First LPV 200 approach in Europe

Paris Charles de Gaulle

Benoit Roturier DSNA

ESSP Workshop Warsaw - 2016

PBN Implementation Status

PBN FOR APPROACHES
TARGETS FOR FRANCE

Modernizing/rationalizing French landing system infrastructure,

- improve safety, airport accessibility
- reduce ANSP's costs (technology transition)

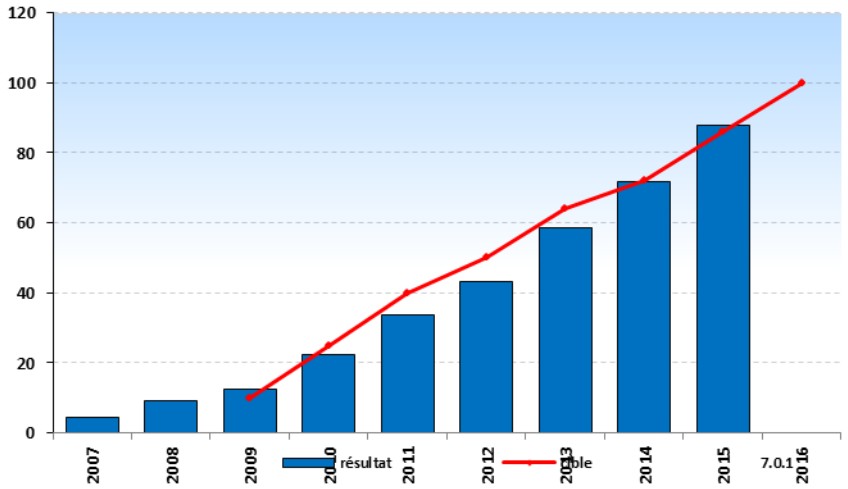
- **PBN target for primary runways:**
  - **Best quality backup to ILS** (outages, maintenance, renewal ,etc…)
    - **First LPV 200 published at Paris CDG March 2016 (4 runways)**

- **PBN target for secondary runways:**
  - More direct paths, increased safety (vertical guidance in final), increased airport accessibility vs. conventional navaids

- **PBN target for about 50 small/medium airports:**
  - Cut landing infrastructure costs (ILS Cat I) by transitioning to PBN
    - **LPV 200 now published at Cherbourg + others to come**

PBN APPROACHES STATUS

- More than **200 runway ends** included in France **PBN plan**
- **GPS** implemented since 2004, **EGNOS** since 2011, **GPS + Barometric** vertical guidance since 2012



ICAO PBN RNP APCH A37-11 target

Yearly achieved rate

PUBLISHED PBN PROCEDURES

ETUDES PUBLIEES à l'AIP	Date : 1 JANVIER 2016 - Cycle 02/16

NPA : approche GNSS (minima LNAV)
APV SBAS ou Baro : approche avec guidage vertical (minima LPV ou LNAV/VNAV)

OUTRE-MER

MIQUELON NPA 12
MIQUELON NPA 30
SAINT PIERRE NPA 08
SAINT PIERRE NPA 26

BORA BORA NPA 11
BORA BORA NPA 29
FAKARAVA NPA 05
FAKARAVA NPA 23
HAO NPA 12
HAO NPA 30
HIVA OA NPA 02
HIVA OA NPA 20
HUAHINE NPA 07
HUAHINE NPA 25
NUKU HIVA NPA 06
RAIATEA NPA 07
RAIATEA NPA 25
RANGIROA NPA 09
RANGIROA NPA 27
TAHITI Baro 04
TAHITI Baro 22
TUBUAI NPA 03
TUBUAI NPA 21

