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INVESTIGATION REPORT

Incident to the AIRBUS - A318 - 100 registered F-GUGM and operated by Air France

on 12 September 2020
at Paris-Orly (Val-de-Marne)

Time	Around 15:50[1]
Operator	Air France
Type of flight	Passenger commercial air transport
Persons on board	Captain (PF), co-pilot[2] (PM), 3 cabin crew members, 81 passengers
Consequences and damage	None
This is a courtesy translation by the BEA of the Final Report on the Safety Investigation published in December 2021. As accurate as the translation may be, the original text in French is the work of reference.	

Non-stabilized approach, activation of MSAW and Glideslope warnings

1 - HISTORY OF THE FLIGHT

Note: the following information is principally based on Flight Data Recorder (FDR) data, statements, radio-communication recordings and radar data. The data from the Cockpit Voice Recorder (CVR) was not preserved.

The Airbus A318 carrying out the Air France flight between Biarritz-Bayonne-Anglet airport (Pyrénées-Atlantiques) and Paris-Orly airport (Val-de-Marne), was in descent to FL 110, en route to waypoint ODILO in order to carry out an ILS approach for runway 25. The crew had not identified any particular threat[3] during the briefing. They were in contact with the approach INI controller of Paris-Orly airport.

At around FL 112 (point ❶ of Figure 1), the controller asked the crew if they were interested in having a shortened route. The co-pilot (PM) replied in the affirmative. The controller then asked the crew to take a direct heading to the CLM VOR and to descend to 3,000 ft QNH. At point ❶ of Figure 1, autopilot AP1 was engaged in DES/NAV mode. The indicated airspeed of 250 kt was selected.

At around FL 110, the vertical guidance mode OPEN DES was engaged and then from FL 100, the crew used the speed brakes.

At around 8,700 ft (point ❷ of Figure 1), the controller told the crew to plan for a short circuit if they were interested, and to call back when ready for the base leg in around one minute's time. Approximately 30 seconds later (point ❸ of Figure 1), the PM reported that they were ready to turn and the controller gave him an initial interception heading northwards. Then, at the PM's request (point ❹ of Figure 1), the controller gave a second heading of 290°. The aeroplane's lateral guidance was then in HDG. The crew were cleared for the ILS approach for runway 25. The altitude of the aeroplane was 5,900 ft and the indicated airspeed 247 kt. The APProach (APP) mode and AP2 were then engaged. The Auto-THRust (A/THR) was in SPEED mode.

[1] Except where otherwise indicated, the times in this report are in Coordinated Universal Time (UTC). Two hours should be added to obtain the legal time applicable in Metropolitan France on the day of the event.

[2] In Air France, a co-pilot is designated by the term First Officer (FO).

[3] Particularly that related to their small amount of recent experience, detailed in paragraph 2.4.

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[4] The LOC* mode engaged when the aeroplane was in the process of capturing the Localizer beam.

At 4,900 ft, the lateral guidance mode LOC*[4] engaged, the aeroplane was around two dots above the nominal descent slope (Glideslope). The aeroplane's vertical descent speed was around 2,200 ft/min. The speed brakes were retracted.

At 3,500 ft (9.1 NM from the threshold of runway 25), the aeroplane was around 600 ft above the Glideslope at a speed of 249 kt, the controller asked the crew to contact the tower frequency (LOC position) of Paris-Orly airport with a "free speed" (point ❺ of Figure 1). At the same time, although the crew wanted to continue the descent towards the Glideslope, the vertical guidance mode ALT* engaged as the selected altitude was 3,000 ft. The engine N1 ratings increased by 27% to 40%. The aeroplane's vertical speed decreased to -1,500 ft/min. The aeroplane was around one dot above the Glideslope. The speedbrakes were extended to half-deflection. The crew disengaged the two AP and selected a vertical speed of -3,000 ft/min and then an altitude of 3,600 ft. The vertical guidance mode V/S engaged, which then quickly changed to G/S*. The crew next selected an altitude of 2,000 ft which corresponded to the altitude of the missed approach procedure. The engine N1 ratings varied between 30% and 40%. The vertical speed of the aeroplane stabilized at around -1,600 ft/min.

At 2,700 ft (7.4 NM from the threshold of runway 25), the lateral guidance mode LOC engaged. The aeroplane was in clean configuration and the indicated airspeed was 250 kt. The crew selected "managed" speed. The target speed then decreased to the "green dot" speed and the engine N1 ratings decreased to 23%. Both AP were re-engaged. The speedbrakes were at this point retracted and then armed. Shortly before entering GS mode, the aeroplane's vertical speed was around -2,200 ft/min and the indicated airspeed 250 kt.

[5] At 2,000 ft AAL at the latest, the SOP indicate that config 2 must be selected.

[6] Maximum speed for extending and retracting landing gear (VLO): 250 kt.

[7] Maximum speed for manoeuvring and using high-lift devices (VFE) config 1: 230 kt.

At 2,287 ft, i.e. 2,000 ft Above Aerodrome Level (AAL), 6 NM from the threshold of runway 25, the aeroplane was established on the Localizer and the Glideslope, and the A/THR was in SPEED mode. The aeroplane was in clean configuration[5], the indicated airspeed was 253 kt and the vertical speed -1,500 ft/ min. Both AP were disengaged. A nose-up input was recorded on the captain's (PF) sidestick. The calibrated airspeed decreased to 237 kt and the Glideslope deviation increased up to +0.8 dots. The landing gear was extended[6]. The aeroplane was 5.5 NM from the threshold of runway 25 (point ❻ of Figure 1). Configuration 1 was then selected[7] (point ❼ of Figure 1). The PF, who had the runway in sight, made a nose-down input and the vertical speed increased to -2,750 ft/min. The Glideslope deviation recorded decreased to -1.6 dots.

[8] The final approach speed when the landing gear has been extended and the slats/flaps are in the landing configuration.

At 1,287 ft, i.e. 1,000 ft AAL, at 3.7 NM from the threshold of runway 25, the aeroplane was in configuration 1, established on the Localizer, 1.48 dots below the Glideslope. The vertical speed was -1,328 ft/ min.

The indicated airspeed was 204 kt, i.e. a VAPP[8] of +78 kt and the engine N1 ratings were close to idle at 28%.

