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SAFETY INVESTIGATION REPORT

Serious incident to the Cessna 525A Citation CJ2 registered F-HMSG operated by Valljet on 28 October 2023 at Paris - Le Bourget airport

Time	Around 00:15[1]
Type of flight	Passenger commercial air transport
Persons on board	Captain (PF[2]), co-pilot (PM), one passenger[3]
Consequences and damage	Aeroplane slightly damaged
This is a courtesy translation by the BEA of the Final Report on the Safety Investigation. As accurate as the translation may be, the original text in French is the work of reference.	

Nose landing gear malfunction on take-off, in-flight fault management, landing with nose gear retracted

1 HISTORY OF THE FLIGHT

Note: the following information is principally based on statements, radio-communication recordings and radar data.

The crew took off at 21:23 from Paris - Le Bourget airport bound for Farnborough airport (United Kingdom) under IFR rules. This was the aeroplane's first flight after undergoing maintenance operations over the previous days, which included work on the landing gears (see para. 2.5).

Shortly after take-off, the PF asked for the landing gears to be retracted. The PM operated the control and a few seconds later, an abnormal noise took the crew by surprise. The red Gear Unlock light was on, and the three green Downlock lights were off. The crew controlled the extension of the gears, the two green lights for the main landing gear illuminated, the green light for the nose landing gear did not illuminate and the red Gear Unlock light remained on. After the crew controlled the retraction of the gears again, the red light was still on and the three green lights were off. The crew then realised that the nose landing gear had a malfunction.

At approximately 21:25, the aeroplane exited the Le Bourget airspaces. The crew contacted the departure (DEP) controller of Paris - Charles de Gaulle (CDG) approach, who asked them to climb to FL 070. The crew replied one minute later, asking to hold at 3,000 ft to solve a gear problem. The crew carried out the "*Landing gear will not retract*" and "*Landing gear will not extend*"

[1] Except where otherwise indicated, the times in this report are in local time.
[2] The glossary of abbreviations and acronyms frequently used by the BEA can be found on its web site.
[3] The passenger was a mechanic from a maintenance workshop based at Paris - Le Bourget airport.

procedures, and used the standby landing gear extension system. The nose landing gear would still not lock. At 21:30, the controller asked the crew to contact another controller on an allocated frequency (SUP IFR) to isolate them from other radio communications.

At 21:32, on the SUP IFR frequency, the crew informed the controller that they were going to return to Le Bourget airport, that they wanted to wait in order to burn fuel and thus lighten the aeroplane, and that they did not know whether the nose gear was extended. The controller asked the crew to contact the North Sector controller[4]. The North Sector controller asked the crew at what level they wanted to dump the fuel. The crew replied that they could not dump the fuel, but that they wanted to burn it at 3,000 ft, in the low layers. The controller asked the crew to climb to FL 070 to remain in the CDG area, and thus avoid the Beauvais areas and the Class G airspaces. The aeroplane started manoeuvring in the Noyon sector.

Between 21:43 and 21:46, the crew indicated to the North Sector controller that they were not in good weather conditions and that they wanted to exit the layer. At this time, the aeroplane was at FL 075[5]. This was followed by discussions between the controller and the crew to identify the best area for holding. The controller indicated that he wanted to hold the aeroplane in his airspaces, so that he would be aware of the surrounding traffic. Finally, the crew descended to FL 070 and followed the radar vectors provided for holding.

At 21:55, the crew informed air traffic control that they were ready to return to Le Bourget airport. The crew planned an ILS 27 VPT 25 approach and a landing on runway 25. They asked for assistance on arrival, as they did not know whether the nose gear was extended and locked. The aeroplane was vectored towards the beginning of the approach and then transferred to the tower controller (TWR position) at Le Bourget.

At 22:14, the controller informed the crew that the fire services were positioned near runway 25. The aeroplane was then established on ILS 27 at 3,000 ft. A few minutes later, the crew decided to make a low pass over runway 25 at Le Bourget to have the status of the landing gear checked. The controller suggested making this pass on runway 27 as it would offer him better visibility at night, which the crew accepted. At 22:22, as the aeroplane was flying over the runway, the fire services and the controller[6] confirmed that the nose gear was not extended.

At 22:25, on being transferred to the CDG (DEP) approach again, the crew repeated their request to remain in the low layers to burn fuel in order to land as light as possible. A few minutes later, the aeroplane was again vectored towards the Noyon sector at FL 070. The crew shared with the new controller in the DEP position the idea of landing at CDG, where runways were longer and wider than those at Le Bourget. The crew were transferred again to the North Sector frequency.

At 22:31, the controller asked the crew if they needed assistance and indicated that he was considering mobilising a Rafale to escort the aeroplane to the final and check the status of the landing gear. The crew indicated that this was not necessary, as they had been given confirmation

[4] Military controller of the EACA (control organisation capable of meeting national defence requirements in Paris airspace).

[5] It is possible that the aeroplane was still using the QNH at this point; the QNH was 997.

[6] The controller used a pair of binoculars.

that the nose gear was not extended during the low pass at Le Bourget. The crew also stated that they were going to maintain the landing at Le Bourget, where the runways were sufficiently long and wide.

At 22:37, the same controller suggested diverting a helicopter equipped with night vision goggles, which was engaged in a surveillance mission at the Stade de France, to check during the final if the gear was extended. Once again, the crew indicated that this was not necessary, as they had received confirmation that the nose gear had not extended during the low pass. The crew informed the controller that they were going to burn fuel for approximately one hour and asked for information about the weather conditions. The controller indicated that no deterioration was forecast for the next hour, but that rain was expected later in the night.

At 22:43, the controller transmitted the suggestion of the fire services at Le Bourget to lay out a foam blanket on the runway[7] so as to prevent any fire, which the crew initially declined, as they did not know whether it would have any impact on landing performance. The crew asked the controller about this option. Control asked the crew to discuss this directly with the fire services over an allocated frequency that he communicated to them.

At 23:17, the crew announced that they were ready to return, and indicated to the controller that they had not managed to contact the fire services in the end[8]. The crew were transferred to the intermediate approach frequency dedicated mainly to aeroplanes bound for Le Bourget airport (ITM BA). The crew specified to the approach controller that they did not want a foam blanket. The controller vectored them towards Le Bourget airport for an ILS 27 VPT 25 procedure. He informed the crew that departures from CDG would be stopped to give them more room when manoeuvring to join runway 25 (see para. 2.2.1). The crew specified that they would turn a little earlier to ensure stabilisation on final.

At 23:26, the crew informed the controller that they wanted to burn a little more fuel, for about 30 min. At this time, they were flying in the Crépy-en-Valois sector at 3,000 ft. Fifteen minutes later, the crew informed the controller that they were going to perform a pull-up manoeuvre to try to unblock the landing gear. The controller specified that Class G airspace was 500 ft below them. The crew carried out the manoeuvre and deduced that this did not correct the problem, since the lights were unchanged.

At 23:55, the crew informed the controller that they wanted to start the approach. They specified that in the event of a missed approach, they would need a “fairly short circuit”, since they would not have much fuel left. The crew finally asked for the foam blanket. The controller transmitted the reply from the fire services, which specified that it would be a 40 m long blanket to avoid sparks when the nose of the aeroplane came into contact with the runway. The controller went on to say that the fire services were not sure whether they would have time to lay out this foam blanket. The controller then suggested extending the aeroplane’s path, to which the crew replied that they would hold to the south of the centreline of ILS 27 at Le Bourget. Discussions continued as to where the foam blanket should be laid on the runway. The crew replied that they wanted it

[7] The fire services had raised this with the control at Le Bourget after the low pass.