* MARIE GALANTE NPA 09
* POINTE A PITRE NPA 12
* POINTE A PITRE NPA 30
* MARTINIQUE NPA 10
* MARTINIQUE NPA 28

* CAYENNE NPA 08
* CAYENNE NPA 26

* DZAOUDZI Baro 16
* DZAOUDZI Baro 34

* LA REUNION NPA 12
* LA REUNION Baro 14
* LA REUNION Baro 30
* ST PIERRE Baro 15

NOUMEA LA TONTOUTA NPA 11
NOUMEA LA TONTOUTA NPA 29

LFVM
LFVP
NTAA
TFFM
TFFR
TFFF
SOCA
FMCZ
FMEE
FMEP
NWWW

SNA OUEST

ANGERS SBAS 26
BREST SBAS+Baro 07R
BREST Baro 25L
CAEN NPA 13
CAEN SBAS+Baro 31
CHOLET SBAS 21
* DEAUVILLE NPA 12
DEAUVILLE SBAS+Baro 30
* DINARD SBAS+Baro 17
* DINARD SBAS+Baro 35
ILE D'YEU NPA 14
ILE D'YEU NPA 32
LANNION SBAS+Baro 29
LAVAL NPA 32
LA ROCHE SUR YON NPA 10
LA ROCHE SUR YON SBAS 28
* LE HAVRE NPA 04
LE HAVRE SBAS+Baro 22
* LE MANS SBAS 02
LE MANS NPA 20
(LORIENT NPA 07)
MORLAIX NPA 04
MORLAIX NPA 22
NANTES SBAS+Baro 03
NANTES NPA 21
OUESSANT SBAS 05
OUESSANT SBAS 23
QUIMPER SBAS+Baro 28
RENNES SBAS+Baro 10
RENNES SBAS+Baro 28
* SAINT BRIEUC SBAS+Baro 26
SAINT NAZAIRE SBAS+Baro 26
* VANNES NPA 04
* VANNES SBAS 22

SNA RP

LE BOURGET SBAS 07
LE BOURGET NPA 25
LE BOURGET SBAS 27
PARIS ORLY SBAS+Baro 02
PARIS ORLY SBAS+Baro 06
PARIS ORLY SBAS+Baro 08
PARIS ORLY Baro 20
PARIS ORLY SBAS+Baro 24
PARIS ORLY SBAS+Baro 26
PONTOISE SBAS+Baro 05
PONTOISE SBAS+Baro 23
* TOUSSUS NPA 07L

SNA NORD

* ALBERT BRAY SBAS 09
AMIENS SBAS 30
AUXERRE SBAS 01
AUXERRE SBAS 19
* BEAUVAIS SBAS 12
BLOIS NPA 30
* CALAIS SBAS 24
LE TOUQUET SBAS 13
* LILLE SBAS 08
* MELUN SBAS 28
* MERVILLE SBAS 04
ORLEANS SBAS 05
ORLEANS SBAS 23
* ROUEN NPA 22
* VALENCIENNES SBAS 11
* VALENCIENNES SBAS 29

SNA NORD-EST

BÂLE-MULHOUSE SBAS 15
BÂLE-MULHOUSE SBAS 33
BESANCON SBAS 23
CHALON CHAMPFORGEUIL NPA 35
BESANCON NPA 23 HEL
CHAMBLEY NPA 23
COLMAR SBAS 01
COLMAR SBAS 19
DOLE SBAS 05
EPINAL SBAS 26
METZ-NANCY-LORRAINE SBAS+Baro 04
METZ-NANCY-LORRAINE SBAS 22
* MONTBELIARD NPA 26
* NANCY SBAS 03
NEVERS SBAS 30
REIMS SBAS 07
REIMS NPA 25
STRASBOURG SBAS 05
STRASBOURG SBAS 23
* ST YAN NPA 15L
* ST YAN NPA 33R

SNA CENTRE-EST

ANNECY SBAS+Baro 04
* AURILLAC SBAS 15
* CLERMONT SBAS 26
* GRENOBLE SBAS 27
* LE PUY SBAS 15
* LE PUY SBAS 33
LYON BRON SBAS+Baro 16
LYON BRON SBAS+Baro 34
LYON ST EXUPERY SBAS+Baro 18R
LYON ST EXUPERY SBAS+Baro 18L
LYON ST EXUPERY SBAS+Baro 36R
LYON ST EXUPERY SBAS+Baro 36L
MOULIN SBAS 26
ROANNE NPA 20
SAINT ETIENNE SBAS+Baro 18
* SAINT ETIENNE NPA 36
VALENCE SBAS 01
* VICHY SBAS 01

SNA SUD-OUEST

AUCH SBAS 18
AUCH SBAS 36
BERGERAC SBAS+Baro 10
BERGERAC SBAS+Baro 28
* BIARRITZ Baro 09
BIARRITZ SBAS+Baro 27
BISCARROSSE NPA 27
* BORDEAUX SBAS+Baro 05
BORDEAUX SBAS+Baro 11
* BORDEAUX SBAS 23
CHATEAUROUX SBAS+Baro 21
* LA ROCHELLE SBAS 27
NIORT NPA 25
* PAU SBAS 31
PERIGUEUX SBAS+Baro 29
* ROYAN SBAS 28