At an altitude of 1,250 ft, i.e. around 960 ft AAL, at 3.6 NM from the threshold of runway 25, an increase in the VAPP (from 123 kt to 126 kt) was recorded due to the PM changing the landing configuration from "flaps full" to "flaps 3" in the PERF APPROACH page of the Flight Management System (FMS). At the same time, the Glideslope alert of the Ground Position Warning System (GPWS) was activated on board and a Minimum Safe Altitude Warning (MSAW)(9) was activated in the control tower. The LOC controller told the crew that there was a terrain alert and that they were to immediately check their altitude (point ❽ of Figure 1). The PM replied that they were maintaining the altitude. The PF then made a nose-up input on the sidestick, the aeroplane's pitch attitude changed from -2.7° to +7° and the aeroplane returned to the Glideslope.

At 1,225 ft, around 940 ft AAL, at 3.2 NM from the threshold of runway 25, the PM selected CONF 2. At this point, he was in communication with the LOC controller who asked him to confirm that they were on the Glideslope. (Point ❾ of Figure 1). He replied in the affirmative. Nine seconds later, at 1,185 ft, around 900 ft AAL, he selected configuration 3(10). The indicated airspeed was 172 kt i.e. VAPP+46 kt (point ❿ of Figure 1).

At 787 ft, i.e. 500 ft AAL, the stabilization altitude, the aeroplane was established on the Localizer and Glideslope in the landing configuration (configuration 3). The indicated airspeed was VAPP+26, (152 kt), the vertical speed was 624 ft/min and the engine N1 ratings were close to idle at 27%(11)(12).

The indicated airspeed reached VAPP 180 m after flying over the runway threshold at a height of 10 ft. The thrust levers were put in the IDLE detent at 6 ft. The aeroplane landed on the runway, at 380 m from the threshold at an indicated airspeed of 123 kt (point ⓫ of Figure 1).

(9) This system provides the controller with a warning in the event of a potentially dangerous distance between an aircraft and the terrain. This warning is independent of the GPWS Glideslope alert.

(10) VFE config 3: 185 kt.

(11) The manufacturer's Flight Crew Operating Manual (FCOM) defines stabilized thrust as being above idle.

(12) These conditions exceeded the operator's non-stabilized approach detection thresholds.

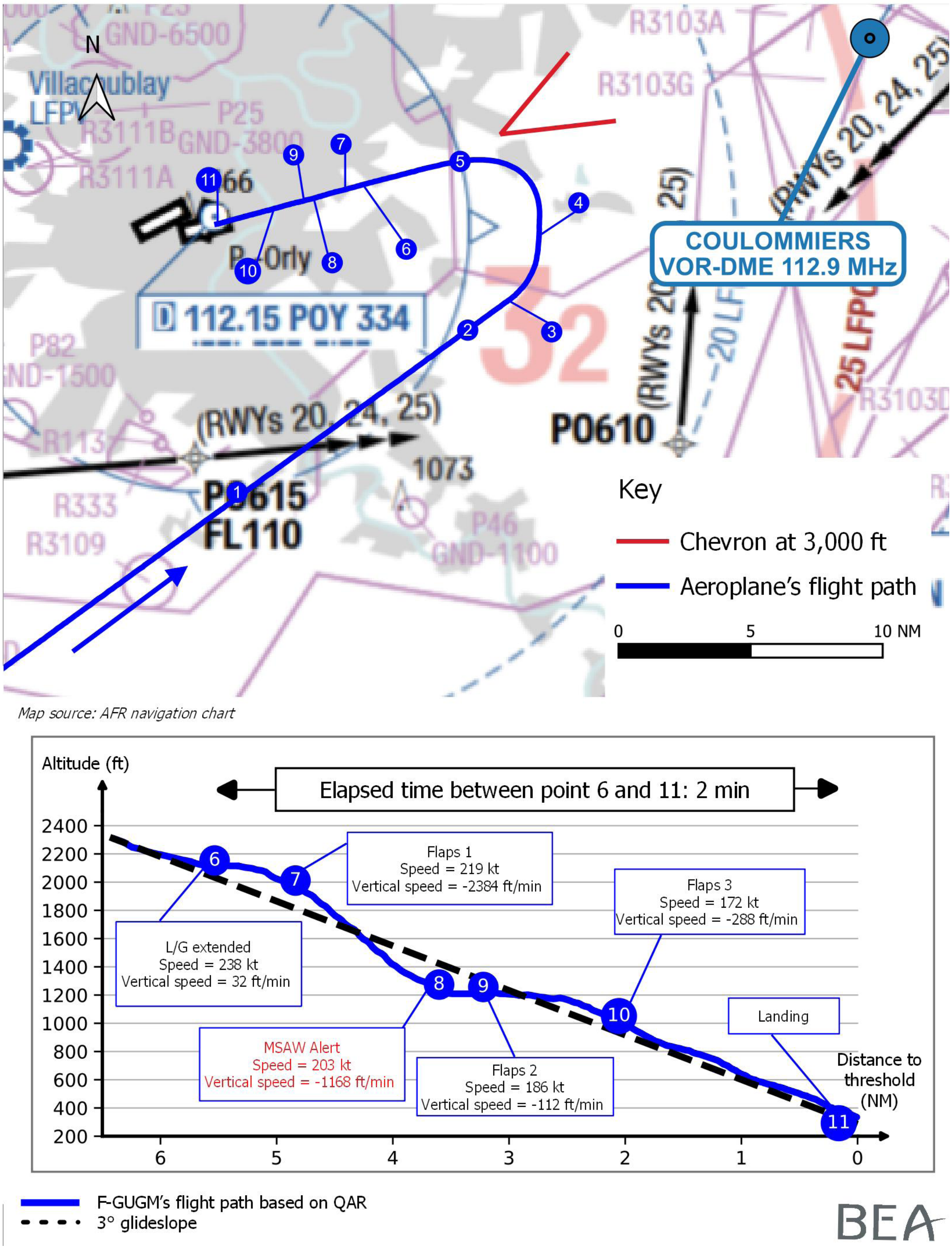

Figure 1: F-GUGM's flight path

2 - ADDITIONAL INFORMATION

The following paragraphs give detailed information about:

- The airport, the control service and the crew (paragraphs 2.1, 2.2, 2.3, 2.4).
- The carrying out of approaches at the operator's, the detection of non-stabilized approaches and the link with the crew recurrent training (paragraphs 2.5, 2.6, 2.7, 2.8, 2.9).
- Recent publications and measures taken (paragraph2.10).