[8] It seems that the frequency range allocated to the fire services was not sufficient. A test was attempted on another emergency frequency at Le Bourget, then a test with the captain’s mobile phone was also attempted, but to no avail.

to be at the runway mid-point. The controller transmitted the fire services' request to know whether they wanted to ignore the displaced threshold for landing. The crew replied in the positive. The crew indicated that they wanted to start the approach, due to the amount of remaining fuel. Finally, the controller warned the crew that there would be no foam blanket, as there was too much uncertainty about how long the foam would hold. He confirmed that all the fire service resources were mobilised for the arrival of the aeroplane. The crew were transferred to the TWR controller at Le Bourget, who had been informed that the crew were going to ignore the displaced threshold for landing. The controller specified to the crew that in the event of a missed approach, he would stay with them on the frequency for a short circuit.

At approximately 00:15, the crew, located 2 NM from the runway threshold, on final on the standard approach slope, increased the rate of descent to land on runway 25 before the displaced threshold. The crew landed, the main landing gear touched the runway first, then the nose of the aeroplane, without further incident. The fire services then sprayed the aeroplane with foam to prevent any risk of fire.

2 ADDITIONAL INFORMATION

2.1 Statements

2.1.1 Crew's experience and statement

The 45-year-old captain held a Commercial Pilot Licence - Aeroplanes (CPL(A)) issued in 2003. He had logged approximately 5,800 flight hours, around 3,000 hours of which on type. He also held a Flight Instructor - Aeroplane (FI(A)) rating and had logged approximately 2,500 flight hours as an instructor.

The 25-year-old co-pilot held a Commercial Pilot Licence - Aeroplanes (CPL(A)) issued in 2019. He had logged approximately 1,600 flight hours, around 150 hours of which on type. He also held a Flight Instructor - Aeroplane (FI(A)) rating and had logged approximately 1,200 flight hours as an instructor.

The two crew members explained that they had both walked around the aeroplane to carry out the pre-flight visual inspection, at night, on apron MIKE, which is moderately illuminated, according to the co-pilot. They did not notice anything in particular. The aeroplane had just undergone maintenance operations. They added that there were no known landing gear problems on this aeroplane.

They said that during the flight, they quickly realised that there was a malfunction on the nose landing gear. After remembering similar events on other Citations operated by the operator, they tried to extend then retract the gear. They then complied with the procedures associated with this technical problem. In accordance with the operator's procedures, the captain managed the failure. The actions made did not correct the problem. They also performed a pull-up manoeuvre, to no avail. They added that there was good synergy between them for this phase and that air traffic control provided adequate assistance. They activated the autopilot while holding to burn the fuel.

As part of the TEM[9] approach associated with this failure, they had identified several risks for landing:

- fire risk, as landing on the nose of the aeroplane can generate sparks;
- loss of steering during the landing run, as a problem with one of the main landing gears could not be ruled out.

The captain explained that during the flight, he sent a message to the operator's Fleet Technical Manager, who was not able to provide supplementary assistance in resolving the failure.

The two crew members initially had a fuel load of 3,600 lb[10]. They indicated that they had determined a consumption of 600 lb/h[11]. Following the failure, the objective was to burn as much fuel as possible, in order to be light and reduce the reference speeds (target speed of around 100 kt), and to retain enough fuel to carry out a new approach if necessary, i.e. around 600 lb[12]. The minimum amount of fuel to start the approach was reassessed several times. In particular, when they informed the controller they wanted to start the approach to Le Bourget airport the penultimate time, they had around 1,400 lb of fuel, which they felt was still too much given the fire risk.

They explained that they initially refused the fire services' suggestion to lay out a foam blanket for landing: neither the fire services, nor the controllers, nor themselves were informed of the impact of this solution on the aeroplane's performance (running with the main landing gear only). When they finally agreed, the landing was too close to allow the solution to be used.

Finally, they asked to land on runway 25, which is longer. The captain reported that he was not used to landing on this runway; his last landing on this runway had been four or five years before. On landing, the captain held the aeroplane's nose up for as long as possible and shut down the engines. The aeroplane remained on the centreline.

According to the crew, the weather conditions were good[13], despite a little rain.

2.1.2 Other statements

The two agents from the handling company who had towed the aeroplane between the maintenance workshop hangar and the LIMA 1 area, and then between the LIMA 1 area and the MIKE area, noticed nothing unusual about the aeroplane's nose landing gear. To tow the aeroplane, the tow bar is connected to the nose landing gear.

[9] Threat and Error Management.

[10] The pound is a unit of weight: 1 lb weighs around 0.45 kg

[11] According to the documentation, with the landing gears extended, the aeroplane was using around 1,000 lb/h while holding and 1,700 lb/h in cruise.

[12] The aeroplane's usual final reserve is 372 lb.

[13] The METAR reports for Paris - Le Bourget airport mentioned a ceiling at a height of around 1,500 ft, a temperature of 12°C and a wind of 190°/8 kt.

2.2 Airport and air traffic service information

2.2.1 Paris - Le Bourget airport

Paris - Le Bourget airport has three runways:

- runway 09-27, measuring 1,847 m x 45 m;
- runway 07-25, measuring 2,991 m x 45 m;
- runway 03-21, measuring 2,395 m x 45 m.

The Landing Distances Available (LDA) for the runways involved in the serious incident are:

- 1,805 m on runway 27;
- 2,100 m on runway 25.

In the west-facing configuration (in force at the time of the serious incident at CDG and Le Bourget airports), the final approach path to runway 25 intersects with the take-off paths of the south set of parallel runways at CDG, which is very close to Le Bourget airport. Runway 27, equipped with an ILS, is the most frequently used. Runway 25 is not equipped with an ILS. In order not to interfere with departures from the south set of parallel runways, the VPT 25 approach path initially follows the ILS approach path to runway 27, up to approximately 2 NM from the threshold, where it turns right onto a heading of 285° for 1.2 NM to intercept the centreline of runway 25 visually. This runway has a displaced threshold of 891 m, which takes the start of the VPT 25 final away from the CDG paths. There is no procedure for ignoring the displaced threshold to land on runway 25. Moreover, in these conditions, obstacle clearance may no longer be guaranteed. The airport operator, Aéroports de Paris specified, in particular, that cranes were present close to the airport, on or close to the axis of runway 25. These cranes, equipped with obstacle lights, penetrated into the Obstacle Limitation Surfaces (OLS). No impact had been identified for VPT 25 approaches but no analysis had been carried out for a direct approach.

The airport which has an Aircraft Rescue and Fire Fighting (ARFF) service, had an airport protection level 8 at the time of the serious incident.

The aeroplane came to a stop on runway 25, level with taxiway R1.