SNA SUD

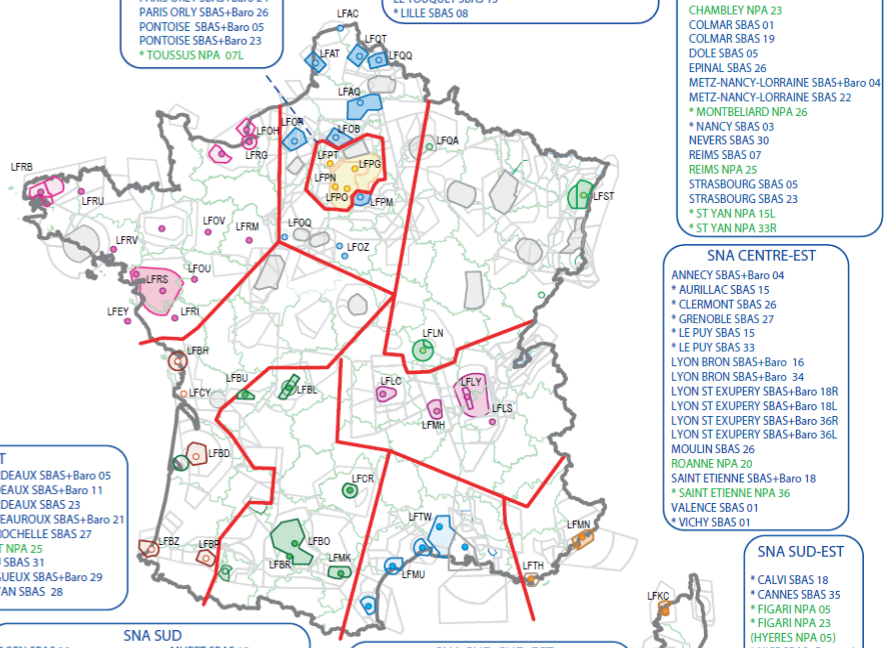
AGEN SBAS 29
* ANGOULEME SBAS 28
* ANGOULEME SBAS 28 HEL
BRIVE SBAS 11
BRIVE SBAS 29
CARCASSONNE SBAS+Baro 10
CASTRES SBAS 14
* LIMOGES SBAS 03
* LIMOGES SBAS 21
* MONTLUCON SBAS 17
MURET SBAS 12
POITIERS SBAS+Baro 03
POITIERS SBAS+Baro 21
* RODEZ SBAS 13
RODEZ SBAS 31
TARBES SBAS 20
TOULOUSE SBAS+Baro 14L
TOULOUSE SBAS+Baro 14R
TOULOUSE SBAS+Baro 32L
TOULOUSE SBAS+Baro 32R

SNA SUD-SUD-EST

* BEZIERS SBAS+Baro 09
* BEZIERS SBAS 27
MARSEILLE SBAS+Baro 13L
MARSEILLE SBAS 13L HEL
MARSEILLE SBAS+Baro 13R
MARSEILLE Baro 31L
MARSEILLE Baro 31R
MARSEILLE SBAS 31R HEL
* MENDE SBAS 13
NÎMES SBAS+Baro 18
NIMES SBAS 36
* PERPIGNAN SBAS+Baro 33

SNA SUD-EST

* CALVI SBAS 18
* CANNES SBAS 35
* FIGARI NPA 05
* FIGARI NPA 23
(HYERES NPA 05)
* NICE SBAS+Baro 04L
* NICE SBAS+Baro 04R
* NICE NPA - VPT 04
* NICE NPA - VPT 22