2.1 Airport information

Paris-Orly airport is one of the operator's operational bases. Runway 25 measures 3,320 m long and 45 m wide. The Air France A320 crews regularly carry out ILS approaches for runway 25.

When traffic permits, for environmental reasons, the last level flight is at 4,000 ft. However, an altitude of 3,000 ft is commonly used. An altitude of 2,000 ft can be used by way of exception.

The airport is equipped with the MSAW system since 1 March 2001.

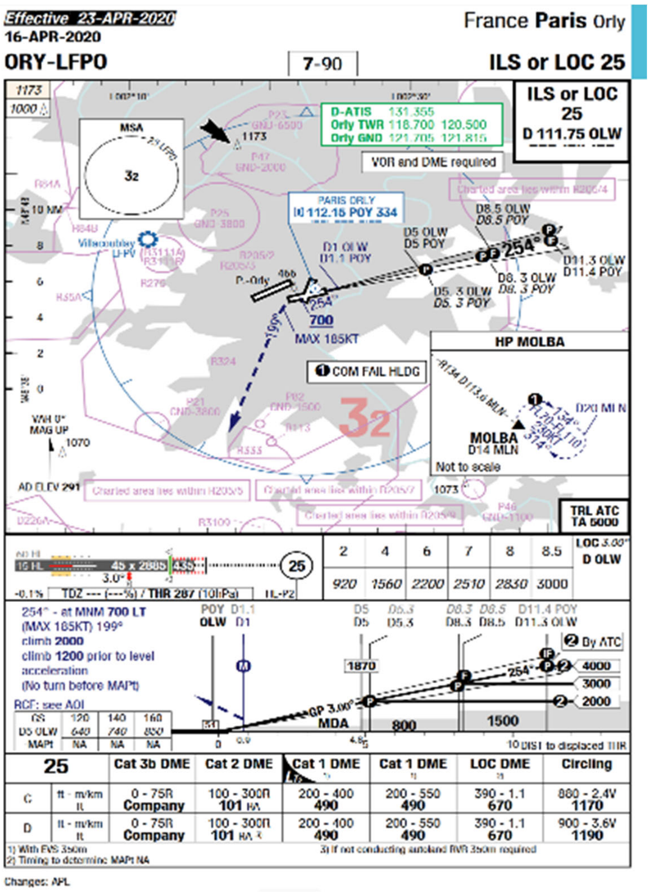

Figure 2: LIDO chart used by Air France crews

2.2 Meteorological information

The general situation was calm and sunny, temporarily overcast with a light northwesterly wind.

The 15:03 ATIS indicated an ILS 25 approach, landing on runway 25, take-off from runway 24, transition level 60, wind 300° 6 kt. CAVOK. Temperature 23°C/dew point 11°C. QNH 1022/QFE 1011.

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2.3 Approach radar vectors

2.3.1 Controllers' statements

Initial approach controller (INI position)

The INI controller indicated that at the time of the occurrence, there was little traffic on the frequency and that he had proposed to the crew that they shorten the standard flight path. In his opinion, the crew's request to turn onto the base leg was a little premature, he gave a northerly heading and then a heading of 290° to intercept the Localizer. The altitude of the aeroplane had not seemed particularly high to him. He believed that if the aircraft had been too high, he would have asked the crew to descend to 2,000 ft. In these low traffic conditions, he indicated that he did not specifically pay attention to the aeroplane's speed. He considered that the pilot manages his flight parameters and is responsible for this.

Tower controller (LOC position)

The tower controller indicated that he usually receives aeroplanes flying at a speed of between 180 and 200 kt. The pilots are familiar with the ILS 25 approach. He had not observed any early warning signs prior to the occurrence, there had been very few exchanges on the frequency.

At 4 NM from the runway threshold, he had seen the MSAW on his screen but could not remember having perceived the aural warning. He indicated that the pilot had immediately reacted to his order and stopped descending. If this had not been the case, he would have asked him to fly a missed approach. The controller added that the MSAW was a surprise as they are rare.

2.3.2 Approach radar vectors

(13) Paragraph 10.7.4.1.

The French air traffic regulation (RCA3(13)) indicates that aircraft vectored for a final approach receive a heading or a series of headings to permit them to join the final approach path. The last heading puts the aircraft on a final approach path before intercepting the specified or nominal Glideslope of the approach procedure from below.

(14) The chevrons are not displayed on the pilots' onboard instruments.

In order to facilitate compliance with the RCA directive, chevrons are displayed on the controller's radar screen(14). They indicate a position on the final approach path which guarantees, at the speed of 200 kt, level flight of 30 seconds before intercepting the Glideslope.

The radar tracks below provided by the air navigation services at Paris-Orly airport, show that in the period of low traffic linked to the health crisis (see Figure 3, right image, for 10, 11 and 12 October), the average vector brought the aeroplanes onto the ILS (Localizer) path of runway 25 closer to the interception point of the nominal Glideslope than in normal times (see Figure 3, left image, for 5 and 8 January 2020).

