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INVESTIGATION REPORT

Serious incident to the Cessna Citation 525B registered F-HCIC on 22 July 2013 at 10 NM north west of Paris Orly airport climbing through FL 180

Time	From 05:48 [1]
Operator	Airailes/Charter company
Type of flight	Commercial air transport
Persons on board	Captain (PM)[2], copilot (PF)[2]
Consequences and damage	Left engine bearings 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.

[1] Except where otherwise indicated times in this report are local.

[2] PM: pilot monitoring
PF: pilot flying.

Smoke in cockpit, emergency descent and flight in a prohibited area for low altitude flight, in a commercial air transport positioning flight

1 - HISTORY OF THE FLIGHT

Note: the following elements are based on the data from the Flight Data Recorder (FDR), Cockpit Voice Recorder (CVR), examinations of the engines and interviews with the crew and controllers.

The crew took off at 05:40 from Paris Le Bourget airport (in the Seine-Saint-Denis department) for a positioning flight to Lannion airport (in the Côtes-d'Armor department). At 05:47, in contact with the departure sector of the Paris Area Control Centre (Paris ACC), they were cleared to climb to FL 240 towards KOKOS. The copilot was the PF and flying was carried out in manual mode. From 05:47:37, the oil pressure in the left engine started to fluctuate. The examination carried out by the manufacturer found that the No. 2 intermediate bearing of the left engine (engine 1) had failed. The meteorological conditions at Paris Orly were CAVOK.

While passing through FL 180 at 05:47:55❶, the two crew members detected a strong burning smell. Within a few seconds, thick smoke invaded the cockpit from the rear. The captain took the controls and ordered masks[3] to be put on. In doing this, he lost his glasses and his headset with which he was communicating. He couldn't find his glasses because of the density of the smoke and so put on his spare pair. The two pilots did not put on their protective goggles. The captain set the two power levers to idle at 05:48:19. Six seconds later❷, a "*Left engine oil pressure*" audio warning sounded[4]. The captain immediately started an emergency descent and the aeroplane progressively adopted a nose-down pitch of 15° ❸. The oil temperature of the left engine increased from 05:48:43 onwards. Meanwhile, the copilot informed the controller of the emergency descent and then made a PAN PAN call❹. The copilot then pointed to the engine 1 dial. The Paris ACC controller acknowledged the descent message but did not receive the PAN PAN message as at that moment another crew was also speaking on the frequency. The controller and his coordinator then ensured the separation of F-HCIC with conflicting traffic departing from Paris Orly airport and heading west.

[3] There is no full face mask in the aeroplane. A mask and protective goggles have to be put on.

[4] It sounded for 2 minutes and 20 seconds.

From 05:49:09, the captain proceeded to shut down the left engine without announcing it. First he set the power lever to OFF❺. The TCAS "Traffic Advisory" warning sounded at 05:49:12❻. The captain shut down the generator associated with the left engine at 05:49:29. Approximately 15 seconds later, as there had been no response to his PAN PAN message, the copilot made a MAYDAY call and asked for a radar vector to carry out an ILS approach to runway 07 at Paris Le Bourget airport❼. The controller accepted the request.

From 05:49:48, the overspeed warning sounded for nearly 1 minute 30 seconds in concomitance with the *"left engine oil pressure"* warning. The pitch varied between - 13° and - 6° following a nose-up input by the copilot. The copilot did not call out his input on the controls. The speed[(5)] varied between 295 kt and 215 kt and the vertical speed between - 8,000 ft/min and - 1,500 ft/min.

[(5)] This is the calibrated airspeed.

The captain did not reply to the copilot when the latter repeatedly reported an overspeed by shouting "*speed*". The captain subsequently told the investigators that his priority had been to descend as quickly as possible. The aeroplane turned left. The captain set the air selector to FRESH AIR. According to the two crew members, the smoke in the cockpit was still dense and did not disperse. The captain could not see the aeroplane instruments as well as the copilot.

At 05:50:20, the controller asked the crew if they could change frequency. This request was not heard as it was masked by the captain pressing the push-to-talk to try and send a MAYDAY message. The executive controller concluded that the crew was no longer able to change frequency. Consequently he kept them on the same frequency and the position planner controller coordinated by telephone, the clearances with the Paris Charles de Gaulle (CDG) Approach controllers responsible for the Le Bourget approach and the airspace in which the aeroplane was situated at this time. A short time after, the control position was reinforced by a third person who was responsible for coordinating with Paris CDG. This coordinating generated continuous exchanges between the position controllers.

At 05:50:26, the aeroplane descended through 9,384 ft with an average rate of descent of 3,000 ft/min. The ATC vectored the aeroplane to heading 290❽. Observing that this instruction had not been taken into account, the copilot yelled "*cap deux ! neuf ! zéro !*" (heading two! nine! zero!) six times. The aeroplane stabilized on heading 030 and then headed towards the city of Paris.

At 05:50:58, the airbrakes were extended for 1 min 19 s. The speed dropped from 286 kt to 225 kt.

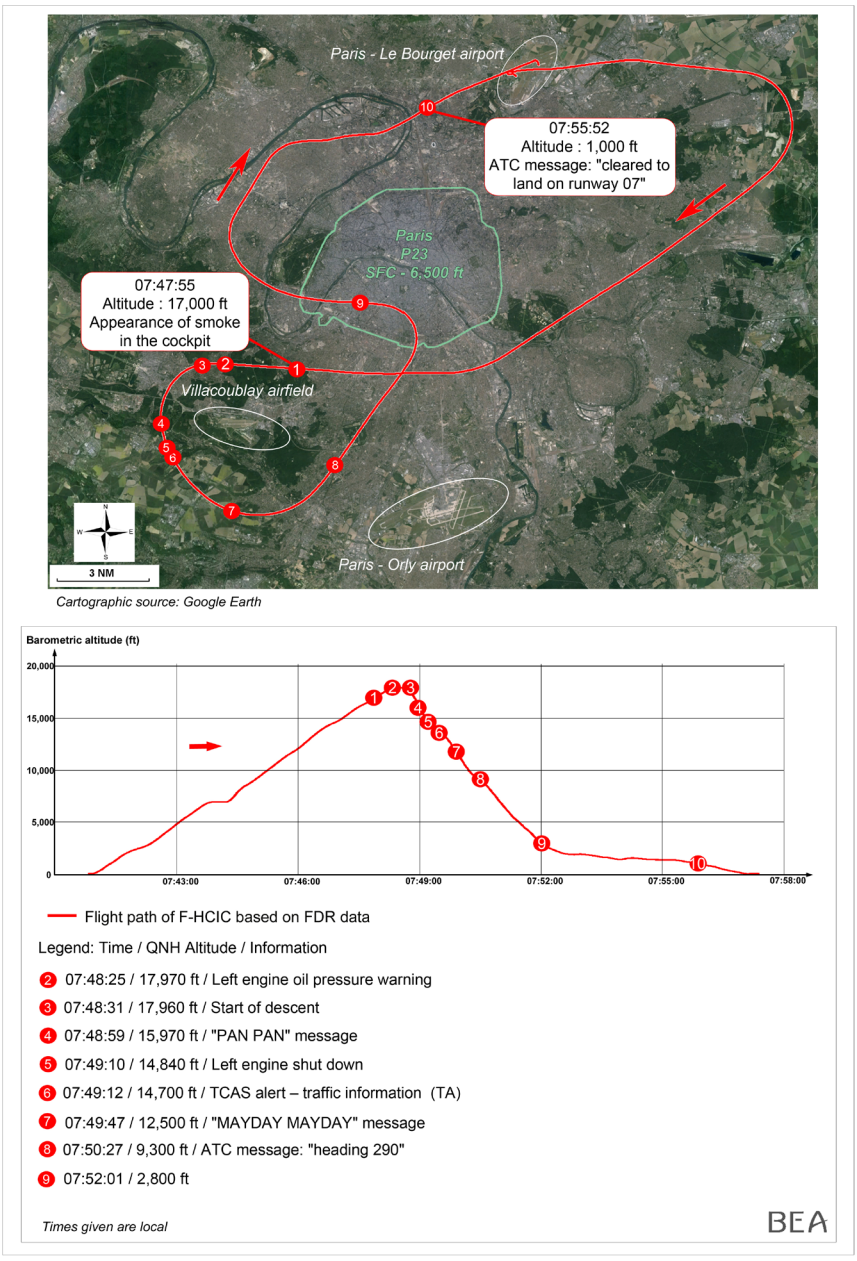
The aeroplane entered the prohibited area P23[(6)] at 05:51:24 at an altitude of 5,275 ft and continued to descend. At 05:51:25, the oil temperature of the left engine reached a maximum of 131°C while the oil temperature of the right engine remained stable at 71°C. The crew then turned to the left at 05:51:48. Ten seconds later, the copilot received clearance for descent to 3,000 ft that he read back indicating that the aeroplane was situated at an altitude of 2,800 ft❾. At this point, the aeroplane was on heading 270° and still in the prohibited area. The captain stated that the smoke started to disperse. Exchanges between the crew, which had been practically non-existent from the appearance of the smoke, resumed. The captain had not put his headset back on.

