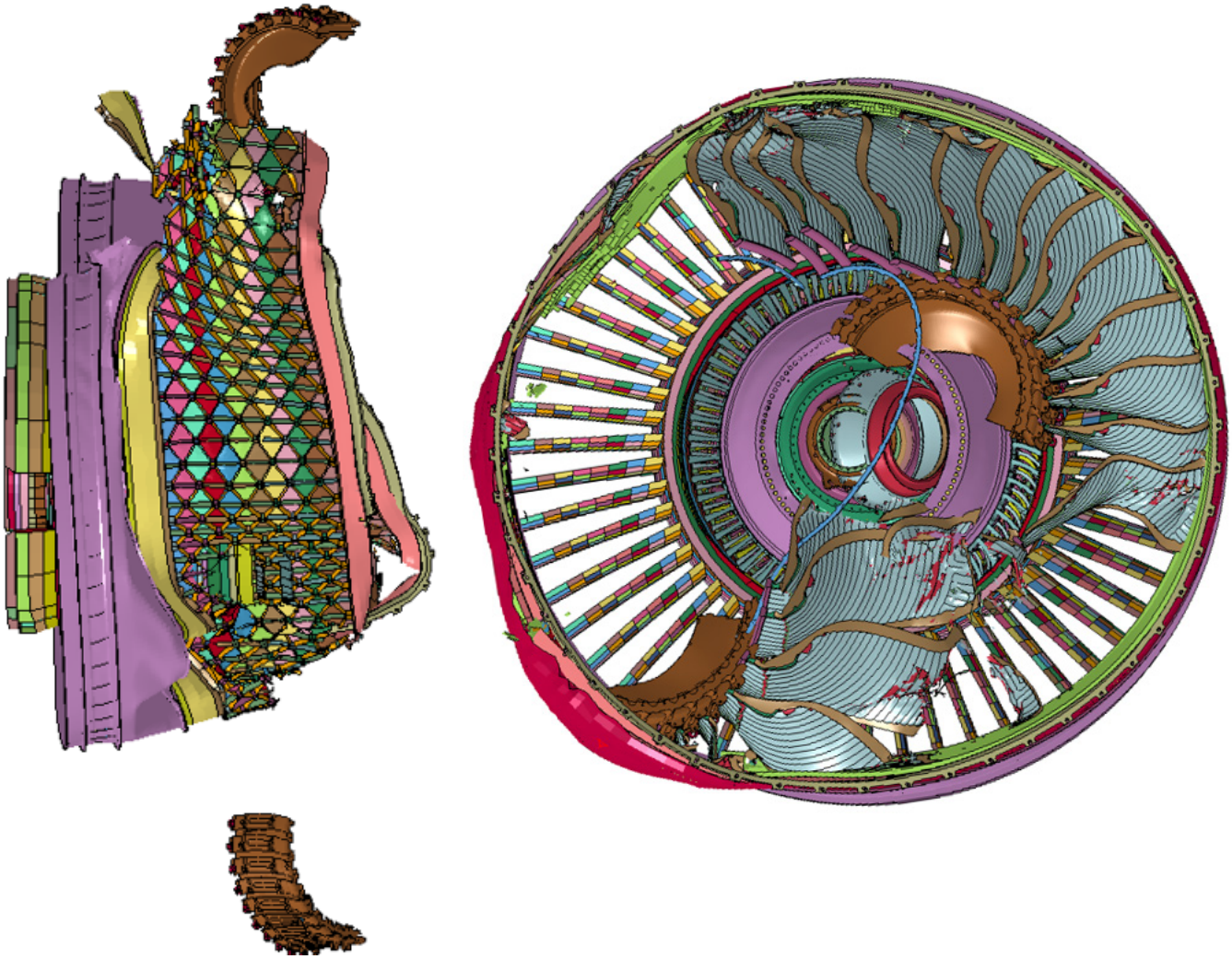
BEA

Bureau d'Enquêtes et d'Analyses
pour la sécurité de l'aviation civile



ACTIVITY REPORT 2020

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Safety together

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Cover illustrations:
Simulation of the fracture of the LS-Dyna fan hub (courtesy of Engine Alliance)
Accident to the AIRBUS A380 registered F-HPJE operated by Air France on 30 September 2017.

A MESSAGE FROM THE DIRECTOR

The BEA activity report is mainly aimed at two categories of reader: those reading the report now and those reading it in the near or more distant future out of historical interest.

Whilst those reading the report now are fully aware of the current context, it is perhaps important to remind those who will read this in the future that, globally, and for the civil aviation community in particular, 2020 was what is commonly referred to as an "annus horribilis". The COVID-19 coronavirus pandemic resulted in a number of Governments implementing lockdown measures and travel restrictions - notably international travel - resulting in a dramatic decline in commercial air traffic of around 70%, and periods of total or partial grounding of general aviation flights.

Whilst this situation interfered with the BEA's operation, overall it maintained its level of activity due to the commitment and versatility of its staff.

The number of investigations opened, and especially accredited representatives appointed to foreign investigation authorities certainly fell, but we were able to redeploy staff to work on on-going investigations. At the same time, the decline in the number of investigations opened was not as sharp as we had expected due, in particular, and contrary to what was happening in commercial aviation, to the fact that general aviation activity was relatively unaffected, with periods of national lockdown being offset by an increase in activity, and unfortunately also an increase in the number of fatal accidents during unrestricted periods.