* participation du BPS

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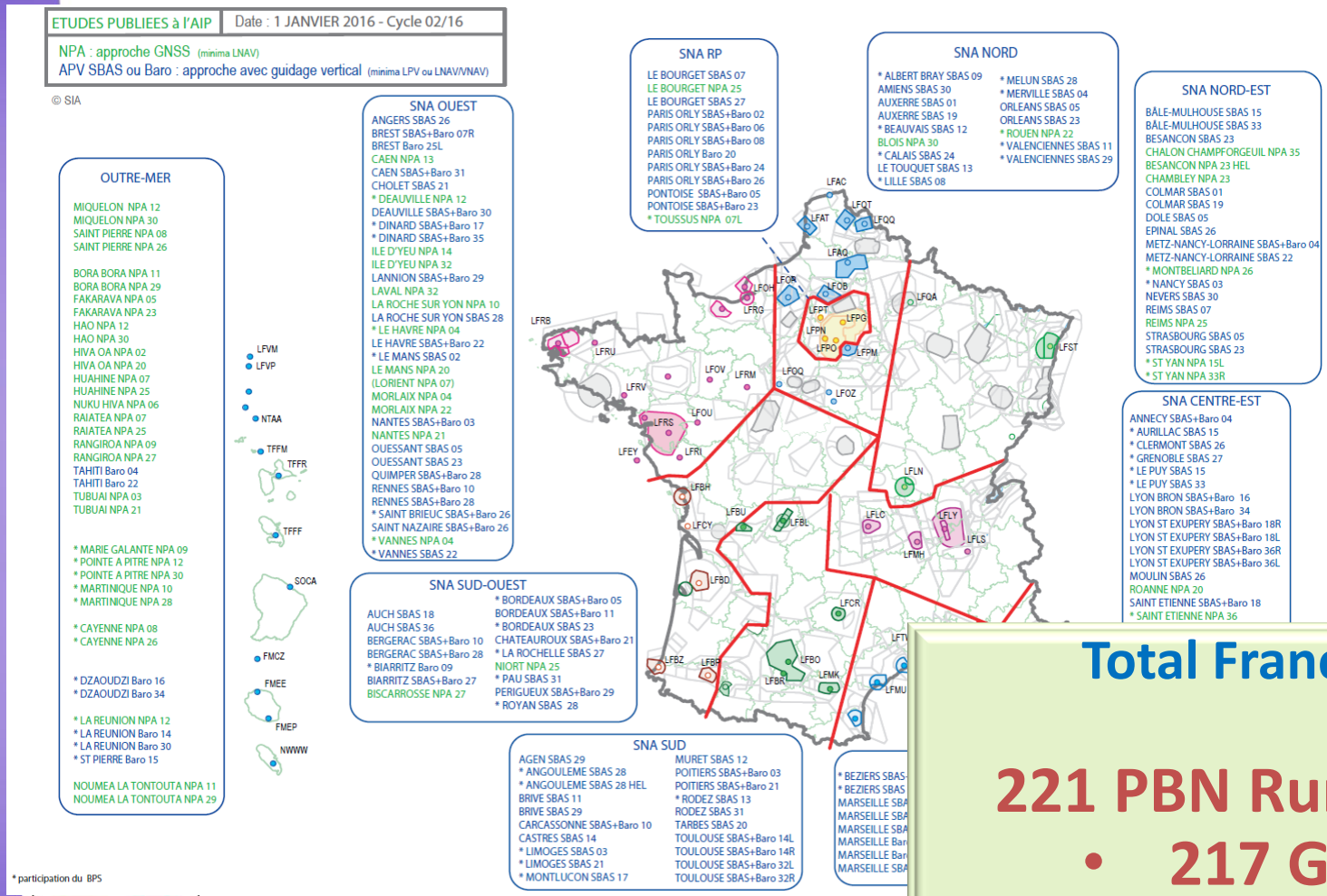
MEMBER OF SESAR JOINT UNDERTAKING

PUBLISHED PBN PROCEDURES



* participation du BPS

Total France Sept 16

221 PBN Runways:

- 217 GPS
- 138 EGNOS
- 6 LPV 200 EGNOS
- 73 GPS + Baro

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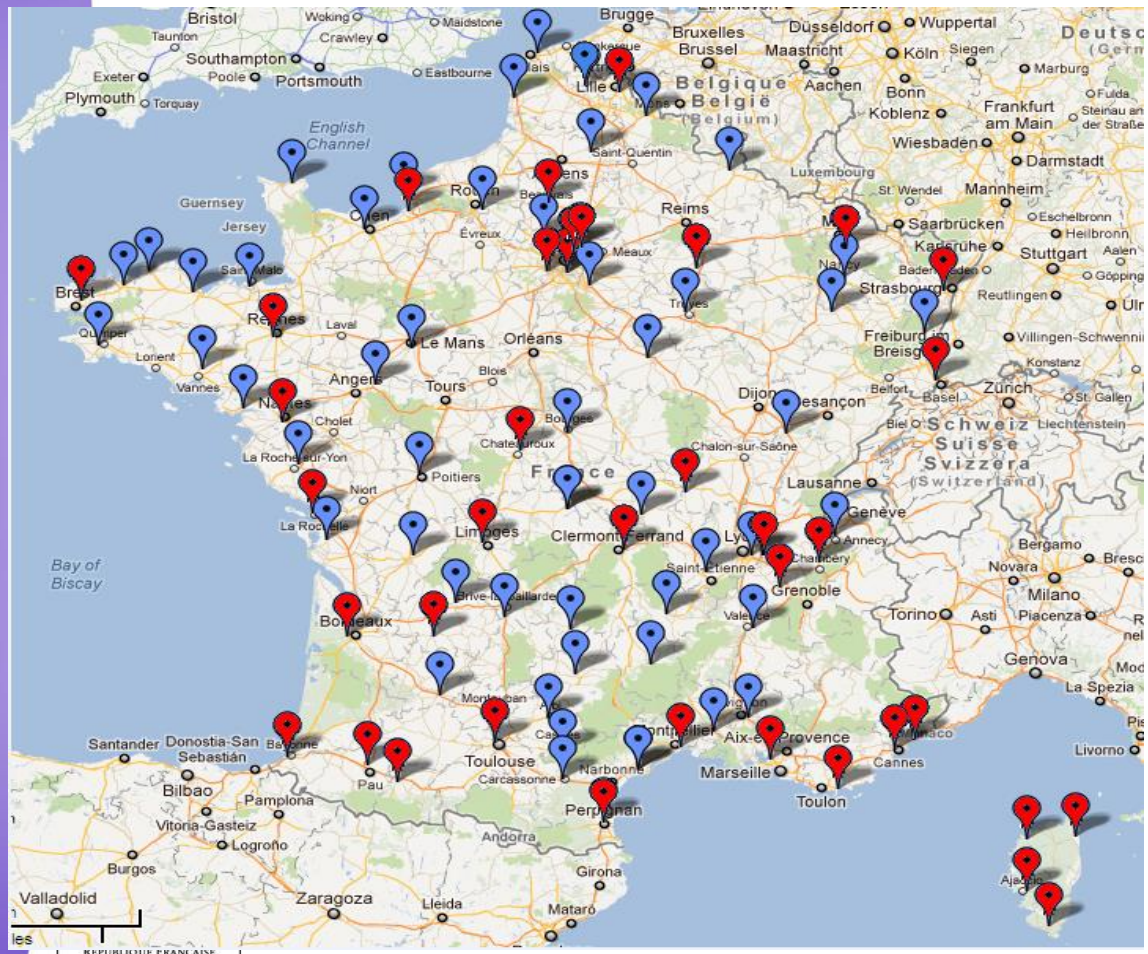
PBN with EGNOS supports France ILS CAT I rationalisation plan