[(6)] Prohibited area (corresponding to the city of Paris) from ground to an altitude of 6,500 ft. It is not shown on the Paris ACC Departure positions, as this sector is not responsible for controlling aeroplanes at low-altitude near Paris unlike the Paris CDG or Paris Orly TMA positions.

A Paris CDG controller detected that the aeroplane was too low. This information was sent in fine to the Paris ACC controller in contact with the aeroplane. This controller informed the crew that they were too low. The aeroplane left the Paris prohibited area. The captain reduced the rate of descent and ordered the copilot to advise that they had a fire on board, this was carried out by the copilot shortly afterwards. The controllers then gave a radar heading 040 to the aeroplane. The aeroplane stopped its descent at 05:52:46 at an altitude of 2,000 ft.

The smoke dispersed little by little although there was still an irritating odour present. After being issued a radar vector, the crew was then authorized to land ⑩ at runway 07 at Paris Le Bourget airport. The captain passed below the glideslope so as to be able to perform a smooth flare. The "*Glideslope*" GPWS warnings were activated at 05:56:53.

Touchdown took place at 05:57:09. The airport firefighters followed the aeroplane which had no visible damage. After stopping in the parking area, the crew was surprised by the absence of visible external damage and carried out a debriefing that they recorded on a smartphone. They then notified the incident to the civil aviation authorities.



2 - ADDITIONAL INFORMATION

2.1 Crew's experience and witness statements

2.1.1 Captain's experience and witness statement

The captain is an instructor and has logged more than 17,000 flight hours, 800 on type and approximately 90 hours in the last three months.

Although the incident flight was a commercial air transport flight without passengers, the captain considered it as a training flight for the copilot. He specified that training was not carried out in a simulator but on a real aeroplane.

After informing the copilot that there was a smell of smoke, he turned around and saw a large quantity of thick black smoke arriving from the rear of the cabin and invading the cockpit relatively quickly. He was horrified, thought that there was a fire on the aeroplane and that consequently he and the copilot had little chance of surviving. He recalled the scenario of the Swissair accident and therefore wanted to land as quickly as possible (at Villacoublay, at Paris Orly or in a field). The captain ordered the masks to be put on. He said that he orally informed the copilot that he was taking the controls and was thus going to be the PF.

While trying to put his mask on, his headset fell off and he lost his glasses. He then put on his spare pair and did not waste time looking for his headset because of both the density and opacity of the smoke and the urgent need for action.

During the descent, he tried to understand the situation and think about ways of resolving it while staying focused on flying the aeroplane. He heard the copilot's comments and his calls but said he did not reply to them intentionally as he was concentrated on flying. He stated that he could not see the instrument panel during the emergency descent due to the smoke. He heard the copilot inform him that the left engine had failed.

He shut down the left engine with the lever. He did not consult the QRH for the procedure due to the urgent need to act which he somewhat regretted in hindsight. He stated that he looked and confirmed that he had actually shut down the correct engine.

He heard the copilot tell him about the overspeed warning but did not reply to him as he was busy. The overspeed warning was not his priority as according to him, the aeroplane was certified to withstand a greater overspeed and, in any case, the aeroplane had to be landed as quickly as possible. He thought that he only had an action time of between one and two minutes. But he did perceive the "*engine oil pressure*" and overspeed warnings.

He did not have time to look at the descent procedure and the procedure to be carried out in the event of smoke. He carried out the actions from memory: ordered the masks to be put on, selected "*fresh air*" and then shut down the engine with the power lever. He thought that he had reduced the thrust and extended the speedbrakes during the descent.

He wanted to descend to a "*reasonable*" altitude. When he understood where the smoke was coming from, he accepted to go to Paris Le Bourget airport and asked the copilot to specify that they had a fire on board so that they would be given ATC priority. He did not want the ATC to delay them in order to land as quickly as possible.

He could see the instruments when the aeroplane flight path was between heading 290 and 040.

Right up to the end of the event, he did not have his headset on. He specified that he flew manually and without the AP as he was comfortable with manual flying.

On the final approach, he deliberately descended below the glide slope on short final in order to land with a smooth flare.

He specified that he did not use the familiar form to address someone (*tutoiement*) with copilots until they had shown their worth. Before 2008 he had used this familiar form. He then imposed the more formal form (*vouvoiement*) due to a disagreement with a former copilot. After this serious incident, he asked himself whether it was not better to use the more familiar form. He also said that the policy was to switch off the audio warnings.

2.1.2 Copilot's experience and witness account

The copilot had logged 1,200 flight hours of which 160 hours on type.

He obtained his Type Rating at San Antonio in November 2011. He joined the airline in May 2012. At Airailes, he had not had smoke with emergency descent training in the simulator.

Generally speaking, he was sometimes "*bothered*" by the captain's use of formal speech as it created a very strong sense of rank; for the copilot it was very difficult to counter if necessary, a decision made by the captain. He had already brought up the possibility of using the more familiar form of address with the captain, and the latter had refused. Since the serious incident, they use the more familiar form.

During the flight, he was PF and before the incident, there was nothing specific to report. As soon as the smoke appeared, the captain ordered the masks to be put on. From this moment on, the PF/PM roles were reversed and the captain became PF. He saw the captain set the air conditioning selector to "*fresh air*" just before the pitch down input. The captain immediately started an emergency descent. The smoke was thick as it was coming from the rear of the aeroplane's cockpit.

The copilot did not initially hear the "*left engine oil pressure*" warning.