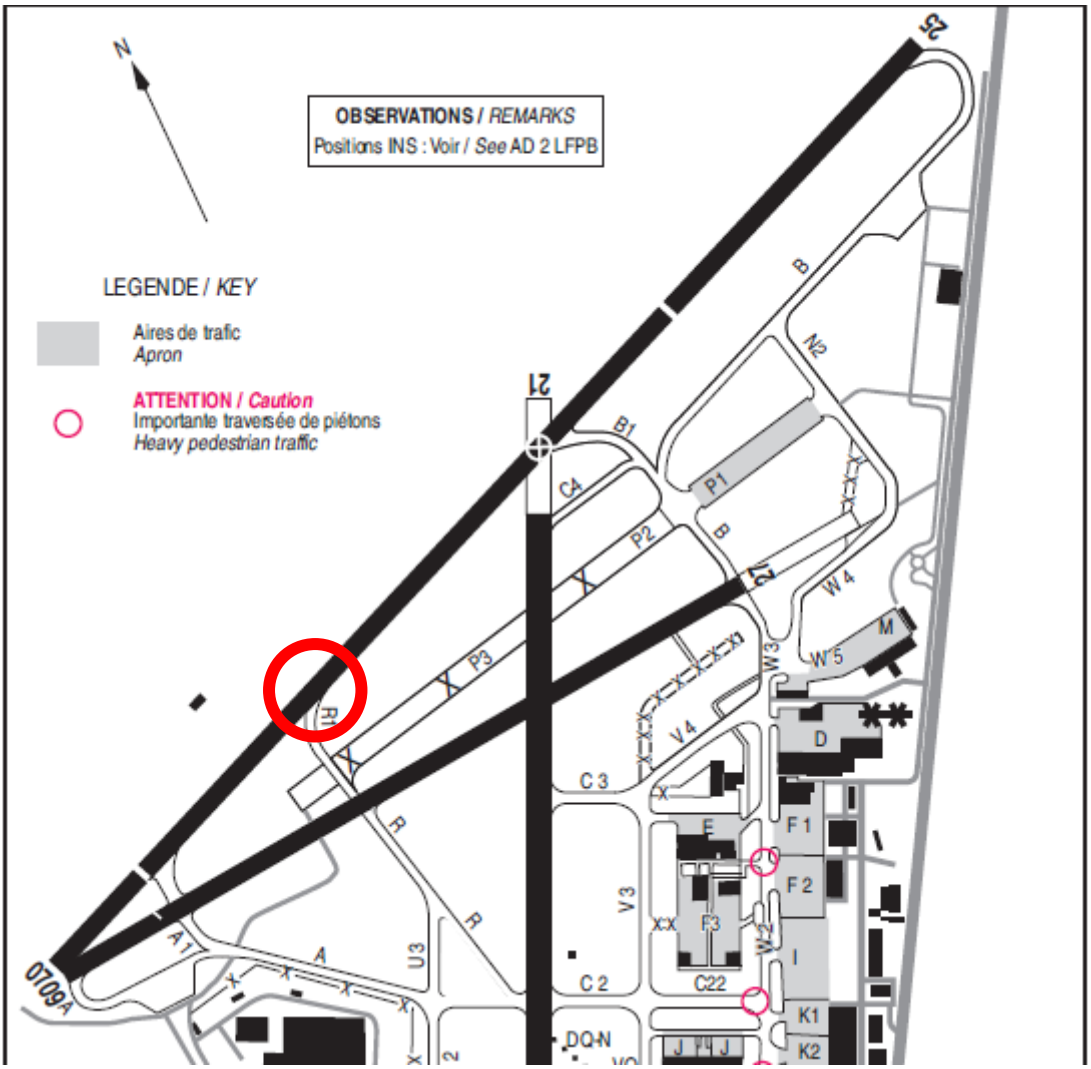

Figure 1: Runways 07-25 and 09-27 (Source: AIS)

The documentation from the Air Navigation Services at Le Bourget airport (SNA-RP/LBG) does not include a procedure for dealing with a malfunctioning landing gear. This is not a subject covered in recurrent training.

2.2.2 Paris - CDG airport

The LDA for the runways at CDG used in westerly operations are:

- 2,700 m on runway 27R (60 m wide);
- 3,600 m on runway 27L (45 m wide);
- 3,616 m on runway 26R (45 m wide);
- 2,700 m on runway 26L (60 m wide).

The documentation of the Air Navigation Services at CDG airport (SNA-RP/CDG) includes a quick-reference card for "Belly landing". This card indicates the preferred runway at CDG, the people to contact/inform and how to manage traffic in the event of a belly landing. In addition, the card entitled "*PAN PAN ou MAYDAY*" (PAN PAN or MAYDAY) specifies isolating the aeroplane in difficulty on a frequency. The card entitled "*Assistance à VFR*" (Assistance to VFR) provides for the activation of an operational duty mission (Rafale from the French Air and Space Force), if necessary.

The operations manual for CDG airport specifies that a Defence aircraft mission to assist an aeroplane in an emergency (e.g.: PAN PAN PAN) or distress (e.g.: MAYDAY, MAYDAY, MAYDAY)[14] situation is conducted in whole or in part by the EACA. A landing gear check is mentioned in the list of examples of emergency or distress situations. The assistance operation is only activated at the pilot's request.

The operations manual also specifies that in the event of an aeroplane in difficulty, the latter can be vectored towards the holding sectors defined at the IAFs. The first usable levels are generally close to FL 070 to remain in controlled airspace. Using the altitude of 3,000 ft can be difficult due to the fact that CDG and Le Bourget airports (where air traffic can be heavy) are close to each other. At the request of the North Sector military controller, it is possible to activate, in the north part of CDG, a military area managed by an EACA military controller, and to transfer the aircraft in difficulty to this area. This area extends from FL 065 (floor of Class A TMA) to FL 195.

2.3 Aeroplane information

F-HMSG is a Cessna 525A Citation Jet CJ2 built by Textron Aviation and certified for single-pilot operations. Valljet[15] operates it with a minimum crew of two pilots for commercial air transport operations, in accordance with the applicable regulatory requirements.

The aeroplane's engines are attached to the rear section of the fuselage.

In the section relating to the external (pre-flight) inspection of the normal procedure, the aeroplane flight manual stipulates that the doors, wheels and tyres of the nose, right main and left main landing gears must be inspected.

The aeroplane flight manual and the operator's QRH[16] include a procedure entitled "Landing gear will not retract (gear unlock light remains ON)". In particular, this procedure specifies resetting the Gear Control Circuit Breaker with the landing gear control in the UP (gear retracted) position. If the landing gear does not retract, the control must be set to the DOWN (gear extended) position and pilots must land as soon as possible, checking that the landing gears are effectively extended.

The aeroplane flight manual and the QRH also include a procedure entitled "Landing gear will not extend". In particular, this procedure specifies resetting the Gear Control Circuit Breaker at speeds below 200 kt, with the landing gear control in the DOWN (gear extended) position. If the landing gear does not extend, pilots must pull the Gear Control Circuit Breaker and use the standby landing gear extension control. The procedure does not specify any additional actions in the event of the landing gear not extending with the standby control.

Neither the flight manual nor the QRH include a procedure on landing with a malfunctioning landing gear, for example a "Landing with abnormal landing gear" procedure, which may exist on other types of aeroplane.

[14] Neither phraseology was used during the serious incident flight.
[15] European business aviation company based at Paris - Le Bourget airport, offering on-demand flights.
[16] Quick Reference Handbook.

The operator's documentation imposes the addition of a safety margin of 15% to the landing distance, based on the tables provided by the manufacturer, to obtain the Landing Distance at Time of Arrival (LDTA). The operator calculated the following LDTAs, for the following conditions, at the time of the serious incident: weight of approximately 8,500 lb, temperature of 12°C, headwind of 4 kt, at sea level (reference altitude at Paris - Le Bourget airport = 220 ft), in landing configuration and at reference speed (VREF):

- around 3,660 ft i.e. 1,110 m, on a dry runway;
- around 5,130 ft i.e. 1,560 m, on a wet runway[17].

2.4 Nose landing gear malfunction

2.4.1 Examination of the aeroplane

The BEA was not present when the aeroplane was recovered and transferred to the hangar. These operations took place on the night of the serious incident. A technician who was present during the operations indicated to the BEA that aluminium adhesive strips were taped on the doors of the nose landing gear and that he removed them after taking photographs of them.

Figure 2: adhesive strips on nose gear doors (Source: R&O)

The aeroplane was examined by the BEA in the hangar of the R&O maintenance workshop (see para. 2.5). It was observed that the door actuation mechanism for the nose landing gear was disconnected:

- The right rear hinge was disconnected from the right door (green circles on Figure 3) and the corresponding six screws were in a bag attached to the left door actuating rod.
- The left door actuating rod was disconnected from the left rear hinge (red circles on Figure 3) and the corresponding screw-nut assembly was present in the bag containing the screws.

[17] The controller had informed the crew that the runway was slightly wet.