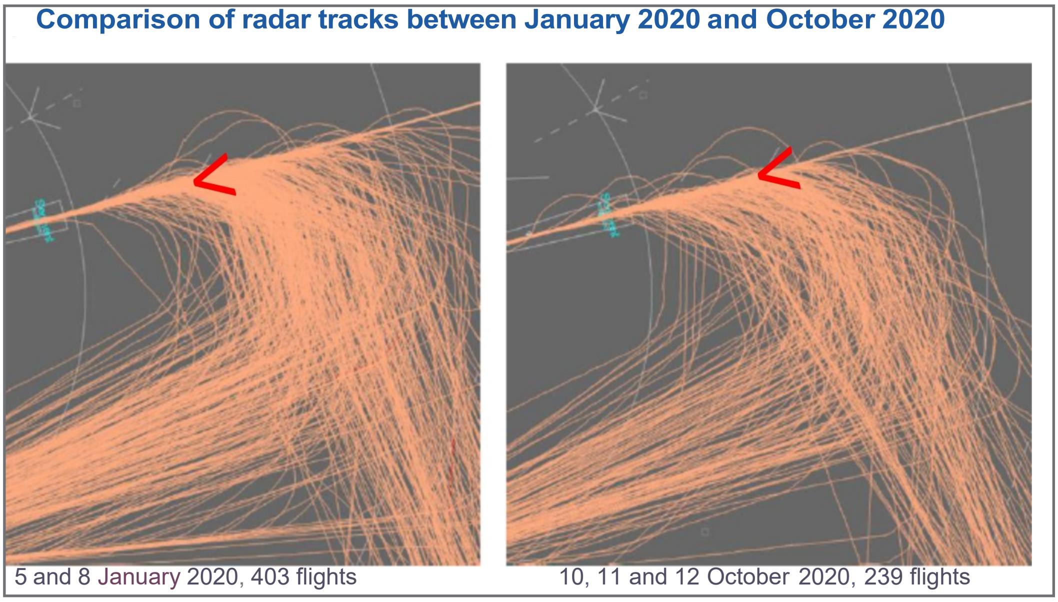


Figure 3: Comparison of radar tracks for Orly runway 25 in January 2020 (before health crisis) and in October 2020

Orly airport statistics indicate that for runway 25, the average Localizer interception speed was 166 kt in January 2020 (before health crisis period) and 194 kt in September 2020 (during health crisis period).

Lastly, 12 MSAW on final were recorded from January 2019 to February 2020 and 8 between March 2020 and December 2020, i.e. five times more warnings of this type (in relation to the number of flights) during the health crisis period.

2.4 F-GUGM crew statements

2.4.1 Captain (PF)

The captain was recruited by Air France as co-pilot in 1997. He had been captain on the A320 since 2008 and had logged around 10,200 flight hours, of which 4,200 hours on the A320.

Between the beginning of March and the end of August 2020, the captain had carried out 64 flights hours and four legs per month (two take-offs and two-landings as PF), i.e. a 75% drop in his activity with respect to the same period in the previous year. He had carried out two simulator sessions in the scope of his recurrent training at the end of July 2020. He had not been scheduled any flights between 14 August and 9 September 2020. The occurrence flight was on the fourth flight day of his roster.

He could not remember the arrival briefing nor having identified specific threats. He indicated that he had wanted to get some training and stretch his limits a bit. He thought that the decision to land in configuration 3 was taken sometime during the descent. On arriving on final, he had had to make a high nose-down input to intercept the Glideslope and indicated that everything accelerated. He could not remember the PM’s call-outs during this flight phase.

At a height of around 1,000 ft, he perceived the "*GLIDESLOPE*" alert and heard the controller's message concerning the MSAW which had occurred at the same time. He indicated that these warnings took them out of a form of "incapacity". The PF then saw that he was not following the FD. According to him, there had been a "break" in his instrument scanning as he had been looking outside. He then envisaged a go-around without following this through. He considered that at 1,000 ft, there was no danger as there was still a margin and they had the runway in sight.

At 500 ft, he was aware that the approach was not stabilized as the engine ratings were still close to idle. He did not doubt that the landing could be carried out safely but he needed the co-pilot to validate his decision to continue.

After the occurrence, the crew took a minute to debrief. This allowed them to put the occurrence behind them and continue the following legs. He indicated that the crew increased their margins for the following flights.

The PF added that he considered this flight as a non-event.

2.4.2 Co-pilot (PM)

The co-pilot was recruited by Air France as co-pilot in 2019. He had logged approximately 5,500 flight hours of which 3,200 hours on the A320.

Between the beginning of March and the end of August 2020, he had carried out 70 flight hours, i.e. a 77% drop in activity with respect to the same period in the previous year. He had not been scheduled any flights between 11 August and 8 September 2020. The occurrence was on the second day of his roster.

He indicated that the briefing had been very succinct and that the choice of flap configuration for landing had not been discussed. The PF wanted to perform a fast approach. The co-pilot explained that he had a high workload during the approach. He had to monitor the flight path and the trends as well as extend the flaps and landing gear and manage the radio communications. He remembered that the landing gear had been extended in a non-standard manner[(15)].

(15) The landing gear can be extended before the aeroplane is in config 1 if there is an operational necessity.

He indicated that he would not have chosen to disconnect the AP once established on the Glideslope but it was the only way of reducing the speed. He also indicated that he would not have chosen flaps 3 for the final configuration. However, he considered that it was for the PF to decide, a captain's decision. When the PF asked him for his opinion on this decision, he replied positively. He did not call out any flight path deviations as each time he was going to do so, the PF was already making the corrections. During the final, he described the PF as experiencing almost "tunnel vision". As a consequence, he considered that interrupting him with a call-out would have been more dangerous than letting him continue.

Before the activation of the GPWS *"GLIDESLOPE"* alert, the PM indicated that he had not seen the vertical speed. The GPWS alert was something of a wake-up call and he then saw that the PF was not following the FD. He was certain that the stabilization criteria were going to be reached, and if this was not the case, the aeroplane would be quickly stabilized after 500 ft. However, he kept the option of a missed approach in mind.

Lastly, according to him, the role of the co-pilot is to act as a safety net. He makes suggestions and gives indications. When everything is not carried out exactly to procedure but it does not affect safety, he does not intervene. He thought that on this flight he had carried out his job of co-pilot.

2.5 Non-stabilized approaches

Percentage of non-stabilized approaches detected during LOSA observations[16]

In the scope of the Data Report for Evidence Based Training, LOSA Collaborative provided part of its archives, from 42 LOSA projects (8,375 observation flights) with operators around the world, carried out between 2003 and 2010.

The "LOSA" programme is a formalized process set up by certain operators on a voluntary basis, with the purpose of collecting the observations made by experts present in the cockpit during scheduled flights. The series of in-flight observations records the threats, errors made by the crews and how they are dealt with in a real operational environment.

The programme is carried out at the operator's for a given period. It is not linked to the flight data monitoring system.

The LOSA observations provide consolidated information about the rate of non-stabilized approaches detected in operation. The LOSA observer knows the operator's Standard Operating Procedures (SOP). He takes into account the actual stabilization height retained by the crew as well as the meteorological conditions at the time of the approach.

The LOSA archives indicate that out of the 8,375 flights observed, around 4% of the approaches were not stabilized. These non-stabilized approaches can be characterized as follows:

- 87% were continued and ended with an uneventful landing;
- 10% led to a landing which was long, short or offset with respect to the centreline;
- 3% resulted in a go-around.