After observing that the speed and "*speed trend*" were increasing too quickly during the descent, the copilot pointed out the excessive pitch value which reached -12°, to the captain. During the descent, he pulled back on the control column to prevent the speed from becoming excessive.

In the haste to act and the stress, the captain did not call out the published procedure which worried him. But he observed that the captain complied with a "*logical*" procedure: nose down to descend, reduce thrust and extend the speed brakes.

On putting on his mask, the captain lost his headset and was without it up to the end of the flight. The captain could not hear the ATC exchanges and the copilot thought that the captain could not hear him either.

The copilot specified that this created stress and an additional difficulty as he was obliged to shout and repeat himself in order to make himself heard.

His first call was to warn the control that they had started an emergency descent. He then declared a "*PAN PAN PAN*" as he considered that there was no fire aboard and, according to him, the situation was not that serious.

When the captain said "MAYDAY" out loud, the copilot interpreted this message as an attempted exchange with the ATC. Having understood that the captain no longer had his headset on and having detected the engine problem, he pointed to the information concerning engine 1 with his finger after the transmission of the "PAN PAN PAN" message.

He did not hear the TCAS TA[7] warning.

[7]Traffic Advisory.

He then asked the ATC to vector them to Paris Le Bourget airport as the aeroplane was not far from it and he knew the airfield and procedures well. In addition, the charts for closer airfields were not displayed on the Multi-Function Display (MFD) and he did not know the frequencies and approach procedures for the other airfields. However, there was Jeppesen documentation on the aeroplane.

He said that if the "*engine oil pressure*" warning continued to sound, this was because it was not switched off by the captain. When the copilot asked him if he should switch off the warning, the captain did not reply which worried the copilot and increased his stress. He sometimes thought that the "*captain was no longer apt*" as the latter did not reply to his calls. In any case, the captain talked very little.

When the ATC instructed the crew to turn to a heading of 290, the copilot told the captain. He then started to have doubts as he saw the captain was constantly turning the heading bug. He nudged him with his elbow to make him react.

The copilot finally switched off the "*engine oil pressure*" audio warning at 05:50:45.

The copilot did not know how far down the captain wanted to descend. When the captain asked him to tell the ATC that they have a fire on board, the copilot did not know if there was really a fire.

When they were on heading 040, the smoke had cleared. The pilot then set the ILS on the RTU[8] to 109.5.

[8]RTU: Radio Tuning Unit.

On short final, the glide slope warnings started to sound. He was not worried because the weather conditions were good and he knew that the captain had the habit of "ducking under" the path in short final.

He added that all the training/checks he had had, were on the aeroplane and with the instructor pilot. He had not carried out an emergency descent, or performed any exercises in the presence of smoke or in putting on a mask in the airline.

The copilot said that his eyes stung after the incident.

2.2 Aircraft information

2.2.1 General information

The Cessna 525B is certified under FAR 23 in the single-pilot High Performance Aircraft Certification (HPAC) category.

The aeroplane is equipped with two WILLIAMS INTERNATIONAL FJ44-3A engines (PN 67000-200). On the day of the incident they had each logged flight hours of 812 h 10 min.

2.2.2 Examinations of left engine

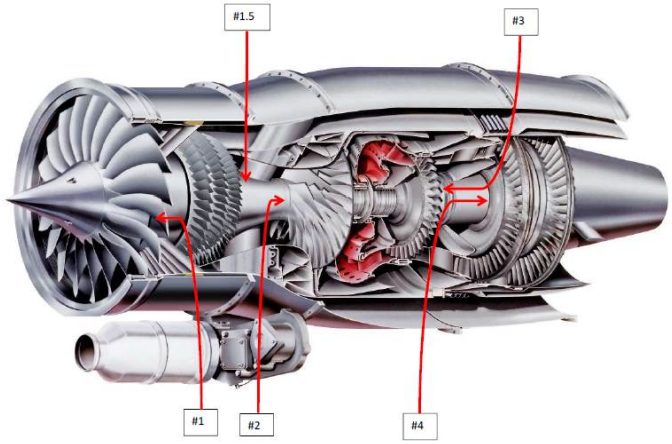
After the incident, there was no sign of external damage on the left engine There were faint traces of oil on the rear of the aeroplane.

Left engine of F-HCIC

The engine was sent to the manufacturer in the United States for examination.

An initial visual examination of the engine found that there was no oil and that the magnetic plugs on the reduction gearbox and oil tank had metal particles on them.

During disassembly, failure of the No. 2 bearing was detected.



No. 2 bearing

The No. 2 bearing holds the N2 high pressure shaft. The failure of this bearing resulted in the shaft moving. The consequences of this movement included secondary damage to the components of the high pressure shaft and the bearing seals.

Metal particles spread through the lubrication system and damaged all the engine bearings.

It was not possible to determine the cause of the failure of the No. 2 bearing due to the extent of the damage resulting from the incident.

The damage to the bearing seals led to an oil leak in the engine body. On coming into contact with the hot parts, the oil burnt and the smoke produced spread into the cabin through the air conditioning system.

History of bearing

According to the manufacturer, there had already been thirteen cases of similar failures for this type of bearing between 4 March 2009 and 22 July 2013. In nearly all the cases, odours and/or smoke appeared in the cabin. The manufacturer said that in the cases mentioned, the crew managed to control the situation and stop the arrival of smoke by shutting down the defective engine. The incident to F-HCIC was the most serious incident recorded in terms of density of smoke.

The manufacturer specified that in the event of failure, oil fumes can spread in the cabin. The pilots have protective goggles and oxygen if necessary. When the pilots shut down the engine as indicated by the procedure, the production of oil fumes ceases and just a few minutes are necessary to evacuate the fumes present in the cabin.

The manufacturer said that the No. 2 bearing P/N 55666 can have high amounts of unbalance which can then lead to its premature wear. This bearing should be replaced in Check 4 (general overhaul) of the engine.

An intermediate solution with a bearing P/N 79026 was designed. The manufacturer issued a Mandatory Service Bulletin stipulating that the bearing had to be replaced with this new type (P/N 79026) in the next Hot/Cold Section Inspection or when the bearing was accessible. At the time of the incident, one in five engines had this bearing. F-HCIC was not equipped with it. Today, there are around 1,000 engines of the same type as the F-HCIC engine. The manufacturer then introduced a new bearing P/N 118017; no failure of this bearing had been reported on the date of issue of this report. They accelerated the replacement of the original bearing by publishing a Service Bulletin requiring the replacement of the bearing in check 3 (hot section). The replacement of the bearing remains mandatory in check 4 (general overhaul). The manufacturer specified that in February 2017, 53% of the original bearings had been replaced.

2.3 Organizational and management information

2.3.1 Operator

The operator holds an Air Transport Certificate issued by the DSAC NordEst (French north east civil aviation safety directorate). Its operation are overseen and its Operations Manual (OM) was approved by the DSAC (French civil aviation safety directorate). The checks relating to the oversight of the airline did not bring to light notable deviations in connection with the incident.

The Airailes OM states that the C525B F-HCIC is a certified single-pilot high-performance aircraft but is operated with more than one pilot in the scope of commercial air transport.

The aeroplane is operated in compliance with the manufacturer's procedures (part B of OM).