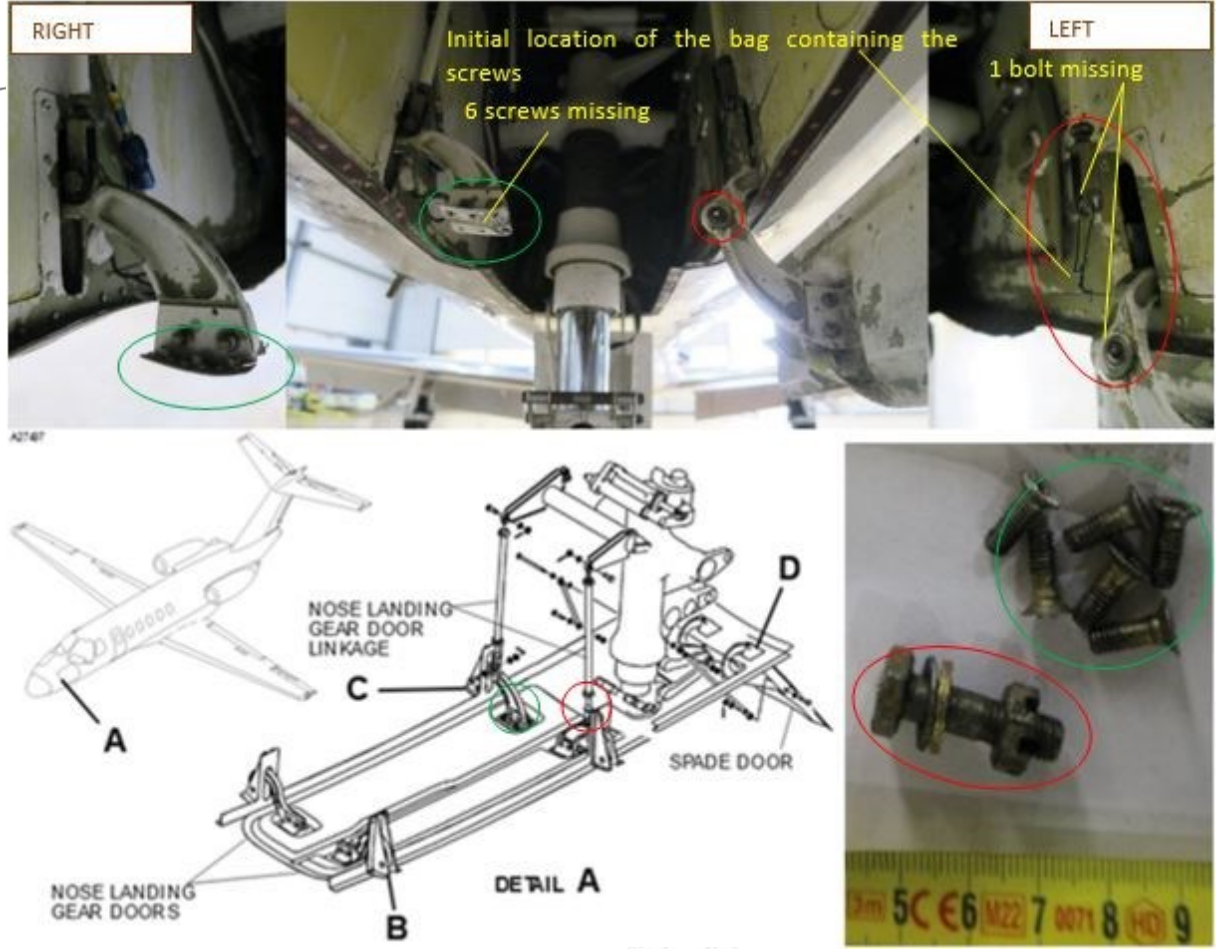

Figure 3: door actuation mechanism for the nose landing gear on F-HMSG
(Source: AMM Textron Aviation; photographs and annotations BEA)

2.4.2 Scenario regarding the blocking of the nose landing gear

During normal use of the landing gear, the nose gear doors are closed when the landing gear is in the extended or retracted position. The doors of the nose landing gear are only open when the latter is moving.

The rear hinges of the doors are operated by two rods mechanically linked to the gear retraction and extension mechanism. These two rods move vertically when actuated at the start and end of the nose gear extension and retraction movement.

At the time of the serious incident, these rods were no longer connected to the nose gear doors because the screws had not been refitted, preventing the nominal movement of the doors.

In flight, when the crew controlled the retraction of the nose gear while the doors were held closed by adhesive tape, the right door was probably forced open by the downward force exerted by the right door actuation rod on the rear hinge. The adhesive tape holding the doors closed probably tore, allowing the left door to open, with it then remaining suspended in an intermediate position between fully open and fully closed. The right hinge probably held the right door fully open until the gear retraction sequence began to raise the right rod, which was not attached to the right hinge. At this point, the right door probably also ended up suspended in a position determined by aerodynamic forces. It is very likely that, when the nose gear retracted, the doors were sufficiently raised to interfere with the nose gear, causing a blockage that subsequently prevented the nose gear from extending.

2.5 Maintenance information

2.5.1 General

The maintenance of the Valljet aeroplanes is entrusted to R&O[18], a Part-145 maintenance workshop also based at Paris - Le Bourget airport.

F-HMSG had undergone maintenance operations between Monday 23 and Thursday 26 October 2023, on various systems. Three maintenance operations required work in the area of the nose landing gear, in particular Task 53-00-00-215.

2.5.2 Maintenance Task 53-00-00-215

This task specifies the items to be carried out in preparation for the general visual inspection of the nose landing gear well. The manufacturer's maintenance manual includes the following information:

> ***"Task 53-00-00-215: Nose Landing Gear Wheel Well General Visual Inspection (Corrosion Inspection)***
>
> *(1) Open the nose landing gear doors. Refer to Chapter 52, Nose Landing Gear - Maintenance Practices.*
>
> *(2) Complete a preliminary examination of the nose landing gear wheel well and all hardware, tubing, cables and other components in the wheel well area for cleanliness, foreign objects, deformed or missing fasteners, security of installation, corrosion, damage, paint swelling, bubbles, blisters, pits, discoloration, buckling, powdery deposits, bulging, dents, or chafed components.*
>
> *(3) Clean and dry the nose landing gear wheel well area and other components in the wheel well area to remove all dirt, contaminants and grease from the inspection area.*
>
> *(4) Use a flashlight held at an angle approximately parallel to the inspection surface to examine the nose landing gear wheel well area for any indications of corrosion.*
>
> *(5) If you suspect corrosion exists in a specific area that has paint or primer on it, do the following:*
>
> *(a) Use MPK to clean the area that is to be examined.*
> *(b) Firmly apply 3M 250 tape to the affected area.*
> *(c) Remove the tape quickly.*
>
> *1 If the paint is removed but the primer is not, apply the tape directly to the primer and quickly remove it.*
> *2 Corrosion is indicated if the primer is removed from the surface of the structure.*
> *3 If the paint is removed but the primer is not, apply the correct paint to the affected area. Refer to the Citation Standard Practices Manual, Chapter 20, Exterior Finish - Cleaning/Painting.*

[18] The accountable manager for the Valljet operator is also the accountable manager for the part 145 maintenance workshop, R&O.

(6) If corrosion is found, refer to the Model 525A Structural Repair Manual, Crack, Scratch, Gouge and Corrosion - Description and Operation or the applicable Component Maintenance Manual for information on allowable damage and repair procedures.

(7) If the corrosion damage exceeds the limits specified in the applicable manual or if damage limits are not specified, complete a written report on the location and severity of the corrosion. Include photographs and any other necessary information. Contact Textron Aviation Customer Service, Structural Repair to report the corrosion findings. Refer to the Introduction - Introduction, How to Get Customer Assistance.

(8) Close the nose landing gear doors. Refer to Chapter 52, Nose Landing Gear - Maintenance Practices."