The Data Report for Evidence Based Training indicates that whatever the crew's decision, the non-stabilized approaches resulted in a significant increase in the number of high severity events, with, particularly, a significant increase in the landing risk level (+140%) or go-around risk level (+85%).

Furthermore, the Unstable Approaches Risk Mitigation Policies, Procedures and Best Practices report published by IATA and CANSO[17] (2016) indicates that between 2012 and 2016, the main contributing factors to non-stabilized approaches are manual handling problems (77% of cases), and the deviation from the SOP (58% of cases).

2.6 Standard Operating Procedures (SOP)

2.6.1 Role of PF on approach

Part A of the operator's Operations Manual indicates that in a normal situation:

- The PF's main task is to fly the aircraft and to control and monitor the flight path and the navigation in compliance with procedures;
- The PF's secondary task consists of monitoring the actions which do not directly concern the flight path (ATC communication, carrying out of C/L[18], checking of aeroplane systems, other operational activities).

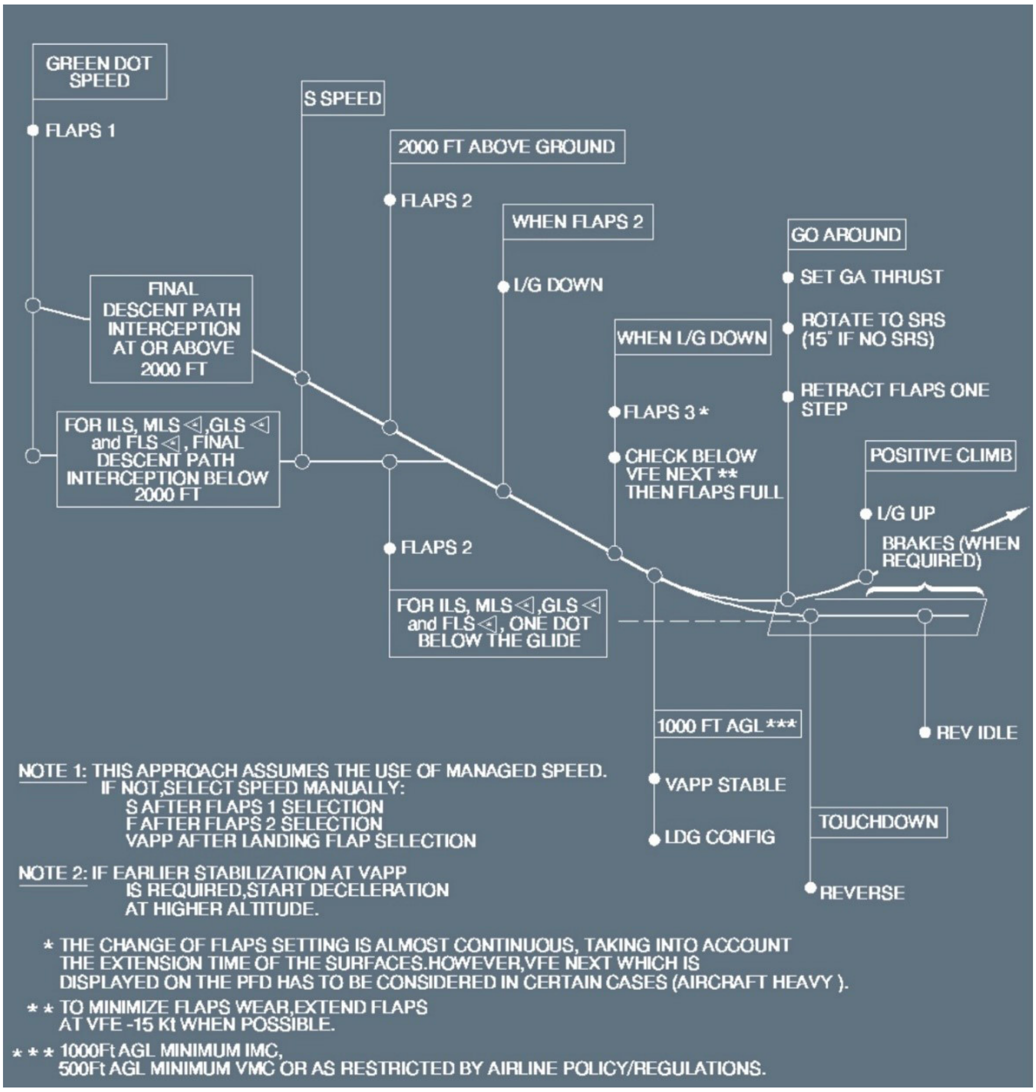
Part B of the Operations Manual, otherwise known as the Flight Crew Operations Manual (FCOM) contains the operational procedures on approach[19]. The profile specifies extending the flaps to configuration 1, 3 Nm before intercepting the Glideslope, selecting configuration 2 at 2,000 ft AAL at the latest and then extending the last items in sequence to reach stabilization at 1,000 ft.

(16) Line Observations Safety Audits- www.losacollaborative.com

(17) https://canso.org/publication/unstable-approaches-risk-mitigation-policies-procedures-and-best-practice-third-edition

(18) Check-lists.

(19) Normal procedures – approach - intermediate / final approach.



Source: Air France FCOM -SOP Configuration management

Figure 4: Deceleration profile on final approach

2.6.2 Role of PM on approach

In part A of its Operations Manual, the operator defines the role of the PM:

- The PM's main task is to monitor the flight path and the navigation; in the event of a deviation, the PM must immediately draw the PF's attention to this and intervene if necessary.
- The PM's secondary task consists of carrying out the actions which do not directly concern the flight path (ATC communication, carrying out of C/L, checking of aeroplane systems, other operational activities).

The manual specifies that as mental resources are limited, the workload must be managed in a fitting way to ensure continuous effective monitoring.

[20] On the A320, the vertical speed usually recorded at VAPP with the aeroplane in final configuration on a slope of 5% is approximately - 700 ft/min. In the case of the occurrence, at the speed of 126 kt, it should have been approximately - 630 ft/min.

According to the FCOM (*SOP - standard call outs - flight parameters in approach)*, the deviation standard call outs must be made by the PM, acknowledged by the PF and rapidly corrected by the PF if:

- the speed drops below VAPP-5 kt or exceeds VAPP +10 kt;
- the pitch attitude is less than - 2.5° or more than + 10°;
- the bank exceeds 7°;
- the vertical speed exceeds -1,000 ft/min[20].