2016: ILS reduced network

2016: Airports where the existing ILS Cat I is proposed to be replaced by a PBN approach with LPV

About 5 M€ yearly savings
Contributes to the French Landing Tax reduction program:

2018 : 225,50 €
2017 : 224,45 €
2016 : 227,1 €
2015 : 228,62 €
2014 : 233,23 €

Charles de Gaulle LPV 200

PARIS CDG TARGETS

- **The 8 ILS of the 8 CDG runways have to be replaced between 2016 and 2020**
  - **Decision to implement PBN**, with vertical guidance required, as the main backup to mitigate ILS unavailability (around 2 month per ILS)
  - Implementing **LPV 200 was an opportunity** to demonstrate to the community the potential benefits of LPV over a major European airport
  - We also have **LPV 200 early users** (Vietnam Airlines A350, HOP ATR 42, SWISS Bombardier,…)
- **Inaugural LPV 200 flight conducted the 3rd May 2016**
  - With **Airbus A350**, a **Falcon 2000X** and an **ATR42-600**

LPV 200 APPRECIATIONS

- **Jean- Christophe Lair, Airbus Experimental Test Pilot:** "Airbus is pleased to have demonstrated that the A350 XWB complies with the new RNAV (GNSS) approaches with satellite-based augmentation, as implemented at Paris Charles de Gaulle. **These approaches will be a valuable backup to the airport's traditional ILS approaches** and will maximise runway availability for the A350 by maintaining CAT1 capability, down to 200ft decision height, even **when the ILS ground station is not available**."

- **Eric Delesalle, ATR chief pilot:** "The LPV system is much more stable and **more reliable in terms of safety, but also more efficient than the ILS approach**. It really makes a difference"