2.5.3 Maintenance technician statements

All the technicians who worked on F-HMSG during the operations in the area of the nose landing gear were interviewed by the BEA:

Maintenance technician	Age	Seniority within R&O	Part-66 licence	Type-rated on Citation	Internal competence assessment[19]	Work schedule
1	59	4 months	yes	no[20]	no	06:00 - 18:00
2	42	2 years	yes	no	yes	06:00 - 19:00
3	19	2 months	no		no	06:00 - 18:00
4	23	8 months	no		no	06:00 - 18:00
5	22	4 years	no		yes	08:00 - 16:30
6	61	13 years	yes	yes	yes	08:00 - 16:30

Technicians 1, 3 and 4 had a 14-day work cycle. During the first seven days (work period), from Thursday to Wednesday, they worked every day from 06:00 to 18:00, then had the following seven days off. Technician 2 also had a 14-day work cycle. During the first seven days (work period), from Thursday to Wednesday, he worked every day from 06:00 to 19:00, except on Sunday, then had the following seven days off. Some technicians specified that this is a tiring work pattern, and that they were tired at the end of the service period, on Wednesdays. They added that this could contribute to errors and reduced vigilance. Technicians 5 and 6 worked from Monday to Friday only, from 08:00 to 16:30. Another team of technicians worked the days when the team of technicians involved in the serious incident were off.

	jeudi	vendredi	samedi	dimanche	lundi	mardi	mercredi	jeudi	vendredi	samedi	dimanche	lundi	mardi	mercredi
#1	6h-18h	6h-18h	6h-18h	6h-18h	6h-18h	6h-18h	6h-18h	Repos						
#2	6h-19h	6h-19h	6h-19h	Repos	6h-19h	6h-19h	6h-19h	Repos						
#3	6h-18h	6h-18h	6h-18h	6h-18h	6h-18h	6h-18h	6h-18h	Repos						
#4	6h-18h	6h-18h	6h-18h	6h-18h	6h-18h	6h-18h	6h-18h	Repos						
#5	8h-16h30	8h-16h30	Repos	Repos	8h-16h30	8h-16h30	8h-16h30	8h-16h30	8h-16h30	Repos	Repos	8h-16h30	8h-16h30	8h-16h30
#6	8h-16h30	8h-16h30	Repos	Repos	8h-16h30	8h-16h30	8h-16h30	8h-16h30	8h-16h30	Repos	Repos	8h-16h30	8h-16h30	8h-16h30

Figure 4: work cycles of the various technicians (Source: BEA)

[19] If competence has not been assessed, the technician is not allowed to work unsupervised.

[20] He was type-rated on Falcon aeroplanes.

Work on F-HMSG began on Monday 23 October. Technician 1 reported that in the absence of the team supervisor[21], who was on holiday, he decided to organise and supervise the tasks. This was the second time he had taken on this role in this workshop; he explained that he had already performed this function for his previous employers. Technician 1 instructed technicians 4 and 5 to perform the tasks associated with the left engine. Both technicians reported that they were supported by technician 1 during their work. Technician 1 assigned the tasks associated with the landing gears to technician 3. For the nose landing gear, technician 1 decided to divide work between several technicians. He indicated that he asked technician 3 to carry out the cleaning (Item 3 of Task 53-00-00-215), and since the latter had little experience, he first asked technician 2 to open the doors (Item 1 of Task 53-00-00-215). Technician 1 had limited confidence in the competence of technician 3. According to a number of technicians, it is preferable to entrust a task in its entirety to a single technician in order to limit the occurrence of errors.

Technician 3 started work on the landing gears on Monday and finished on Tuesday with the nose landing gear. In particular, he inspected and cleaned the nose landing gear (Items 2 and 3 of Task 53-00-00-215). He specified that he did not know who had previously opened the doors. He explained that, once finished, he informed technician 1 and asked him if he should connect the nose landing gear doors to the closing system. He stated that technician 1 replied in the negative since he wanted to check the work and close the doors himself. However, he reported that technician 1 asked him to fill in the work card for Task 53-00-00-215, which he did.

As for technician 1, he explained that technician 3 never came to tell him that he had worked on the nose landing gear. On Tuesday morning, technician 1 inspected the nose landing gear (Item 2 of Task 53-00-00-215). He added that on Tuesday afternoon, technician 3 asked him for another task to carry out. Technician 1 therefore considered that the work on the landing gears was fully completed, but he did not check this. He specified that he could not be everywhere and check everything.

Technician 3 stated that, after consulting technician 4, he sought the advice of technician 1 regarding the nose landing gear, based on photographs. These requests concerned:

- Signs of corrosion on springs: technician 1 indicated that this was surface corrosion and that cleaning and greasing would be sufficient. He had also noticed this during his inspection.
- The lack of anti-corrosion protection on the walls of the well: technician 1 indicated that this was not very important, that this could wait until the next major check and that it was not possible to repaint everything.

[21] This team supervisor held a Part-66 licence and was type-rated on Citation. In the workshop documentation, the team supervisor is referred to as the production manager. When present, the team supervisor signs the Certificate of Release to Service (CRS).

Figure 5: signs of corrosion on springs of nose landing gear mechanism[22] (Source: R&O)

Figure 6: no anti-corrosion protection (yellowish in colour) on the walls of the nose landing gear well (Source: R&O)

On Wednesday 25 October, technician 3 was absent for personal reasons. Early that afternoon, technicians 4 and 5 towed the aeroplane out of the hangar in preparation for a run-up to check various systems. To avoid damaging the nose gear doors with the towing vehicle, the two technicians taped the two doors closed with aluminium adhesive tape. Technician 5 indicated that a "red flag" was present. According to him, it was hanging from the inside of the well and was visible from the outside with the doors closed. Technician 4 could not remember whether he installed the flag by force of habit, because the doors were not connected to the closing system, or whether it was already there[23]. The two technicians explained that they used "long strips" of adhesive tape to make them visible.

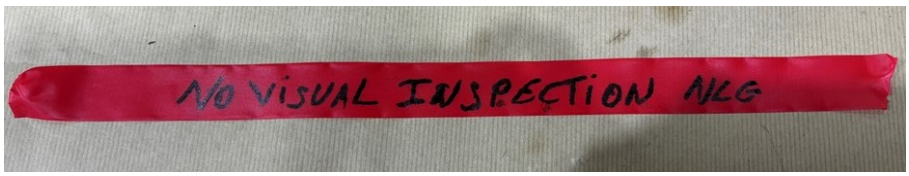

Figure 7: flag on the nose landing gear (Source: R&O)

Technician 1 explained that before doing the run-up with technician 6, he walked around the aeroplane to inspect it. He saw a flag taped on the fuselage of the aeroplane near the nose landing gear and removed it, as he had inspected it the day before. He did not ask himself any questions and did not visually check the area around the landing gear. The doors were closed, which was consistent with the completed task. He added that if the doors were not connected to the closing system, then they should not have been closed, and that in this case, this had to be notified. He specified that he had had to "run around" that day.

[22] The BEA shared some photographs with Textron Aviation. The latter indicated that, given the level of corrosion observed in the photographs, had they been consulted, they would have recommended replacing the springs.

[23] None of the other technicians mentioned having installed this flag.

Several technicians reported that Wednesday was a very busy day, due in particular to several priority changes on various aeroplanes, involving numerous movements of aeroplanes. A technician mentioned that the chief-pilot of Valljet's Citation sector[24] came to give him instructions on priorities. He specified that it is not unusual for this person to come and put the work of the technicians into a hierarchal order. Another technician specified that technicians follow the instructions of this person, because he is very close to the accountable manager of the workshop and also because he was a maintenance technician in the past.