2.7 Operator's stabilization criteria

The stabilization criteria are described in part A of the Operations Manual:

The aeroplane is stabilized on final approach when the following conditions have been met:

- landing gear/flaps in landing configuration;
- aeroplane on published flight path (lateral flight path and slope) at the approach speed;
- consistent thrust;
- pre-landing C/L carried out.

The stabilization height is: 1,000 ft AAL in IMC and 500 ft AAL in VMC.

These values are hard stops and not objectives:

- In case of non-stabilization at the stabilization height, a go-around must be carried out;
- Below the stabilization height, only slight corrections are authorized to correct small deviations with respect to the stabilization conditions.

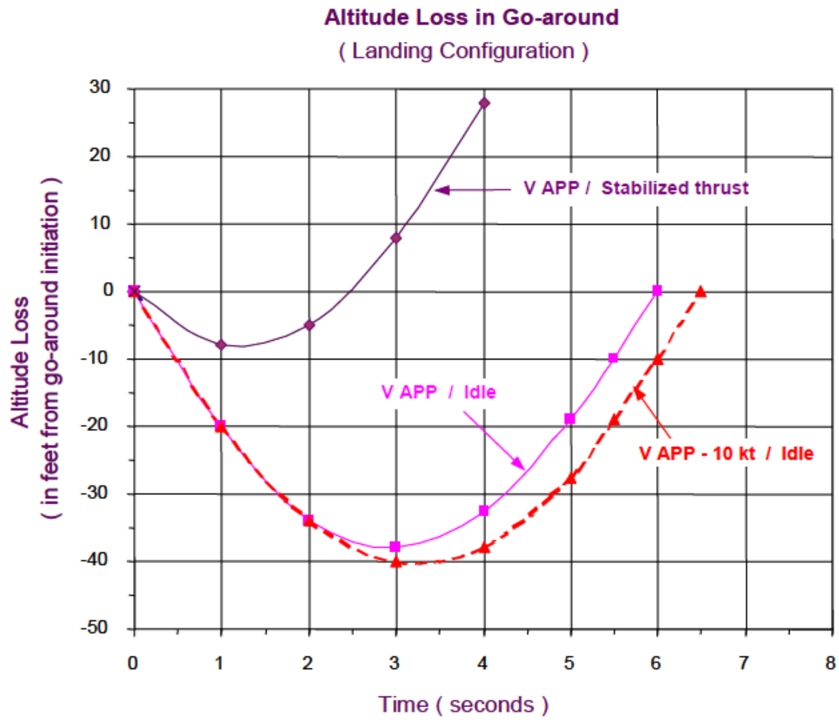
Below the stabilization height, a go-around must be carried out:

- As soon as a pilot calls out "Go around";
- In case of an EGPWS (TAWS) warning[21] (except in the case of specific aeroplane/approach configurations mentioned during the briefing);
- In case of successive deviation call-outs by one of the pilots or if the stabilization conditions are not obtained quickly enough.

[21] Operations Manual Part A.

The operator states in its FCOM that the thrust must generally be stabilized above idle with an indicated airspeed at VAPP.

The manufacturer explained in the 2005 Flight Operations Briefing Notes entitled Aircraft Energy Management During Approach, that the aim of having stabilized thrust above idle is to ensure a minimum loss of altitude in case of a go-around.



Source: Airbus

Figure 5: Effect of initial speed and thrust on altitude loss during go-around

2.8 Flight Data Monitoring (FDM)

2.8.1 Principles

The regulatory requirement ORO.AOC.130 of Consolidated Regulation (EU) No 965/2012 (also known as AIR OPS[22]) requires the operator to establish and maintain a Flight Data Monitoring (FDM) programme, which shall be integrated in its Safety Management System (SMS), when it has aeroplanes with a maximum certificated take-off mass of more than 27 tonnes.

In the annexe to the AIR OPS regulation, AMC1.ORO.AOC.130(c) indicates that FDM analysis techniques should include:

> *"(1) Exceedance detection: searching for deviations from aircraft flight manual limits and standard operating procedures. A set of core events should be selected to cover the main areas of interest to the operator. [...] The event detection limits should be continuously reviewed to reflect the operator's current operating procedures.*
> *(2) All flights measurement: a system defining what is normal practice. This may be accomplished by retaining various snapshots of information from each flight."*

> *"(A)(1)(i) FDM programmes are used for detecting exceedances, such as deviations from flight manual limits, standard operating procedures (SOPs), or good airmanship."*

[22] Commission Regulation (EU) No 965/2012 of 5 October 2012 laying down technical requirements and administrative procedures related to air operations (Version in force on the day of the incident).

2.8.2 European Operators Flight Data Monitoring (EOFDM)

The European Aviation Safety Agency (EASA) created the EOFDM group to facilitate the implementation of FDM programmes by all the European operators, and to help them draw the maximum safety benefits from such a programme. This group is a voluntary partnership between operators, manufacturers, pilot associations, FDM system designers, university research centres and national authorities.

The EOFDM group's work includes the development of advanced algorithms for monitoring approach path management, and determining the best practice for the integration of FDM into an operator's SMS.

EASA indicated that the subject of non-stabilized approaches generated a lot of discussions due to the complexity of the subject (criteria vary according to the weather conditions and type of approach) and that it is currently carrying out work to review the stabilization criteria.

EASA also indicated that there are currently several obstacles to a form of standardization of FDM at European level:

- The multitude of aeroplanes and thus variability in the method of recording the flight parameters;
- The diversity of operations;
- The lack of operator resources, notably for the smaller companies.

2.8.3 DSAC good practice guide (2015)

The French civil aviation safety directorate (DSAC) set up a working group bringing together operators, manufacturers and flight-analysis subcontractors in order to note all of the group's good practices, and to draw up a document about good practices for selecting and processing flight data monitoring parameters[23]. The DSAC chose not to adopt a systematic approach. With respect to non-stabilized approaches, the aim was to identify the cases where the stabilization criteria had not been met below a height for a given terrain (stabilization height). The criteria provided are for information purposes and are not prescriptive. The document is a promotion tool and is not enforceable in the scope of the oversight activity.

