Incorrect parameter value in the RNAV GNSS procedure coding in the database: inaccurate coordinates of the waypoints…;
- Introduction of an error during the RNAV GNSS procedure loading onboard the aircraft;