The division of tasks between the captain and the copilot was determined by the operator. The emergency procedures are given in detail as are the programmes for the recurrent training and checks on the Cessna Citation. They can be carried out on the aeroplane or in a simulator. The examination of the programmes showed that the captain had carried out a simulated emergency descent/fire and smoke exercise on aeroplane, in March 2012. The copilot had not yet carried out this exercise in the airline. He had carried it out in a simulator for his Type Rating in November 2011.

Four operational procedures concern the incident and are given in Appendix 1. The procedures in the inserts are to be carried out from memory. The main procedure actions are summarized below:

Engine failure or commanded engine shutdown

The priority action, assigned to the PF, is to set the power lever of the engine concerned to: "OFF ". This action must be cross-checked by the PM.

The procedure specifies that the crew should do this without haste in order to reduce the risk of error. The PF must next shut down the ignition system and generator. The PM must then cut off the synchronization and monitor the battery charge.

Smell of smoke from air conditioning system

From memory, the two crew must put on their mask and set the microphone to MIC OXY MASK. Next, if necessary, they put on their protective goggles and check that the passengers have their masks and are supplied with oxygen.

The PM then tries to determine where the smoke is coming from by switching the air source to the left engine. After waiting and if the smoke persists, he must set the air source to the right engine. If the smoke persists, he must descend and select the Fresh Air position.

Dispersal of smoke

The procedure is the same as that described above, up to the passenger item. Depending on the electrical configuration, the cabin altitude must be increased and an emergency descent performed according to the situation.

Emergency descent

From memory, the PF must call out the procedure, cut off the AP, reduce power using the two power levers, bank the aeroplane by 30° [(9)] and establish a pitch of - 7.5°. From memory, the PM must extend the speedbrakes. During this phase, each crew member has specific, distinct actions which isolate them in their task.

In a second phase, the PM must monitor that the aeroplane speed is equal to VMO/MMO, then squawk 7700 on the transponder and send a message to the ATC. The aeroplane must be landed as quickly as possible.

[(9)] The purpose of this manoeuvre is to exit the airway.

2.3.2 Air traffic services

The objectives of the air traffic services are to prevent collisions between aeroplane, expedite and maintain an orderly flow of air traffic and provide advice and information useful for the safe and efficient conduct of flights.

The airspace in the Paris region is managed by three ATC centres which cover interlinked spaces corresponding to the envelopes of the TMA departure and arrival flight paths.

The Paris ACC covers the airspace over the Paris CDG and Paris Orly TMA. The TH and LN sectors of the Paris ACC manage the westward departures and incorporate the Paris Orly and Paris CDG traffic departure flows.

The three control centres have developed their own display parameters which correspond to the specificities of the traffic for which they are responsible. In particular, the Paris ACC does not have displays showing the P23 low altitude area or the intermediate approach procedures to Paris CDG which are in force.

The Paris ACC has a manual, procedures and training for its personnel, notably for emergency situations.

In cases of emergency or distress, the aeroplane must be given priority. It is given the ATC's maximum attention (SERA 11005).

Situation at Paris ACC

The controllers follow regular training in handling emergency situations. In the event of an emergency descent, the controllers consider that the aeroplane is in distress. At the Paris ACC which was in contact with the aeroplane at the time of the incident, there is an emergency instruction sheet for this situation for the control room supervisors. This sheet, shared with the position controllers, states:

CRNA/Nord Service Exploitation	Fiche réflex CDS	Détresse Date : 10/09/2012

DETRESSE

Manuel CDS 2.5 p 11

Un aéronef est en situation de détresse lorsqu'il court un danger grave et qu'une assistance immédiate lui est nécessaire. Un état de détresse est connu soit:

- Par réception d'un message de détresse (MAYDAY 3 fois)
- Par affichage du code transpondeur 7700
- Par réception d'un message relatant une situation de détresse (hors balises reçues)

Actions CdS:	Effectuée par:	Heure UTC:
Faire confirmer l'affichage du code 7700		
S'assurer que le contrôleur a demandé ses intentions au pilote et peut lui fournir l'assistance nécessaire		
Si nécessaire et possible, faire isoler l'aéronef sur une fréquence		
Relever la position et la route suivie de l'aéronef		
Alerter le BTIV, qui déclenche une DETRESFA et avise le CCS		
Recueillir par le BTIV les infos complémentaires du Plan de vol		
Alerter les terrains ou centres potentiellement utiles ou concernés		
Prévenir le RPO, qui avisera la hiérarchie du Centre, le BEA et la DSNA/DO; éventuellement l'opérateur		
Prévenir le DMC		
Demander à la MO un vidage STR		
Remplir le formulaire Alerte Accident-Incident (BTIV)		
Noter dans le cahier de marche les actions entreprises		
Collecter les pièces et les renseignements pouvant être utiles à une enquête		
Si nécessaire, faire une revisu rapide		

In the case of the incident, the controllers acted from memory.

2.3.2.2 Controllers' witness statements

Note: The controllers were seen at the same time. Their joint witness statement is summarized below.

At the time of the incident, three controllers were in position: a planner controller instructor (CTL A in this report), an executive controller (CTL B) and a planner controller trainee in training. A controller C went past the trainee position and due to the high work load generated by the incident, the trainee handed over the position to CTL C who then became the second planner controller for CTL B.

The controllers emphasized that there were few exchanges with the crew and that these were relatively spaced out. However, the work load was very high as they had to carry out a lot of coordination and the two position telephones were in constant use. They were worried that they might lose the aeroplane from the frequency.

The controller actions during the incident and their concerns are given below:

- CTL A contacted the De Gaulle Departure ATC as the flight path of F-HCIC was initially in conflict with Paris CDG departures. He thought that the De Gaulle Departure ATC and the De Gaulle Arrival ATC could coordinate with each other;
- He stayed with the De Gaulle Departure ATC and then told them that another controller (CTL C) was in the process of coordinating with the De Gaulle Arrival ATC so as to avoid any interferences;
- Lastly, CTL A contacted the De Gaulle Arrival PG (INI coordinator);
- CTL C took charge of coordinating a minimum separation distance between F-HCIC and an Aigle Azur aeroplane, transferred from Paris Orly to Paris ACC, and then telephoned the De Gaulle Arrival ATC to obtain the radar vector headings to bring F-HCIC to Le Bourget. Lastly, he relayed the approach and landing clearances and retransmitted the warning from the Paris CDG Approach ATC regarding the aeroplane's altitude over Paris.

The three controllers did not notice that when CTL B requested that F-HCIC change frequency, his request was not heard by the crew. They thought that the absence of a response from the pilot indicated that he could not change frequency. Nevertheless, according to them, the frequency change in principle was not of serious consequence; there was smoke in the aeroplane and by not imposing the frequency change, they did not overload the crew.

They said that in their training they are made aware of errors in changing frequency and of the probability that pilots select the wrong frequency in an emergency situation. They therefore minimized the frequency changes for pilots.

During the incident, two frequencies were grouped together. It would therefore have been possible to select one to isolate the aeroplane if necessary. In addition, the controllers said that they could always use the emergency frequency 121.5 as a last resort.

With respect to the display and compliance with the emergency instruction sheet, the controllers said that their priority was managing the emergency in real time rather than strictly following the procedure.

When a crew declares smoke or an emergency descent, the controllers consider that the aeroplane is in distress whether there has been a MAYDAY message or not.