Technician 6[25] explained that he signed the aeroplane's Certificate of Release to Service (CRS) on Thursday 26 October. His check of the aeroplane lasted around ten minutes. He reported that he had not noticed anything particular. He generally trusts team supervisors to point out any problems. Team supervisors are usually in charge of the CRS, but when they are away, he takes over. Finally, he reported that some of the last tasks entrusted to technician 5 were carried out outside. Technician 5 stated that he did not pay attention to the gear doors and did not see the aluminium adhesive strips that closed them.

Most of the technicians interviewed by the BEA said that R&O's organisation is difficult to understand. They specified that they do not know who is in charge of what, or who is responsible for what. They added that there is a high employee turnover and that this does not help consolidate collective methods and experience. It was one of the first times that the supervisor was absent for this team. Given his experience, technician 1 took on the role of "substitute" team supervisor. He had not received any instructions from his managers, in the absence of his team supervisor. He specified that the work had to be done. The technicians indicated that the team working on the seven days when they are off does not have a team supervisor. Technician 1 reported that there is no formal way of transmitting information. For example, to inform the next team of the work to be completed, he uses a piece of paper placed on the computer keyboard. One technician specified that the many different schedules between technicians make it difficult to monitor and hand over tasks.

Finally, several technicians reported that it is not unusual to interrupt work tasks, either to assist a colleague with another task, or to help members of management with operations that may be completely unrelated to aeroplane maintenance.

2.5.4 Analysis of the work cards associated with the nose landing gear inspection

It was not indicated on the work card for Task 53-00-00-215 that this task was divided between several technicians, nor that the doors were not closed. Only technician 3 signed the work relating to this card. The operations carried out by technicians 1 and 2 were not mentioned.

2.5.5 R&O workshop information

R&O specified that a technician carrying out a task must sign the corresponding document. Depending on the technician's competence assessment or the criticality of the task to be carried out, the latter may be checked before being fully confirmed. If several people are involved in the same task, R&O asks each technician to sign the part they completed.

[24] This person is Valljet's Fleet Technical Manager.

[25] He also indicated that he did not want to be a team supervisor, as he did not want to assume management tasks.

R&O indicated that at the time of the serious incident, there was only one team supervisor, who was away at the time of the work on F-HMSG, for the two teams, and that there was no deputy team supervisor. R&O specified that to become a team supervisor, the person must first accept the mission proposed. Secondly, this mission is entrusted to technicians with a taste for team management, in-depth experience of aeronautical maintenance and a satisfactory knowledge of the trade standards and practices. A team supervisor organises the work of his team, assigns maintenance tasks to technicians according to their competence, supervises checks, ensures that the technicians in his team comply with the trade rules and standards, and carries out competence assessment interviews with team technicians.

R&O specified that Valljet's Fleet Technical Manager has no prerogatives to prioritise the various maintenance tasks. However, his position means that he is Valljet's representative at R&O. As such, he can present his point of view and provide technical advice. He can also, when several aeroplanes are under maintenance at the same time, set out his needs by expressing an order of priority for the maintenance work to be carried out.

2.5.6 OSAC oversight mission

Following the serious incident, the workshop was subject to an oversight mission carried out by OSAC[26] from 30 October to 10 November 2023. Several deviations were observed, most of which were directly linked to the serious incident:

Level 1 deviations[27]:

- Requirement 145.A.30(d): The organisation does not have a man-hour plan to ensure it has sufficient and appropriately qualified staff to perform, supervise and inspect the maintenance activities, nor does it have a procedure to reassess the work to be carried out when the actual staff available is reduced for a particular team or period. During the investigations, an Excel schedule for the year 2023 was presented, but it was not up to date with the organisation's actual staff or their absence. For example, technicians 1, 3 and 4 did not appear in this file; on the other hand, a technician who had left the organisation was still shown as present; the Cessna team supervisor, on holiday from 23 to 27 October, was shown as present.
- Requirement 145.A.30(e): The competence of the personnel is not managed. During the maintenance operation on F-HMSG from 23 to 26 October, three technicians, including one acting as a team supervisor, worked unsupervised while they were not authorised to do so, as their competence had not been assessed. In addition, four other technicians working on this maintenance operation were assessed as being able to work under partial supervision. However, their competence assessments did not identify the activities requiring supervision.
- Requirement 145.A.30(h)1(i): Support and certifying staff do not ensure that maintenance tasks have been carried out to the required standard. During the work carried out on F-HMSG from 23 to 26 October, technician 6, acting as B1 and B2 support and certifying staff, did not check during the maintenance operations, that the maintenance and inspection tasks were carried out in accordance with the maintenance documentation. The latter indicated that he only carried out administrative checks on work cards.

[26] OSAC, mandated by the DSAC, oversees Part-145 maintenance workshops.

[27] A Level 1 deviation is a non-compliance that lowers the safety standard or hazards seriously flight safety, and justifies immediate action by the Authority (OSAC in France) to prohibit or limit the activities carried out under the approval.

- Requirement 145.A.50(a): Aircraft are returned to service even though not all the work has been carried out in accordance with the maintenance documentation. The Cessna 525A registered F-HMSG was returned to service, even though, after visual inspections of the landing gears, the nose gear doors had not been reattached and were taped closed. It was also determined that the aircraft was not jacked up to open the doors and inspect the landing gears, as required by the maintenance documentation.
- Requirement 145.A.47(a): The availability of resources is not planned to ensure that maintenance work is carried out safely. Between 23 and 25 October, four Cessna 525As were being maintained, although the organisation only had one person who was qualified and authorised to work on this type of aircraft and who worked from 08:00 to 16:00. The other technicians who worked on the aeroplane did not hold the ratings for this type of aircraft, required full or partial supervision and worked from 06:00 to 18:00. Moreover, it was found that the checklist of the start of maintenance work meeting (Form-20) for F-HMSG was countersigned by the Technical Office only and did not indicate the team supervisor and certifying staff for the work.

Level 2 deviations[28]:

- Requirement 145.A.45(e): The work cards do not make it possible to determine the maintenance staff who intervened successively and whether all the tasks were completed. During the maintenance work on F-HMSG from 23 to 26 October, it was found that:
  - the successive steps of the nose landing gear inspection procedure were not validated;
  - technician 2, who removed the nose gear door, did not fill in the work card;
  - the work file did not include a detailed work card for checks 1 and 2 of engine #1;
  - the general work card for check 1 of engine #1 included the wording "*oil and fuel leak check to be performed*" without any information about how to do it;
  - the steps for the cabin door seal functional test (Doc. 24) were partially validated: Section C (leak test) was not validated. Moreover, not all the staff who carried out this task was mentioned on the work card;
  - the checklist regarding the opening and closing of access panels (Form-72), which lists the panels opened and certifies that they have been closed, was not completed.
- Requirement 145.A.95(a)1: The actions implemented by the organisation in response to the deviations notified by the Authority are ineffective. Deviations similar to the first two deviations were reported in March and May 2023 for failure to supervise unassessed staff and there being no man-hour plan.
- Requirement 145.A.70(a): The shift/task handover procedures are not complied with. It was found that the instructions for the maintenance work on F-HMSG had been transmitted on a loose leaf found in a dustbin and that the instructions for the maintenance work on the Embraers were transmitted by e-mail, whereas the organisation's procedures stipulate the use of notebooks available at the workstations.

[28] A level 2 deviation is a non-compliance that could lower the safety standard and possibly hazard flight safety, and for which the Authority grants a period of time to implement an action plan appropriate to the nature of the non-conformity.

2.5.7 Corrective action plan implemented by the R&O workshop following the serious incident

By decision of the OSAC approval committee, the notification of Level 1 deviations was combined with a suspension of the Part-145 approval for the maintenance workshop, R&O. Approval was suspended from 16 to 23 November 2023 and then partially until 6 December 2023. The suspension was lifted after the workshop implemented corrective actions, including the following:

- reorganisation of production teams and changes in management personnel;
- reduction of the field of activity;
- changes in the procedures used to assess competence, authorise staff and plan, record and certify work;
- assessment of the competence of all staff and organisation of any additional training required.