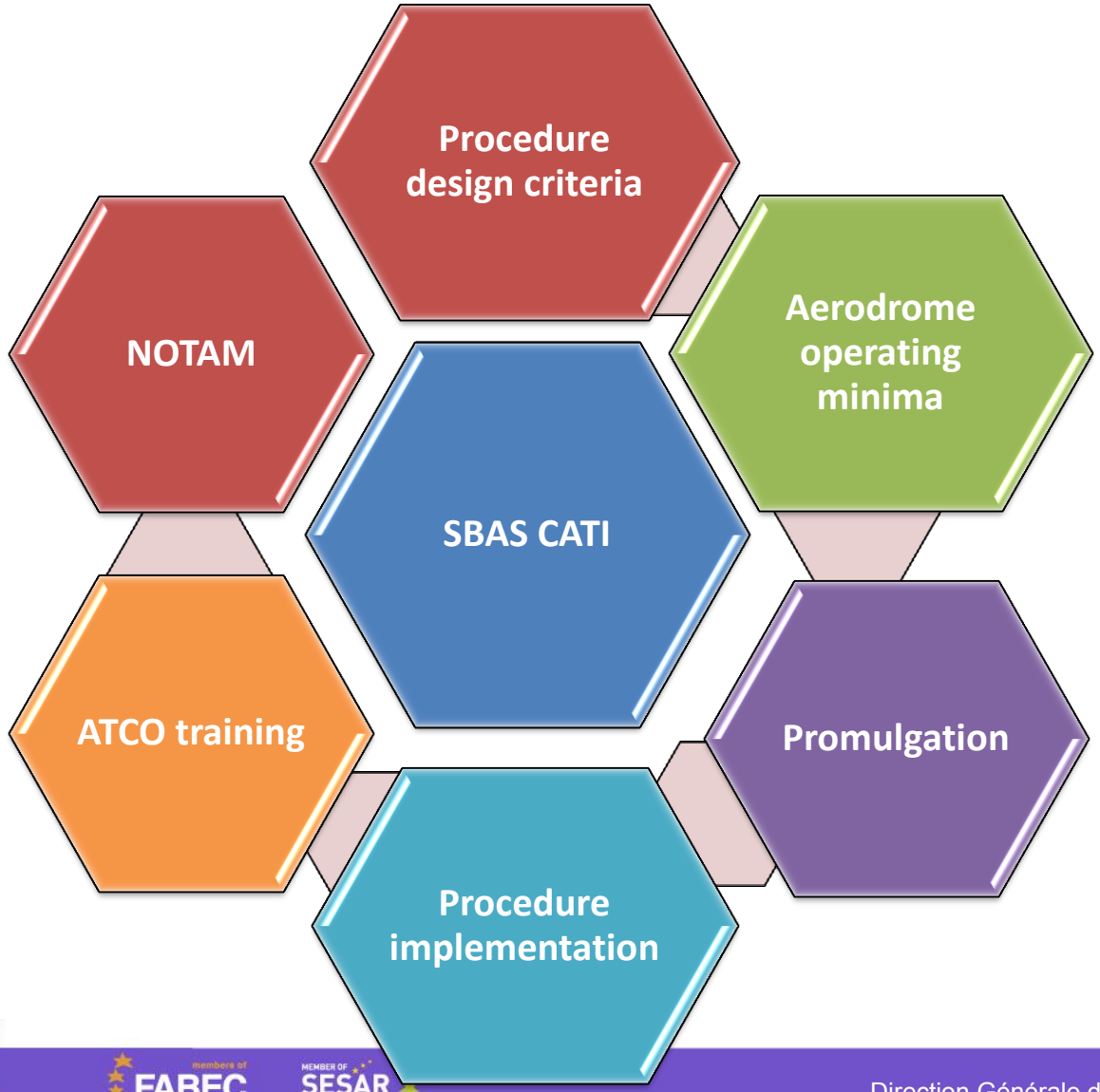
- **Jean-Louis Dumas, Dassault flight test pilot:** "Lowering the LPV minima down to 200ft in Europe is a great improvement enabled by EGNOS, and is **very valuable for business aviation operations**"

- **Peter Koch, chief of the Bombardier C Series fleet at SWISS:** "The accuracy and stability of the LPV guidance is impressive, as completely independent from ground installations. Lowering the LPV minima down to 200ft in Europe is a great improvement and very valuable. **The approach procedure is straight and simple, and there is no necessary changeover regarding the FGS with respect to conventional approach aids**"

CHANGING FROM LPV TO SBAS CATI

- Is it an easy-to-conduct change?
- Introduction of “LPV 200” procedures on French airports led to analyse in detail if and how the different bricks that are involved in procedures design and promulgation processes are impacted by the change .

MAIN BRICKS CONSIDERED BEFORE IMPLEMENTATION



Procedure design criteria

Change of criteria to assess obstacles in final :

- Same criteria as ILS (OAS and CRM) **because it is a precision procedure**
- No influence of the runway category on design criteria (precision RWY or non precision RWY)
- Change of FAS DB (VAL 35m)
- Same trajectory cannot always optimize both LPV and LNAV/VNAV minima

Procedure designers need continuous training

aerodrome operating minima

Depend on OCH value (PANS OPS)

Influenced by runway category (annex 14)

SBAS CAT I operation can be designed for

- Non-precision approach runways (DH ≥ 250ft)
- Precision approach runways (DH ≥ 200ft)

SBAS CATI procedure can be designed for **a Non-precision Runway** but the **DH shall be higher than 250ft**

ATCO training

No specific phraseology

Significant aspects to be pointed out to ATCOs

- SBAS CAT I lighting requirements are the same as for ILS CAT I
- SBAS CAT I operations do not require an ILS available on the runway