During the incident, the controllers did not ask the pilot to squawk 7700 on the transponder for several reasons:

- as the pilot's work load was very high, they considered that he should not be disturbed;
- the 7700 code ensures that the aeroplane is seen by everyone. In the Paris area where the aeroplane was located, it was "*visible to everyone (controllers and aeroplanes)*".

One controller said that in such an emergency situation, he would find it difficult to quickly give the crew accurate heading and distance information for airports close by. Another controller considered, on the contrary, that given the elements present on their radar screen, it was possible to give this type of information.

However, all agreed that given the heavy traffic at Paris Orly and Paris CDG airports, they would hesitate whether to give an aeroplane in distress information regarding airports nearby as the probability of a conflict with other traffic would be very high.

It was the control room supervisor who was informed of the serious incident and who took charge of the coordination with the Flight Information Office.

After the incident, the controllers were relieved. An event notification sheet (FNE) was subsequently written. There was no Local Safety Commission for this incident.

2.3.3 Regulatory aspects

With respect to flight crew recurrent training and checks and the regulatory requirements for Licences, the following points were noted:

Recurrent Training and Checks

The EU OPS regulations in force at the time of the incident did not impose the carrying out of flight crew training and operator proficiency checks in a FSTD[10] type simulator.

Discussions between the DSAC (French civil aviation safety directorate) and High Performance Aircraft (HPA) operators concerning this point had taken place. Due to strong economic constraints, operators did not want the DSAC to impose simulator training only for operator proficiency checks. The DSAC underlined that moreover regulations require revision and training in major system failures at least every three years (para 7.3 below). Carrying out these sessions exclusively on aircraft does not comply with this important point (e.g. "Smoke", "windshear", etc. exercises).

This is why an annual programme performed on an aircraft is accepted subject to the precise definition, in part D, of a three-year programme indicating the exercises selected and specifying the means used for training in them. The annual programme must be drawn up with reference to this three-year plan and its approval is subject to compliance with this plan.

Licences

The exercises for the renewal of type rating under PART-FCL are described in its appendix 9. The emergency descent exercises can be carried out in the aeroplane or in a FFS[11].

However, in view of the difficulties expressed by operators as to training costs in FFS, the DSAC drew up an alternative AMC to PART-FCL with respect to complex HPA. It specifies that for certain FCL training and checking items which normally have to be performed in an aeroplane or FFS, it is possible to use simulators without "motion" (such as FTD level 2 / FNPT II MCC[12] type simulators). The emergency descent exercise forms part of this.

[10] Since the change in regulations and the implementation of the AIR OPS in September 2014, it is requested - as far as possible - to use a Flight Simulation Training Device (FSTD) to train in emergency procedures (reference AMC1 ORO.FC.230 Recurrent training and checking) or the aeroplane.

[11] Full Flight Simulator.

[12] Flight Training Device Flight and Navigation Procedure Trainer Multi Crew Cooperation.

BEA investigators carried out an emergency descent with fire and smoke in a FTD level 2 + FNPT II MCC type simulator equipped with a smoke generator. They observed that it was quite possible to carry out and manage in a pedagogical way, a fire, smoke and emergency descent procedure with this type of simulator.

Unlike what can be observed for heavy aeroplanes (for example Airbus, Boeing), FFS for Cessna Citations cost at least twice the price of the aeroplane. A FTD level 2 + FNPT II MCC type simulator costs approximately a third of the price of the aeroplane. For these economic reasons, training centres have not acquired a FFS but a FSTD. Consequently, there are very few FFS representative of HPAC aeroplanes in the world and practically no FFS in Europe.

2.3.4 Certification

The Cessna 525B is certified in accordance with standard FAR 23.

Generally speaking, paragraph 23.1309 states that:

> *The airplane equipment and systems must be designed and installed so that:*
>
> *(2) Any equipment and system does not adversely affect the safety of the airplane or its occupants, or the proper functioning of those covered by paragraph (a)(1) of this section.*

In particular, the aeroplane must be designed to minimize the risks arising from an engine fire. There is a specific requirement with respect to the spreading of smoke through the air conditioning system. Paragraph 23.1111 entitled Turbine Engine Bleed Air System states in sub-paragraph (c):

> *(c) Hazardous contamination of cabin air systems may not result from failures of the engine lubricating system.*

The aeroplane manufacturer advised that the certification requirements of these paragraphs had been met by similarity with a previous aeroplane, the Cessna 525A. No flight test was carried out to validate these requirements.

The aeroplane manufacturer said that they had not carried out a risk analysis or flight test in compliance with paragraph 23.1111 with respect to failure of the lubricating system.

The engine manufacturer said they they monitored the failure modes of their engines and that their analysis did not show new failure modes with respect to this incident.

3 - LESSONS LEARNED AND CONCLUSION

3.1 Flight operations

Before the smoke appeared, the crew did not have any particular concerns. The aeroplane was climbing to its cruise altitude in manual flight and was above FL100. The PF's main tasks were to monitor the primary instruments and the automatic pilot modes of the aeroplane in order to follow the departure flight path. From time to time, he also had to monitor the engine parameters. The PM had to ensure the radio exchanges and monitor the actions of the PF. The work load in this climb phase was not high.

When the smoke filled the cockpit, the situation instantaneously became difficult to manage for the crew. The captain could not clearly see the instruments, and he could neither communicate with the copilot nor the ATC as he had lost his headset.

The crew instantaneously lost control of the flight path and there was a real risk of them losing control of the aeroplane.

The element of surprise was all the greater in that there had been no forewarning allowing the crew to anticipate a problem of this kind. The fluctuations in the oil pressure recorded by the FDR were not sufficient to warn them of the nature of the danger to come. On seeing the thick smoke fill the cockpit, the two pilots did not assess the situation in the same way. The copilot thought that they were in an emergency situation but not in distress. The captain thought that the aeroplane was on fire and had in mind the scenario of the Swissair aeroplane accident in September 1998[13]. His aim was therefore to descend and land as quickly as possible. The analysis of the facts confirmed that the aeroplane was in distress as soon as the smoke appeared.

[13] http://www.tsb.gc.ca/eng/rapports-reports/aviation/1998/a98h0003/a98h0003.pdf

After the smoke appeared, the captain prioritised control of the aeroplane and management of the flight path. Some of the crew's actions and the consequences of these actions did not correspond to what was stated in the OM and affected the safety of the flight.

The main concerns are:

- neither crew member had time to put on their protective goggles. Yet the smoke was thick and this could have caused difficulties – especially for the captain – or at the very least discomfort. The QRH was not used by the captain because of the urgency and he therefore could not make sure he had remembered everything on the checklist, and the copilot could not check his actions;
- overspeeds occurred during the descent due to the aeroplane having excessive pitches. However, these were corrected through positive action by the copilot;
- in general, the captain acted alone. In particular, he shut down an engine without announcing this to the copilot. Not all the items on the checklists were performed. The teamwork and communication between the two crew members were almost non-existent;
- the captain did not attempt to switch the air source selector to the left, then to the right. He switched it straight to "Fresh Air". This stopped feeding the smoke into the cockpit but also depressurized the aeroplane. The FAA emphasizes that switching the air source selector to the right would have evacuated the smoke more quickly. The serious incident occurred at a medium altitude (FL 180). The emergency descent was rapid because the aeroplane descended through FL 100 in approximately 1 minute and 40 seconds. As there was residual pressure in the cabin above FL 100, the cabin altitude probably did not reach extreme values causing severe hypoxia;

- the captain took a long time to react to the heading and altitude orders given by the ATC and relayed by the copilot and therefore to enter a safe flight path. Playback of the CVR strongly suggests that the captain was partially unable to follow these orders during the descent when the smoke was dense and he could not read the instruments. The copilot had to yell the heading 290 to the captain a number of times but the captain did not respond. It took more than a minute for the captain to react to the shouts, and that is why the aeroplane flew over Paris, while still descending;
- the aeroplane came close to conflicting traffic, losing separation (triggering a TCAS warning).