2.6 "Foam blanket"

2.6.1 ARFF service manager's statement

The ARFF service manager at Le Bourget airport reported that there was no procedure for preventive "foaming" operations, and that this was left to the initiative of the fire officer on duty (one of his colleagues at the time of the serious incident). He specified that preventive foaming can be imagined for an aeroplane making a "belly landing" as large sparks can occur around the edges of the wings, and therefore the tanks, which could lead to a fire breaking out. A preventive foaming measure may therefore be justified by the rise in temperature, or even the abrasion of the airframe in contact with the runway. According to him, in the case of a landing on the main landing gear, without the nose gear, preventive foaming may, on the other hand, cause the tyres to slide and make the aeroplane exit the runway.

At Le Bourget, the fire service has three emergency trucks, each with a capacity of 9,000 l. With this amount of water, they can spread around 70 m^3 of foam, i.e. a length of around 150 m with an average thickness of around 10 cm. They contain enough emulsifier for two foaming operations, and it takes around 10 minutes to refill the truck with water. The manager added that the time that the foam will hold depends on a number of factors (whether or not it is subject to fire, wind strength, temperature on site, etc.), bearing in mind that foam spread under ideal conditions can last three hours, and can be renewed (depending on the conditions encountered) at the discretion of the fire officer on duty.

2.6.2 Information provided by the STAC (French Civil Aviation Technical Centre)

The STAC specified that in France, neither the impact of a "foam blanket" on landing performance has been assessed, nor the actual operational benefit of such a procedure, whether for aeroplanes of an aluminium or composite fuselage.

Indeed, foaming runways is not a practice that the ICAO recommends to the ARFF, nor is it a practice arising from the European Aviation Safety Agency (EASA) or from national provisions in force as regards the ARFF. This practice is the result of instructions/practices issued in the 1960s, probably by the Federal Aviation Agency (FAA), based on practices implemented by the Army in the event of emergency landings of military aeroplanes.

The ICAO Airport Services Manual (Doc. 9137-AN/898) included, in its 1990 edition (3rd edition), chapter 15 concerning the Foaming[29] of Runways for Emergency Landings. This was not a recommended practice, but rather a sharing of information by some States. This chapter was completely removed when the manual was revised in 2015 (4th edition), due to questions/uncertainties about this practice. At the time, however, the issue of the impact on aircraft performance was only raised indirectly in the "Operational problems" section of the manual.

In the 1950s-1960s, the foams used by the fire services were protein/fluoroprotein-type foams, which tended to be very abundant and resistant over time. From the 1970s-1980s onwards, the use of synthetic, Aqueous Film Forming Foams (AFFFs), offering better extinguishing performance, became widespread, but these could no longer form foam blankets that were as "thick" and long-lasting (foaming and landing time) as protein foams. Today, fluorine-free foams, which have been gradually implemented by French airports since the mid-2010s, show foam quality characteristics that have not been assessed by the authorities. Their effectiveness when being used as a foam blanket is not known.

Finally, in a guide relating to airport operations published in 2002, the FAA advised against the use of foam blankets for emergency landings: *"The FAA does not recommend the foaming of runways for emergency landings and warns against the practice with any foam other than 'Protein' foam."*

2.6.3 Belly landing of a Piper PA31

The BEA was informed of the incident to the Piper PA31, registered F-HPXR, on 13 January 2024 at La Rochelle - Ile de Ré airport (Charente-Maritime). The BEA did not open an investigation into this incident, however, information was gathered. The pilot landed with the landing gear retracted (belly landing). The fire service had previously laid a foam blanket on the runway.

The pilot and the fire services had discussed the length of the blanket and the forewarning required before foaming the runway in order to have an effective layer when the aeroplane landed. The objective was to reduce the risk of fire. The fire services reported to the BEA that there was no established procedure on this topic, and that this tool could be used at the initiative of the fire officer on duty. They specified that a blanket around 800 m long, 20 m wide and 10 cm thick was laid out. This blanket had no influence on holding the path in the centre of the runway during the landing. Finally, the aeroplane suffered little damage to the fuselage.

2.7 Analysis of operational aspects of the serious incident flight

The Cessna 525 is an aeroplane certified for single-pilot operations and operated by Valljet in multi-pilot operations, whatever the type of operation. This offers greater flexibility in the event of a change in the action plan or strategy, in the management of a fault or in response to external requests (from controllers or the fire services, for example).

2.7.1 Landing gear malfunction

The aeroplane flight manual and the QRH include two procedures relating to a landing gear malfunction:

- "*Landing gear will not retract (gear unlock light remains ON)*", which mainly consists in repeating a landing gear retraction/extension sequence;
- "*Landing gear will not extend*", which mainly consists in using the standby landing gear control.

[29] Scope limited to protein foams.

The crew made an initial attempt to extend/retract the landing gear without referring to the procedures. This initial action was based on similar symptoms encountered on other aeroplanes operated by the operator.

The crew then applied the procedures in the flight manual during the first holding phase, which did not solve the problem.

The crew also contacted the operator's Fleet Technical Manager for assistance from the ground, but this too failed to resolve the fault.

Finally, the crew improvised a pull-up manoeuvre to try to unblock the nose landing gear. This practice is not mentioned in the aeroplane's documentation; it is sometimes taught in primary flight training on light aeroplanes equipped with retractable landing gear.

2.7.2 Reducing fuel load and management of landing

Unlike the "*Landing gear will not retract*" procedure, the "*Landing gear will not extend*" procedure does not require pilots to land as soon as possible. In the absence of any other recommendations, the crew decided to reduce the fuel load in order to avoid any further incidents during the landing on the nose of the aeroplane (risk of fire).

On several occasions, when the crew reviewed the amount of fuel to be burnt, they increased the value. They announced to the controller that they were ready to start the approach to Le Bourget airport on three occasions:

- approximately 30 minutes after take-off;
- approximately 2 hours after take-off;
- approximately 2 hours and 30 minutes after take-off.

As the aeroplane was not equipped with a system for dumping fuel in flight, the crew wanted to fly in the low layers, to use fuel as quickly as possible.

Following the first announcement, the crew began an ILS 27 VPT 25 approach for landing, then changed their plan of action, making a low pass in order to have the position of the landing gear visually confirmed by the controller and the fire services.

Following the second announcement, the aeroplane still contained approximately 1,400 lb of fuel, according to the crew. However, while they were being vectored towards the start of the approach, the crew considered that this amount still represented a significant hazard. The crew revised the final target to 600 lb, i.e. approximately one hour of flight, enough for one runway circuit (in the event of a missed approach) in addition to the final reserve fuel, according to the crew's statement. These elements suggest that the crew had not taken into account the extra fuel consumption of the aeroplane with the landing gear extended.

Following the third announcement, as the crew were being vectored towards the start of the approach, the controller suggested that the crew should hold, to give the fire services enough time to lay out the foam blanket that the crew had finally requested a few minutes earlier. The crew finally told the controller that they would not be able to hold due to the amount of fuel remaining.

2.7.3 Landing strategies

The crew changed their landing strategy several times during the flight, which could make it difficult to prepare the approach, landing and briefing contents. However, the crew were very familiar with Le Bourget airport.

A first approach was initiated. This was an ILS 27 VPT 25 approach for landing on runway 25. On final, the crew decided not to land and to make a low pass. After a few exchanges with the controller, they made a low pass over runway 27, closer to the control tower.

Even if they are not mentioned in the aeroplane's documentation, the principles of a low pass are known and can be implemented in order to check the position of the landing gear.