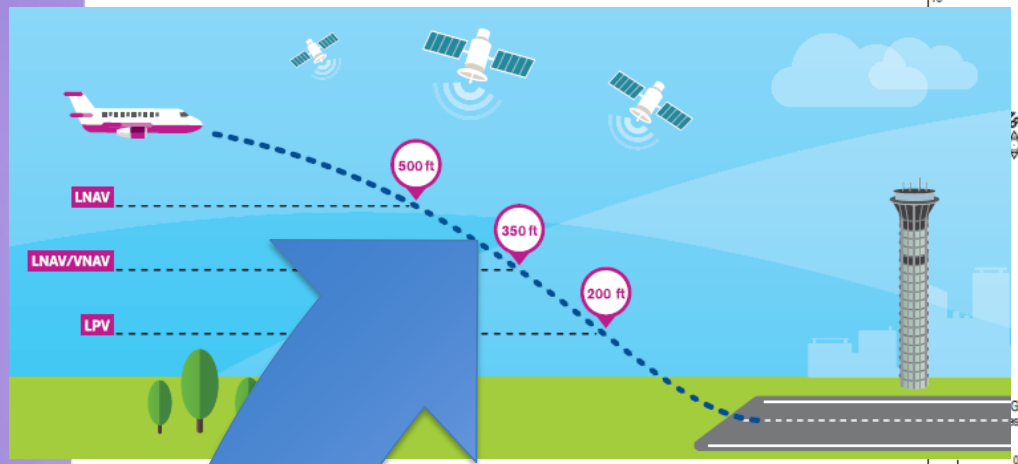
No specific training but some information to facilitate good understanding of the procedure.

NOTAM

On aerodromes with both legacy LPV and SBAS CAT I procedures, a NOTAM is published when SBAS CAT I unavailability is predicted

Only **ONE** *SBAS NOTAM* is published **per aerodrome**

CHARTING



AIP FRANCE — IAC 15.1 — AD 2 LFPG IAC RWY26L GNSS — 28 APR 16

APPROCHE AUX INSTRUMENTS — PARIS CHARLES DE GAULLE
Instrument approach
CAT A B C D
ALT AD : 392, THR : 316 (12 hPa)
FINAL **RNAV** (GNSS) RWY 26L

FREQ : Voir / *See* AD 2 LFPG IAC COM 01

RNP APCH

T° MNM Baro-VNAV : - 20°C. Procédures LNAV NON autorisées pendant les opérations simultanées. Utilisation du FD ou de l'AP fournissant un guidage de trajectoire RNAV requis durant les opérations simultanées. Fonction du FMS permettant d'intercepter l'axe de la piste suite à un guidage radar.
LNAV procedures NOT authorized during simultaneous operations. Use of FD or AP providing RNAV track guidance required during simultaneous operations. FMS function allowing the interception of the runway centerline after radar vectoring.

EGNOS CH 61919 E 26 A RDH : 57 | VAR 1°W (10)

HLDG MOPAR — PROTECTION IAS : 230 kt FL 070/110 — 274° — 094° — MOPAR FL 070 — 316° 16.8 — PON FL 070

EN L'ABSENCE D'INSTRUCTION DU CONTRÔLE
WITHOUT ATC INSTRUCTION
En route convergente sous un angle inférieur à 070°, intercepter l'axe FNA (sauf instruction préalable de traverser l'axe)
On a course converging at an angle of less than 070°, intercept FNA axis (unless previously instructed to cross the axis)

Approches simultanées avec RWY 27L ou 27R PARIS CDG et RWY 27 PARIS LE BOURGET (1)
Simultaneous APCH with RWY 27L or 27R PARIS CDG and RWY 27 PARIS LE BOURGET (1)

Prévenir l'ATC si seulement capacité LNAV
Advise ATC if only LNAV capable.

PG442 / PG443 / PON / MOPAR — Positions non à l'échelle / *Positions not to scale*

PON FL 070 — 316° 8.0 — PG443 FL 070 4000 — 316° 21.4 — MATF PG442 4000 — 15.1 — LFPB — 266° — MAPT RW26L — SDF — 266° (265.6°T) 11.1 — FAF PG441 4000 — 266° 3.0 — IF PG440 4000

TWR 689 (373) — TWR 617 (301) — TWR 614 (298) — 523 (207) — 470 (154) — Pylône/Pylon 384 (68) — Pylône/Pylon 417 (101) — Pylône/Pylon 481 (145)

Prévoyez un guidage radar pour rejoindre l'axe de piste
Expect radar vectoring to runway extended centerline
Voir / *See* AD 2 LFPG AMSR

P 23

002°10' — 002°20' — 002°30' — 002°40' — 002°50'

TA : 5000

APP : Monter **dans l'axe** vers **4000** (3684) puis prévoir guidage radar.
En cas de panne radio, monter **dans l'axe** vers **4000** (3684).
A **PG442**, tourner à droite vers **PG443**. A **PG443** monter au **FL 070** et suivre **PON**.
A **PON** procéder **MOPAR**.
Monter à 1200 (884) avant d'accélérer en palier.

*Missed APCH: Climb **straight ahead** up to **4000** (3684) then plan radar guidance.*
*In case of radio failure, climb **straight ahead** up to **4000** (3684).*
*At **PG442**, turn right towards **PG443**. At **PG443** climb up to **FL 070** and follow **PON**.*
*At **PON** proceed **MOPAR**.*
Climb up to 1200 (884) prior to level acceleration.