[23] https://meteor.dsac.aviation-civile.gouv.fr/meteor-externe/#communication/1200

2.8.4 Operator's FDM

According to AMC.ORO.AOC.130 (see paragraph 2.8.1), FDM is meant to allow the operator to ensure, in an operational context, that the crews comply with the procedures in the Operations Manual.

During the approach phase, the flight profile described in the SOP has key gates at which the configuration and speed must be established in order to guarantee compliance with the stabilization criteria.

The investigation was able to determine at the date of the occurrence:

- That the operator's FDM did not acquire the parameters at the key approach gates, before stabilization.
- That due to a variable stabilization height, according to the unrecordable weather conditions, the operator had chosen to only measure the deviations at 500 ft.
- That at 500 ft, only the approaches with a deviation of more than 16 kt above the VAPP were identified as non-stabilized approaches.
- That the "thrust" criteria was not taken into account above 400 ft.

In the scope of the investigation, Air France provided the BEA with its non-stabilized approach statistics (table below). We can see that this percentage is significantly lower than that indicated by LOSA Collaborative.

	Air France Flight analysis (all types)	Air France Flight analysis COVID period - A320	LOSA archive percentages
Non-stabilized approaches	0.27%	0.53%	3 to 4%
Non-stabilized approaches continued	77%	77%	97%

2.8.5 Occurrence flight

The deviations of the occurrence flight can be compared with the maximum deviations specified in the SOP in the table below. The occurrence flight was identified as being class 2 (medium risk).

QFE height (ft)	MSAW (1530)	1000	500 stabilisation	200	*SOP*
QNH altitude (ft)	1817	1285	787	489	-
IAS (kt)	220	205 VAPP +78 kt	152 VAPP +26 kt	135 VAPP+9kt	*VAPP =126* *-5< VAPP< +10*
Vertical speed (FPM)	-2752	-1328	-624	-656	*<-1000*
Average N1 (%)	24	28	27	35	*>25 (idle)*
Deviation from G/S (dot)	0.18	-1.48	0.14	0.11	*-0.5 < d < +0.5*
Position of flaps	1	1	3	3	*3*

2.9 Evolution of operator's training system: transition to Evidence Based Training (EBT)

In June 2021, the operator's training system adopted EBT[24]. In part D of its Operations Manual, EBT is described as a new approach to crew training in that:

- More time is spent on the management of the risks and threats identified by the company.
- Training is adapted to the pace and individual needs of pilots.

It is indicated that this will permit the pilot's performance to be improved by dealing with the weaknesses identified, by means of an optimized training programme. Based on the Air France Safety Management System, EBT replaces the conventional checking system with an assessment of the pilot's proficiency followed by a study of situations based on occurrences which arose in commercial operations on similar generation aeroplanes. These occurrences are reported by personnel, collected by Flight Safety or picked up by the external watch and working groups in which Air France participates.

[24] Operations Manual D 5.1.12.1.1.1 21/6/2021

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One of the basic principles of EBT is that of efficient data collection based on a global and individual safety analysis and information from training, flight data monitoring, incidents and accidents, as well as LOSA type audits if conducted by the operator.

2.10 Actions and publications at the time of the occurrence

2.10.1 DGAC report Assessment and Analysis of Civil Aviation Risks in the 2020 Low Activity Period[25]

The aim of this report was to assess the impact of the health crisis on flight safety, to ensure that the risks are acknowledged by the operators and to make recommendations to reduce the risks.

The conclusions of the report include the following points:

- "In *the face of the erosion of the skills of frontline actors that has sometimes been observed, adherence to procedures has proved to be a particularly effective defence. Operators are therefore invited to recall the necessity and usefulness of adherence to operational procedures."*
- *"Operators should encourage, in the context of a low volume of activity, crews to give priority, through TEM (Threat and Error Management, [...] to the application of procedures with a sufficient margin and not in competition with performance and compliance with schedules."*
- *"Stabilisation criteria could be revised to enhance the safety of approaches, for example by uniformly raising the stabilisation heights to 1000 ft, both IFR and VFR."*

The conclusions of this report have the status of recommendations and do not constitute a regulatory requirement. The objective is that they are incorporated in the operators' SMS.

EASA also published comparable information regarding the impact of the health crisis on flight safety[26].

[25] https://www.ecologie.gouv.fr/mesures-prises-france-dans-domaine-securite-aerienne-faire-face-aux-consequences-lepidemie-covid-19

[26] https://www.easa.europa.eu/newsroom-and-events/news/easa-publishes-practical-scenario-crew-skill-decay-support-return-normal

2.10.2 Air France

Besides the general philosophy of adhering to the doctrine of the SOP adopted during all training actions, the operator had already issued a specific document in June 2020, about flight safety being the overriding objective in a world of COVID restrictions ("*Le monde COVID, objectif absolu de Sécurité des vols*"). The key points were the drop in performance of pilots and of all other actors, and non-standard operations which require increased margins.

In November 2020, following a series of non-stabilized approaches, the operator published a certain number of documents:

- FOCUS SV ANS "*Les approches non stabilisées et haute énergie en période de faible activité*" dealing with non-stabilized and high-energy approaches in a period of low activity;
- FOCUS SV: "*ANS ? = remise de gaz !!* " inciting go-arounds when the approach is not stabilized.
- FOCUS: "*Le plancher de stabilisation*" about stabilization heights;
- SAFETY FIRST (Air France memorandum): "*Approche à faible poussée prolongée = attention risques augmentés*" discussing the increase in risks when flying long approaches with low thrust.
- FLYSAFE No 61 and No 62.

2.10.3 Paris-Orly airport air navigation service

In November 2020, following a study carried out in the previous months, the Paris-Orly airport air navigation service held a meeting about non-compliant approaches and non-stabilized approaches. The incident involving F-GUGM was discussed.

Certain proposals were adopted following this meeting:

- Produce feedback regarding non-compliant approaches and non-stabilized approaches, notably for the incident to F-GUGM.
- Start discussions regarding non-compliant approaches and non-stabilized approaches with operators at the beginning of 2021 (Analysis and feedback meeting).
- Create a basemap on the radar image to allow the controller to better estimate the remaining distance of an aeroplane on approach, to the Final Approach Point (FAP) or threshold.
- Study a high-approach detection tool.
- Perpetuate the chevron method in the Operations Manual (30 s of regulatory level flight).