The crew had little experience of landing on runway 25, which is not commonly used. For the final landing, the captain (PF) started the final to runway 25 a little earlier than specified (about 1 NM), in order to ensure stabilisation. The CDG controllers had stopped departures from the airport to facilitate this manoeuvre.

During the flight, the crew also considered the appropriateness of landing at CDG, whose runways may be longer or wider. After some reflection, the crew maintained their decision to land at Le Bourget airport.

Finally, with regard to the deployment of a possible foam blanket, the fire services asked whether the crew wanted to ignore the displaced threshold for landing on runway 25. This question was transmitted by the controller at CDG. The crew agreed with this suggestion. The controller at Le Bourget was also informed of this decision. None of the stakeholders were conscious of the risks associated with landing before the displaced threshold. Indeed, the displaced threshold on runway 25 was established in particular, due to the proximity to CDG, but it can also be associated with obstacles or roads in the approach path. These elements were not taken into consideration by the stakeholders as part of their reflections. No text or procedure provides for ignoring a displaced threshold. Moreover, in doing so, the crew no longer had any light aids (e.g. the PAPI whose angle is set for the displaced threshold) or ground markings for landing.

2.7.4 Airspace

CDG's quick-reference cards do not include any specific information on how to manage an aeroplane holding in order to process an in-flight failure. The crew wanted to fly at 3,000 ft to burn fuel quickly. The holding time requested by the crew changed several times. The controller asked the crew to climb to FL 070 so that they would not be in Beauvais airspace, nor in uncontrolled airspace, in order to prevent collisions.

The discussions between the crew and the CDG controllers were over the allocated SUP IFR frequency, in accordance with CDG's quick-reference cards. Most of the radio exchanges occurred over the North Sector (military) and ITM BA frequencies.

During the flight, the crew had specific questions about the foam blanket suggested by the fire services. To avoid acting as a relay, the controller at CDG suggested that the crew talk directly to the fire services over their portable radio, but the range of this device was not sufficient to allow these exchanges. The fire services and the crew also tried to talk on the phone, but to no avail.

The crew mentioned their need for ground assistance several times during the flight. After the crew were able to confirm the status of the landing gear during the low pass, the North Sector military controller offered assistance to the crew, without specifying the nature of this assistance. The crew

accepted this assistance, thinking that this would be the ground assistance they had previously requested. The controller then considered mobilising a Rafale on operational duty, which the crew declined, as this escort could not aid them further. A few minutes later, the same controller suggested diverting a helicopter engaged in a mission nearby and equipped with night vision goggles, which the crew also declined for the same reasons.

2.7.5 Foam blanket

In the absence of procedures and documentation, the laying out of a foam blanket to prevent the risk of fire is left to the initiative of the ARFF officer on duty.

The investigation brought to light that the fire officer on duty did not seem to know the characteristics of a foam blanket, in particular its size. He initially suggested a 40 m long blanket which required a precision landing, for a crew likely to be tired, at night. In the end, the fire services did not know where to position this foam blanket.

The main question raised by the crew regarding the impact on the aeroplane's landing performance was not answered.

The effectiveness of a foam blanket does not yet appear to have been demonstrated. However, it would seem to reduce the risk of fire during landing, as would the foam sprayed by the fire brigade after landing.

Finally, this topic, which was undocumented and therefore improvised, monopolised a lot of resources for the different stakeholders involved: crew, controllers and fire services. The investigation brought to light that the ARFF responders on duty at Le Bourget airport were not prepared to deal with this type of incident.

2.7.6 FORDEC

The operations manual of the aeroplane's operator specifies that, in the event of a failure, the FORDEC method (Facts, Options, Risks, Decision, Execution, Check & communicate) must be used.

The investigation revealed a sort of variability in the crew's decision-making criteria (maximum fuel wanted for landing, request for the foam blanket, request for assistance, low pass, etc.) even though there were no new facts to justify this. These changes in strategy and their implementation seem to show that the crew's decision-making process was not structured.

The methodology set out in the operations manual is very general. It lacks any truly operational tools to help crews establish a structured decision before starting the approach.

3 CONCLUSIONS

The conclusions are solely based on the information which came to the knowledge of the BEA during the investigation.

Scenario

The aeroplane was returned to service following maintenance operations that included a visual inspection of the nose landing gear well. However, the task relating to closing the doors of the nose landing gear, after its inspection, was not completed. Three technicians from the maintenance workshop worked on the aeroplane, one of them not type-rated for the aeroplane, assumed the role of team supervisor, in the absence of the only team supervisor of the Citation sector in the workshop.

The technicians all indicated that, in hindsight, they were very tired at the end of their week's work, accentuated by a reorganisation of the tasks requested by Valljet's Fleet Technical Manager. According to the technicians, this situation led to aeroplanes being moved several times in the hangar and on the apron, thus increasing the overall workload.

To move F-HMSG without damaging the nose gear doors, whose rods were not connected, one of the technicians closed them with aluminium adhesive strips and a red flag was put in position.

Before the aeroplane's run-up on the apron, the technician assuming the role of team supervisor removed the red flag without noticing the aluminium adhesive strips. He thought that the maintenance task on the nose landing gear had been completed in full.

At the end of the maintenance operations, the technician responsible for the CRS did not linger over the nose landing gear and did not identify that the task associated with the nose landing gear inspection had not been completed. In fact the rods actuating the gear doors were not attached and the screws were still hanging in a bag from the nose landing gear. The work card filled in by the technician who carried out the inspection did not show this information.

Following these maintenance operations, the two agents in charge of towing the aeroplane between the maintenance workshop apron and the operator's apron did not notice the aluminium adhesive strips. Furthermore, the two pilots did not notice them either when they carried out the pre-flight external inspection of the aeroplane at night.

After take-off, when the crew controlled the retraction of the landing gear, as the rods of the nose gear doors were not attached, this affected the movement of the doors, and resulted in them blocking the nose gear.

Complying with the emergency procedures did not correct the problem. The crew then decided to burn as much fuel as possible before landing in order to limit the consequences of a landing with an unlocked nose gear. On landing, the contact of the aeroplane's nose with the runway did not result in any particular incident.

Throughout the flight, which lasted around three hours and during which the landing gear failure was not an emergency, numerous suggestions from controllers, pilots and the fire services were discussed and considered, or even improvised, without being assessed or given a concrete form by a structured decision-making process.

Finally, the observations made by OSAC following the serious incident revealed, among other things, deviations within the maintenance workshop, that were consistent with the information gathered during the BEA investigation, in particular deviations relating to:

- the management of the technicians and their supervision;
- proper checking of the work cards by support and certifying staff.

These deviations have since been the subject of corrective actions by the workshop, approved by OSAC.

Contributing factors

The following factors may have contributed to the aeroplane's return to service, when all the maintenance tasks on the nose landing gear had not been completed:

- the fact that the task associated with the nose landing gear inspection was divided between three technicians, over several days, combined with a lack of precise information being shared by the different technicians regarding the actions carried out. As a result, the last item in the task, which included reconnecting the rods of the nose landing gear doors, was omitted;
- the absence of an appropriate organisation meeting the regulatory requirements at the Part-145 maintenance workshop, which did not enable technicians working on F-HMSG to identify the roles and responsibilities of each person correctly, particularly in the absence of the only team supervisor of the Citation sector within this organisation;
- the installation of adhesive strips or a red flag without this being mentioned elsewhere;
- the crew's failure to identify the adhesive strips taped on the nose landing gear doors during the pre-flight inspection.

The following factors contributed to the degraded decision-making process applied by the crew to manage the fault in flight:

- the rather unstructured application of the FORDEC method;
- a large amount of information, sometimes superfluous or improvised, transmitted by the various control services and the fire services, which increased the crew's workload.

The BEA investigations are conducted with the sole objective of improving aviation safety and are not intended to apportion blame or liabilities.