MAPT RW26L — SDF — FAF PG441 — 266° — 4000 (3684) — 1990 (1674) — 266° (265.6°T) 3.0° - 5.2% — MDA — DA — 1000 (684) — 1500 (1184)

THR ◄— (NM) — 0 — 4.8 — 11.0

MNM AD : distances verticales en pieds, RVR et VIS en mètres / *vertical distances in feet, RVR and VIS in metres.* — REF HGT : *ALT THR*

CAT	LPV DA (H)	LPV RVR	OCH LPV	LNAV-VNAV DA (H)	LNAV-VNAV RVR	OCH LNAV VNAV	LNAV MDA (H)	LNAV RVR	OCH LNAV	MVL / Circling (2) 26L→26R MDA (H)	MVL / Circling (2) 26L→26R VIS
A			141	650 (330)	800	325	740 (420)	1200	418	920 (600)	3000
B			152	650 (340)	800	332	750 (440)	1300	432	920 (600)	3000
C	520 (200)	550	178	660 (340)	800	339	770 (460)	1400	451	1020 (700)	3500
D			188	670 (350)	900	346	790 (470)	1500	467	1070 (750)	4000
DL			194	-			-				

DIST RW26L					
NM	11	10	9	8	7
ALT (HGT)	3876 (3560)	3558 (3242)	3240 (2924)	2921 (2605)	2603 (2287)
6	5	4	3	2	1
2284 (1968)	1966 (1650)	1647 (1331)	1531 (1194)	1213 (876)	894 (557)

Observations / *Remarks* : (1) Mouvements simultanés : voir consignes ADC 06 / *Simultaneous movements : see instructions ADC 06.*
(2) MVL : voir consignes ADC 07 / *Circling : see instructions ADC 07.*
Panne de guidage GNSS durant l'approche / *Loss of GNSS guidance during approach* : voir / *see* ENR 1.5.

		70 kt	85 kt	100 kt	115 kt	130 kt	160 kt	185 kt
FAF - THR	11.0 NM	9 min 27	7 min 47	6 min 37	5 min 45	5 min 05	4 min 08	3 min 35
VSP (ft/min)		370	450	530	610	690	850	980

Ministère de l'Environnement, de l'Énergie et de la Mer

Why SBAS Cat I is a significant evolution (a revolution?)

SBAS CAT I INCREASES VERY SIGNIFICANTLY AIRPORT ACCESSIBILITY - ABSENCE OF ILS

- **At virtually no cost !!**
  - **Free Cat I signal** falling from the sky

- People who continue **claiming that GPS +Baro and SBAS are equivalent solutions**, are **misleading the community**
  - See the **performance difference** at Paris CDG

- Statistically, every year, **one of the main European airport (PCP) will have to support close to 2 months of ILS outage** due to ILS life cycle/replacement period needed
  - Why is this significant SBAS Cat I advantage not taken on board for **shaping the future of European network** ?
  - **Why is IATA unable (up to now) to prepare the future** to get progressively these benefits - **at no cost?**

SBAS INCREASES VERY SIGNIFICANTLY APPROACH SAFETY - ABSENCE OF ILS

- Many weak signals shows us that **the other PBN technology supporting vertical guidance (GPS+ Baro) has the potential to create serious incident/accident :**
  - **Internal airline reports:** pilot do mi-set QNH (typically 10 mb = 280 ft vertical error)
  - **Human factor analysis:** altimetry error is suspected to be a 20% contributor to large jet CFIT occurrences
  - **Flight Safety Foundation statistics:** *"Barometric altimeter setting/reading. The incorrect setting or reading of the barometric altimeter has been associated with some CFIT accidents. The necessary data were available in only 16% of the accident reports or summaries. In five accidents (3.2% of the total sample), the barometric altimeter was set incorrectly. In only one accident (0,6%), was the barometric altimeter read incorrectly"*
  - **Official incident reports:** many FSF reports, BEA Incident Report, Lyon St Exupéry Nov. 2009, ATR42, (19 mb mis-setting = 530 ft error), safety nets saved the aircraft
  - **Biarritz ATC QNH system mis-setting by Meteo France:** in 2013, 7 mb = 200 ft vertical error broadcasted by ATC during half a day
- **If any SBAS or GBAS created such errors, they would be stopped instantaneously.**
  - But when Baro is concerned, it seems that nobody really cares
- GPS+Baro is probably acceptable within a transition situation (meaning up to now), **but not as a viable ILS backup strategy for the long term**
  - In particular when **free Category I signals flow from the sky**
  - **We are now in the XXIst century guys !**

THANK YOU !