The presence of smoke or even fire is one of the most stressful situations for a crew. In principle, the crew is supposed to identify the cause of the malfunction. During the incident, the captain did not realise that the smoke that filled the cockpit in a few seconds was caused by a simple engine malfunction. He thought that there was a fire, even though there was not. There was no obvious indication that the fire assumption was incorrect.

Reacting to an assumed fire on board and to an unexpected and worrying situation, given that the smoke filled the cockpit in seconds, the captain had to cope with a very heavy workload. He had to handle several procedures in a very short time: smoke coming from the air conditioning system, an emergency descent, engine failure or commanded shutdown, and dispersal of the smoke. He also had to land as quickly as possible before the fire made the aeroplane condition and controllability any worse. During the descent, he also had to manage the flight path to reach an accessible airfield as quickly as possible while avoiding the risk of collision with another aeroplane. It was therefore not always possible to follow the procedures as planned because of the dynamic operational conditions.

The incident also shows us that, in a situation of haste and urgency, the captain could not communicate with the copilot because he had lost his headset and could not easily find it again. This failure, which could reoccur in similar circumstances, had a major impact on the success of the various actions planned to manage this type of situation.

For these reasons there was no teamwork. The captain mainly acted alone and performed the vital actions relying on his extensive experience. He managed to extend the airbrakes, set the engines to idle, shut down the generator, shut down the malfunctioning engine and close the air conditioning by which the smoke was filling the cockpit. But he was not able to control the overspeed or manage the flight path on his own without positive intervention from the copilot. The copilot was also stressed by the lack of communication, but did not immediately consider it necessary to declare an emergency (MAYDAY). However, this did not have any consequences for the ATC. Procedure states that, in situations of absolute urgency such as fire or smoke on board, an aeroplane should land as quickly as possible. However, the copilot asked to return to Paris Le Bourget even though airports such as Villacoublay and Paris Orly were closer.

Contrary to normal practice, the captain was unable to participate in making this decision because he had lost his headset. At this point the smoke was still present and it was difficult for him to be sure that he could quickly bring the situation under control. The event highlights the fact that crews do not necessarily choose the option enabling them to land as quickly as possible. The report on the accident to flight SWR 111 also highlights the difficulty for a crew of making quick decisions enabling them to land as quickly as possible in the event of a fire.

In the incident, management of the dispersal of the smoke and the emergency descent did not correspond to the operating procedures. Emergency procedures as complex as the ones provided for this incident cannot be considered safe if they are not the subject of training. In the context of the incident, the DSAC acknowledged that carrying out these sessions exclusively on an aeroplane does not make it possible to satisfactorily train for major system failures with respect to this essential point. It is illusory to imagine that appropriate training can be given in flight because, in practice, it is impossible to properly simulate smoke or an emergency descent. The copilot had not carried out this procedure since obtaining his type rating and the captain had simulated it on an aeroplane the year before the incident. The investigation showed that the new FSTD type simulators (convertible to FTD level 2/ FNPT II MCC) can be used to train crew appropriately in these procedures and also solve the problem of coping with the excessively high cost of FFS.

Maintaining separation between aeroplanes is required even in emergency descents, which seems almost impossible in practice. A TCAS warning was triggered during the emergency descent, signifying diminishing separation between the Cessna and another aeroplane. Only the ATC could separate other aeroplanes from the Cessna to avoid any conflict. Because the captain could not see the instruments clearly, he could not comply with the radar vectors provided by the ATC to maintain the separations or follow the TCAS warning instructions. Overflying Paris in descent is another example of the lack of control of the flight path. Compliance with obstacle clearance depended on the amount of time available to the crew for regaining better control of the flight path.

The crew members used a formal form of speech to address each other (*vouvoiement*). This created a climate that was not conducive to teamwork and contributed to an authoritarian relationship between the captain and copilot. This practice is very rare in aviation circles, but is the culture within this airline. It bothered the copilot. In emergencies, the synergy of the crew is essential. Since the incident, the captain has reverted to using the familiar form (*tutoiement*).

When the smoke was present, neither of the two crew members put on protective goggles even though it was necessary, in all likelihood because the actions to be performed to put on the goggles are more complex and take more time. Yet the captain was probably unable to read the instruments properly during the emergency descent, as suggested by his erratic actions on the heading bug and his lack of reaction to the aeroplane overspeeds and the copilot's many loud yells. The use of a full-face mask could remedy this problem, giving better protection. In any case, the incident shows that this safety procedure is fragile. Most light twin-engine HPA are not equipped with full-face masks.

In the light of this incident, the question arises of the feasibility of a single pilot managing this type of emergency situation in an HPA. The copilot actively operated the flight controls several times during the incident to assist the captain. The crew's workload could also have been even greater if there had been passengers on the aeroplane, because the crew would have had to help them put on their oxygen masks. Flight tests under similar operational conditions appear to be necessary to take into account these emergencies during certification.

3.2 Air traffic control

There were few exchanges between the crew and air traffic control during the incident. Playback of the CVR and the ATC communications show that the ATC did little to help the crew manage the emergency.

The three air traffic controllers had a high workload. This was due partly to the controllers' lack of understanding of the crew's ability to change frequency, to concerns about the difficulty of coordination in the case of flight paths unfamiliar to the controllers, and the desire to keep the crew's workload to a minimum, and partly to the fear of losing the aeroplane from the frequency.

The controllers from Paris ACC performed the tasks required in an emergency descent situation. As a priority they tried to minimise the risk of collision with other aeroplanes while ensuring the separation between aeroplanes. They then helped the pilot to return to Le Bourget.

This event shows that the risk of loss of radio contact with the aeroplane due to the distance was zero, even at low altitude. Because of a misunderstanding, the two planner controllers thought that the crew could not change frequency. As a result, they spent all their time coordinating the position and the clearances given to the aeroplane with the adjacent sectors.

The interviews with the controllers show that they did not want to unduly intervene on the frequency so as not to overload the crew. This concern was supported by their recurrent training. Although this is a legitimate concern, it should still be qualified. Managing other aeroplanes at the same time and the lack of a decision to ungroup them possibly reinforced their intention not to intervene with respect to the crew in difficulty. In addition, not squawking 7700 on the transponder prevented all the air traffic controllers from recognising the specific nature of the situation, although the highly unusual flight path in these interlinked spaces would undoubtedly have alerted other Departure and Arrival controllers at Paris CDG and Paris Orly.

Generally, the presence of thick smoke on board an aeroplane is one of the most difficult distress situations for a crew to manage. From a safety point of view, one of the priorities is to land as quickly as possible because time is a decisive factor in chances of survival.

The incident shows that the crew members had great difficulty controlling the flight and the flight path while there was smoke present. However, the crew did not land as quickly as possible at the nearest airport, as required by all the distress procedures. It is generally pilots who ask the ATC to land as quickly as possible or who inform it that that is their intention. In this case the crew was not able to do this. From this moment, assistance from ATC was essential to them. While smoke was present, the crew could not be sure that they would have time to return to Le Bourget.