3 - CONCLUSIONS

The conclusions are solely based on the information which came to the knowledge of the BEA during the investigation. They are not intended to apportion blame or liability.

Scenario

In descent to Paris-Orly airport, the crew took the opportunity of following a shortened route proposed by the approach controller. The captain (PF) decided to carry out a fast approach, outside the profile specified in the SOP. The radar vectors brought the aeroplane to two dots above the Glideslope, after the gate recommended by the Orly unit (*chevron*) on the final path. The PF's strategy was first of all, to maintain 250 kt and to increase the vertical speed to join the approach slope, and then once on the slope, to reduce the speed in order to be able to configure the aeroplane for landing. This led to a temporary deviation from the approach slope.

At 6 NM from the threshold of runway 25, at 2,287 ft (2,000 ft AAL), stabilization was compromised. The crew, who already had a high workload, did not then have the necessary resources to identify that the approach could not be stabilized at 500 ft. At 5.5 NM from the threshold of runway 25, the PF asked for the flaps to be extended to configuration 1. Shortly after, the co-pilot (PM) modified the final configuration for landing, both on the FMS and the overhead panel which probably contributed to his monitoring of the flight parameters becoming less effective. At the same time, having the runway in sight, the PF's eyes left the instruments. He made a nose-down input which resulted in a high vertical speed which led to the activation of the GPWS warning on board and the MSAW in the tower.

Subsequent to this, continuing the approach was not called into question. The PM had a very high workload, between monitoring the flight path, carrying out the radio communications and continuing the configuration of the aeroplane. At 500 ft AAL, the crew considered that the aeroplane was in the process of stabilizing. They chose to continue as they were convinced that both the stabilization would be quickly acquired after 500 ft and that the landing could be carried out safely.

Without being aware of it, the crew, at this point, probably had very few mental resources available to deal with an unexpected event.

A posteriori, after landing, the absence of consequences in continuing the approach probably reinforced the crew's belief that their decision had been the right one.

Contributing factors

The following factors may have contributed to the non-stabilization of the approach:

- The decision to carry out a fast approach on a shortened path, outside the scope of the SOP and without carrying out a specific briefing which generated time pressure for no operational reason.
- The absence of call-outs by the PM regarding the flight path and speed deviations.
- An exceptional context in which the crew's flight activity in the six months preceding the event had been low.
- The final radar vectors bringing the aeroplane above the approach slope which left the crew little room for manoeuvre to reach stabilization at 500 ft AAL.

The following factor may have contributed to the approach being continued below 500 ft AAL:

- The crew's lack of knowledge about the risks associated with continuing non-stabilized approaches.

Safety lessons

Adherence to SOP on approach and flight safety margin

During the approach phase, a crew's workload substantially increases due to the large number of resources required to manage the aeroplane's energy to the stabilization height. In this flight phase, the SOP profile gives the crew references to calibrate the deceleration and reach stabilization from 1,000 ft. This framework allows the crew to manage the energy in a nominal way and to stay mentally available to closely monitor the flight path and deal with unexpected events up to landing.

Complying with the SOP before 1,000 ft is all the more important in that a non-stable approach, whatever the crews decision at the stabilization height, to go-around or to land, will significantly increase the risk level.

Moreover, in a period of low activity, the crew's ease and dexterity may be diminished. Compliance with the SOP, which guarantee the safety margins, plays, even more than in normal times, a fundamental role in flight safety.

FDM and crew training

One of the aims of FDM is to allow the operator to establish if its crews comply with the procedures in its Operations Manual.

The detection of non-stabilized approaches and the crews' management of them (percentage of go-arounds) constitutes one of the key parameters. However, it is difficult to make this occurrence measurement reliable due to the co-existence of two possible stabilization altitudes (500 ft or 1,000 ft) based on factors which are not measured by FDM[27]. Moreover, the current measurement cannot be used to determine the operational reasons for it, especially those relating to the management of the energy during the intermediate and final phases of the approach.

[27] Meteorological conditions and crew's stabilization objective.

It seems that the FDM's systematic measurement of the aeroplane's energy at key gates of the approach defined by the SOP, before the altitude of 1,000 ft, could contribute to identifying certain causes for the destabilization phenomenon observed in operation.

This information is all the more important in that one of its purposes is to feeds the operator's EBT in order to rectify the problems identified in operation.

4 - SAFETY RECOMMENDATIONS

Note: in accordance with the provisions of Article 17.3 of Regulation No 996/2010 of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation, a safety recommendation in no case creates a presumption of fault or liability in an accident, serious incident or incident. The recipients of safety recommendations report to the issuing authority in charge of safety investigations, on the measures taken or being studied for their implementation, as provided for in Article 18 of the aforementioned regulation.

Flight Data Monitoring

Around two thirds of the accidents in passenger commercial air transport occur during the approach and landing phases. In 40% of the cases, the approach was not stabilized or vertical, lateral and speed deviations were detected[28].

[28] Source: IAT Unstable Approaches, Risk mitigation Policies, Procedures and Best Practices 3rd edition – chap. 2.3.

The efforts to improve the safety level during these flight phases must be continued, notably through relevant and robust training programmes based on knowledge about flights in actual operation.

The investigation showed that the Air France Flight Data Monitoring (FDM) system underestimated the percentage of non-stabilized approaches as it did not allow the operator to adequately assess the crews' level of adherence to the approach procedures, notably at the various key gates of the profile specified in the Standard Operating Procedures (SOP).

Consequently, the BEA recommends that:

- **Whereas one of the principles of FDM is to quantify the operational risks by bringing to light not only the critical occurrences but also the deviations from the SOP;**
- **Whereas the reliable detection of deviations in operation is essential for designing a suitable training programme;**
- **Whereas the Air France FDM does not adequately detect non-stabilized approaches nor does it adequately detect the crews' deviations from the SOP on approach before the stabilization height;**

Air France ensure that the automatic detection criteria of non-stabilized approaches, notably before the stabilization height, are close to the reference system described in the Standard Operating Procedures (SOP).
[Recommendation - FRAN-2021-019].

The French civil aviation safety directorate (DSAC) ensure that the Air France flight data monitoring system is more relevant in its detection of the crews' deviation from the Standard Operating Procedures (SOP) on approach.
[Recommendation - FRAN-2021-020].

APPENDIX

Occurrence graphs