The emergency instruction sheet should therefore encourage controllers to ask crews whether they want assistance with landing at one of the nearest airfields. This would help them to make a decision based on the situation.

An example worth mentioning is the accident to the Airbus A320 on 15 January 2009, which landed on the Hudson River in New York.[14] After the distress message was sent by the crew, ATC spontaneously offered radar headings to the nearest airfields numerous times.

[14] http://www.ntsb.gov/investigations/AccidentReports/Reports/AAR1003.pdf

In the F-HCIC incident, the controllers' ongoing training meant that they were able to give the location of the nearest airports and to suggest a direct route if one was requested. They did not do this because some of them were reticent to do so, particularly because of the loss of separation that these unexpected flight paths might cause in this complex air space, controlled simultaneously by the Paris CDG and Paris Orly Approach ATC. Writing air traffic control procedures and giving training that enables the controllers at Paris ACC to direct an aeroplane in an emergency situation to the ground requires close coordination in advance with the Paris CDG and Paris Orly approach organizations.

3.3 Failure of a part of the lubricating system and consequences

The safety principles regarding the No. 2 bearing and the certification regulations did not function as planned and were compromised in the F-HCIC incident.

The simple failure of the No. 2 bearing led to failure of the engine and the rapid spread of smoke and odours in the cockpit, compromising the protections provided by the certification regulations.

As this failure could not be anticipated by an inspection, the bearing had to be replaced as a precaution at each general overhaul of the engine. Around 1% of engines of the same type as the one on F-HCIC have experienced similar failures.

This failure should not lead to hazardous contamination of the cockpit, contrary to what was observed in the incident and in the other 13 similar cases where smoke appeared.

Both Cessna and the certification authorities considered that the crew shutting down the engine constituted a sufficient protective barrier. This rationale is valid in cases of simple engine malfunction. In the case of F-HCIC, the sudden appearance of thick smoke put the crew in serious danger and made it very difficult to control the aeroplane's flight path for a time.

The certification does not seem to have taken account of the observed deterioration of the bearing, or of its consequences for the appearance of smoke in the cabin.

In addition, the safety analyses of cases of failure of the bearing were inadequate. They consisted of relying solely on the crew having the right reaction in these circumstances, even though the safety regulations emphasised the hazardous consequences of smoke in the cockpit and explicitly stated that this must not come from the lubricating system. But this did not prompt those involved to take measures commensurate with the risk, which has clearly been underestimated. No flight test has been carried out on this model of aeroplane to check that the procedures given were realistic.

In view of the serious consequences of the failure of this part, strong measures must be taken to prevent its recurrence and/or consequences. The manufacturer's new S/B improves the reliability of the bearing through the introduction of a new bearing design. In any case, closer monitoring of bearing failures is necessary in the future to prevent their effects.

4 - 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 authority in charge of safety investigations that have issued them, on the measures taken or being studied for their implementation, as provided for in Article 18 of the aforementioned regulation.

4.1 Air Operations

The crew was not sufficiently trained on application of the fire/smoke or emergency descent procedures. These procedures cannot be reasonably simulated in flight. The European Air OPS regulation in force allows for the use of different types of FSTD simulators while the part FCL regulation makes mandatory the FFS level for emergency descent exercises. Due to the prohibitive cost, FFS simulators are not available. Today, fixed FSTD simulators can answer the requirements for crew training in emergency situations on HPA aircraft.

Consequently, the BEA recommends that:

- **EASA amend the regulations so as to authorise, in the context of FCL, the use of types of FSTD simulators with a lower level than FFS during smoke or emergency descent training on Cessna 525B aeroplane types and, more generally, on complex HPA aeroplanes. [Recommendation FRAN-2017-001]**

When the smoke filled the cockpit, the Captain lost his goggles and his headset. Due to the absolute necessity to descend, he did not have time to don his spare goggles. The co-pilot didn't don his goggles either and his eyes stung after the incident. In an emergency situation, it is difficult to quickly don a protective mask and protective goggles when smoke appears in the cockpit. A full-face mask allows time to be saved and better protects crew members. A search in the DGAC database for event reports brought to light crew reports relating to the difficulty in the use of separate masks and goggles.

Consequently, the BEA recommends that:

- **EASA, in cooperation with the FAA, study the in-service experience on the use of masks with separate goggles compared to the use of full-face masks, and that it draws conclusions on making it mandatory for full-face masks to be installed on HPA type aeroplanes mainly used for commercial air transport. [Recommendation FRAN-2017-002]**

4.2. Air Traffic Services

The situation of this serious incident made it essential to land as fast as possible without wasting any time. When the smoke appeared, the crew was not able to land at an airport without outside assistance. The crew returned to Le Bourget without being sure of making it there safely. In the emergency sheet at the Paris ACC, it is not specified that controllers systematically offer assistance to crews on the nearest airports in an emergency situation, while allowing the latter to take the decision on the conduct of the flight.

Consequently, the BEA recommends that:

- **DSNA ensure that, in the case of a MAYDAY declaration, air traffic controllers systematically inform crews of the location of the nearest airports and ask them if they wish to receive assistance to land at one of them. [Recommendation FRAN-2017-003]**

4.3 Airworthiness

The investigation showed that a recurrent failure on the No. 2 bearings on FJ44 type engines on Cessna C525B brought a quantity of smoke into the cabin that strongly compromised the crew's ability to keep control of the flight. This is in contradiction with paragraph 23-1111, which states that "Hazardous contamination of cabin air systems may not result from failures of the engine lubricating system."

Consequently, the BEA recommends that:

- **FAA review Cessna 525B conformity with 23-1111. [Recommendation FRAN-2017-004]**

And that, while waiting for compliance, the BEA recommends that:

- **FAA make it mandatory for Williams to modify the engines in service to eliminate problems from oil leaks associated with bearings on type FJ44 engines. [Recommendation FRAN-2017-005]**

The investigation showed that a complete application of the procedures planned by the manufacturer in case of smoke in the cabin were complex and very difficult to apply, in cases of thick smoke. It is likely that these difficulties would have been much greater in cases where a pilot was alone on board.

Consequently, the BEA recommends that:

- **FAA ensure that Cessna demonstrates the soundness of its procedures in cases of smoke on board for Cessna C525 type aeroplanes or equivalent. [Recommendation FRAN-2017-006]**

APPENDIX 1

CESSNA CITATION PROCEDURES IN THE EVENT OF ENGINE FAILURE OR SMOKE

●❍Le cercle gauche noir s'adresse au pilote assis en place gauche et qui remplit le rôle du Pilote en Fonction (PF)

❍● Le cercle droit noir s'adresse au pilote assis en place droite et qui remplit le rôle du Pilote Non en Fonction (PNF)

3.3.1.2 Panne moteur ou arrêt moteur volontaire

● ●	**MANETTES DE POUSSEE (MOTEUR MORT)**…….. Les deux membres d'équipage vérifieront qu'il s'agit de la bonne manette et agiront sans aucune précipitation	OFF
● ❍	**IGNITION (MOTEUR MORT)**……	NORM
❍ ●	**ENGINE SYNC**……..	OFF
● ❍	**GENERATRICE (MOTEUR MORT)**……	OFF
❍ ●	**CHARGE ELECTRIQUE**…… Le PNF veille à ne pas dépasser la charge maximale admissible qui est de 300 A	REDUITE
● ❍	**FUEL TRANSFER**……	A LA DEMANDE
➨ **SI UN FEU SE DECLARE :**		
● ●	**BOUTON ENGINE FIRE**……..	SOULEVER LE CACHE ET APPUYER
● ❍	**ATTERRISSAGE**…….. Se référer ensuite à la Check List « APPROCHE & ATTERRISSAGE MONOMOTEUR »	LE PLUS VITE POSSIBLE
➨ **SI LES CONDITIONS SONT GIVRANTES :**		
● ❍	**WING XFLOW**…… Note . Le switch WING/ENGINE ANTI ICE peut rester sur OFF. En sélectionnant WING XFLOW, on permet d'alimenter les ailes du côté du moteur mort en air de dégivrage. . A une altitude élevée, il peut s'avérer nécessaire d'augmenter la puissance afin de maintenir la pressurisation	ON WING XFLOW
● ❍	**ANTI-GIVRAGE WING/ENG (MOTEUR VIF)**…..	ENG ON OU WING/ENG
● ❍	**DEGIVRAGE TAIL DEICE**……..	A LA DEMANDE
● ❍	**WINDSHIELD ANTI-ICE**……..	A LA DEMANDE
	QUITTER LES CONDITIONS GIVRANTES DES QUE POSSIBLE	

3.3.2.2 Odeur ou fumée provenant du système de conditionnement d'air

●	●	**MASQUES A OXYGENE**.....	POSES 100 % 02 ET EMER
●	●	**SELECTION DES MICROS**.....	MIC OXY MASK

NOTE

Le port de casques ou casquettes peut empêcher la pose rapide des masques à oxygène

●	●	**LUNETTES ANTI FUMEE**.....	MISES SI NECESSAIRE
●	○	**OXYGEN CONTROL VALVE**.....	MANUAL DROP
○	●	**OXYGENE PASSAGERS**.....	MASQUES TOMBES

Le PNF vérifie ici que les masques à oxygène des passagers sont tombés et que ceux-ci reçoivent l'oxygène.

●	○	**CONSIGNES PAX**.....	PASS SAFETY
○	●	**AIR CONDITIONNE**.....	OFF
○	●	**DEFOG FAN**.....	OFF
○	●	**AIR SOURCE SELECT**.....	LH

Le PNF essaie ainsi d'identifier la provenance de la fumée ou de l'odeur en ne sélectionnant qu'un des 2 moteurs pour alimenter la cabine en air. Le PNF veille à attendre que ce changement ait le temps d'être effectif, s'il doit l'être

➨ **SI LA FUMEE OU L'ODEUR NE SE DISSIPE PAS :**

○	●	**AIR SOURCE SELECT**.....	RH

On attendra quelques minutes.

➨ **SI LA FUMEE OU L'ODEUR NE SE DISSIPE TOUJOURS PAS :**

●	○	**ALTITUDE**.....	DESCENDRE, OU DESCENTE D'URGENCE SI LA SITUATION LE NECESSITE

Le PF descendra jusqu'à 10 000 ft ou à l'altitude sécurité du secteur, si celle-ci est supérieure à 10 000 ft en prenant garde de vérifier l'altitude de sécurité du secteur suivant.

○	●	**AIR SOURCE SELECT**.....	FRESH AIR

A la suite de cette manipulation, la cabine va dépressuriser. On n'alimentera donc plus la cabine en air avec les moteurs ce qui devrait permettre de stopper l'arrivée de la fumée, et de dissiper la fumée déjà présente par le fait de dépressuriser qui va faire sortir la fumée.

Si nécessaire, le PNF pourra se référer à la Check-List « Dispersion de la fumée ».

3.3.2.3 Dispersion de la fumée

●	●	**MASQUES A OXYGENE**.....	POSES 100 % 02 ET EMER
●	●	**SELECTION DES MICROS**.....	MIC OXY MASK

NOTE

Le port de casques ou casquettes peut empêcher la pose rapide des masques à oxygène

●	●	**LUNETTES ANTI FUMEE**.....	MISES SI NECESSAIRE
●	○	**OXYGEN CONTROL VALVE**.....	MANUAL DROP
○	●	**OXYGENE PASSAGERS**.....	MASQUES TOMBES

Le PNF vérifie ici que les masques à oxygène des passagers sont tombés et que ceux-ci reçoivent l'oxygène.

●	○	**CONSIGNES PASSAGERS**.....	PASS SAFETY
○	●	**AIR CONDITIONNE**.....	OFF

* **SI UNE ALIMENTATION DC NORMALE EST FOURNIE**

○	●	**CABIN DUMP**.....	DUMP

L'altitude cabine ne dépassera pas 15 000 ft environ avec AIR SOURCE SELECT sur L / R ou BOTH

●	○	**DESCENTE D'URGENCE**.....	SELON NECESSITE

Se référer à la Check List « Descente d'Urgence »

ATTERRIR DES QUE POSSIBLE

NOTE

Le voyant BAGGAGE SMOKE peut s'allumer si de la fumée ou autre contaminant pénètre dans le compartiment bagage arrière lors de sa sortie de la cabine.

* **SI ALIMENTATION NORMALE DC N'EST PAS FOURNIE**

●	○	**PRESS SYSTEM SELECT MANUAL LEVER**.....	UP

Pour obtenir une altitude cabine max

●	○	**DESCENTE D'URGENCE**.....	SELON NECESSITE

Se référer à la Check List « Descente d'Urgence »

ATTERRIR DES QUE POSSIBLE

3.3.2.6 Descente d'urgence

● ○	**AP TRIM DISC**	PRESSE PUIS RELACHE
● ○	**MANETTES DE POUSSEE**.....	IDLE
○ ●	**AEROFREINS**.....	SORTIS
	Le PNF vérifie que le voyant blanc SPD BKR EXTEND est allumé	
● ○	**ASSIETTE**	PIQUER INITIALEMENT DE 7,5°
	Le PF incline l'avion à environ 30° puis affichera initialement – 7,5° d'assiette	

ATTENTION
SI L'ON SOUPÇONNE UN DOMMAGE DE LA STRUCTURE, LIMITER LA VITESSE A UNE VALEUR RAISONABLE ET LIMITER LES MANŒUVRES JUSQU'A CE QUE LE DOMMAGE PUISSE ETRE EVALUE

● ○	**VITESSE**.....	M_{MO} / V_{MO}
○ ●	**TRANSPONDEUR**.....	7700 AFFICHE
● ○	**CONSIGNES PAX**.....	PAX SAFETY
○ ●	**MESSAGE RADIO**.....	EFFECTUE
	Le PNF prévient l'ATC et obtient les consignes relatives au calage de l'altimètre	
● ○	**ALTITUDE**.....	15 000 FT OU ALTITUDE DE SECURITE DU SECTEUR (LA PLUS HAUTE DES DEUX)
● ○	**BRIEFING PASSAGERS**.....	EFFECTUE
● ○	**ATTERRISSAGE**.....	LE PLUS VITE POSSIBLE

➡ **SI LES CONDITIONS SONT GIVRANTES :**

○ ●	**ANTI ICE / DE ICE SWITCHES**.....	SELON BESOIN