I wanted this activity report to provide a detailed description of the organisation adopted during the first lockdown period, from 17 March to 10 May 2020. This description appears in the form of focus sections in the different chapters. The organisation, which was implemented rapidly, was based of course on nearly all of our agents working from home and sometimes requiring a number of adaptations. At the end of the first lockdown, the organisation was adapted during the interim periods, and then as health measures were stepped up.

Overall, the BEA's activity for this unusual year is finally quite positive. We published a record number of investigation reports, the stock of investigations in progress was considerably reduced, and the average duration of investigations was shortened. The BEA's performance indicators notably improved.

In terms of quality, the BEA, like all civil aviation players, of course questioned how the health situation and the drop in activity would affect safety. In terms of general aviation, an initial analysis of the investigations opened does not appear, at the moment, to suggest any specific trend. In terms of commercial aviation, we note several incidents where the health situation can be considered to be a contributing factor, although, up to now, the consequences have been kept under control or to a minimum. It is possible that these somewhat reassuring elements are the result of a collective awareness of the risks associated with this exceptional situation, and of the different actions introduced by safety stakeholders to prevent or limit them, notably through SMS and SSPs. In any event, we must remain cautious as, at the time of writing this report, air traffic is still at very low levels, and a date when normal levels of activity can resume is still unpredictable.

Lastly, I would like to recognise the commitment and availability of all the BEA staff, who really stepped up in 2020 in these very difficult conditions. Once again, I would like to thank them wholeheartedly. They can be very proud of their work!

Rémi Jouty, BEA Director

REPORT ON LOCKDOWN FROM 17 MARCH TO 10 MAY 2020 (1/10)

BEA organisation

Status of staff during the lockdown

National lockdown measures were adopted on Tuesday 17 March 2020 and were not lifted until Sunday 10 May 2020.

These measures notably prevented travel between home and the workplace except when working from home was not possible. Staff who were unable to work from home but who were unable to travel (for example due to childcare requirements) could apply for Special Leave of Absence.

Most BEA staff were able to work at least partially from home and most had the equipment they needed to do so (work laptop, work telephone, etc.). Moreover, staff without access to work equipment generally had their own equipment at home.

It is worth mentioning that the BEA's IT and telecommunication resources were configured some time ago so that staff can have remote access from their work computer (or private computer for some roles) and can schedule telephone and video conferences.

In these conditions, the BEA adopted the following measures on 17 March:

- The vast majority of its staff switched to home working.
- Travel between home and the work place remained possible to enable staff to come in to access elements required to carry out their work, or to carry out certain tasks that could not be carried out at home, in compliance with social distancing rules.
- Measures were adopted to enable around 10 members of staff to use private resources as they were initially lacking communication resources supplied by the BEA in order to enable them to avoid travel as much as possible (communication, with their prior consent, via their private phones or private e-mail accounts).
- In addition, most staff who did not have a work computer or telephone were provided with these as quickly as possible.

Teleworking in lockdown led to the existing individual telework agreements being put to one side. The new collective telework framework agreement was defined and circulated by the Director by e-mail. This framework recognised a number of circumstances specific to this exceptional situation, such as teleworking whilst looking after children. The BEA's head office was permanently manned by one person from the contracted security company.

Moreover, after consultation with staff representatives, all BEA staff were asked to take at least 3.5 days annual leave during the lockdown period.

Statistics concerning the number of audio and video conferences

The BEA is equipped with tools and holds subscriptions with telephone operators which allows it to organise teleconference calls (audio conferences), and web conferences (teleconference with document sharing and video exchanges). These tools are used in a normal situation principally to link up the different BEA sites (head office in Le Bourget and branches in Rennes, Bordeaux, Toulouse, Aix-en-Provence and Lyon). They were widely used to conduct work meetings during the lockdown period.

The number of exchanges during the lockdown period can be evaluated by looking at the telephone bills for the period 1 March to 30 April 2020 (32 working days in lockdown).

We note:

- **For Audio conferences**: 1,002 calls for a total duration of 714:36:20 (compared with 2 calls lasting 00:01:05 for the same period in 2019).
- **For Collaborative web conferences**: 1,321 calls for a total duration of 1649:33:03 (compared with 465 calls lasting 522:37:23 for the same period in 2019).

This therefore constitutes an extra 1,856 calls and 1,841 call hours in relation to the same period in 2019. If we break this down for the BEA's 96 staff members, this excess represents 36 minutes of participation in one meeting per staff member and per working day. Although there is no statistical data for work meetings held pre pandemic, these figures suggest that the lockdown had little impact on the meeting activity of the BEA's staff.

***Note**: these figures do not include simple telephone conversations between two employees: these are billed at the fixed rate and the conservation time is not known.*

IT support

In terms of IT resources, the BEA was relatively prepared for the lockdown. Due to the nature of its activities which require frequent travel (Go-Teams, international meetings, etc.) and the significant development of WFH, most staff were already equipped with laptops to enable remote access to the BEA's resources (network and applications) via a secure VPN, and with mobile phones; this situation facilitated the maintaining of communication between agents.

In the first week of the lockdown alone, we totalled around 80 daily VPN logins, and nearly all of our staff who were not equipped with the required equipment on 17 March were quickly provided with this equipment during the first days of the lockdown. In some cases, equipment stored pending recycling had to be recommissioned.

For information, the amount of data transiting via the VPN - extremely stable - totalled just over 800 GB for the period in question.

Note that for IT security reasons, access to some software is not authorised via the VPN. This is the case in particular for the DGAC finance management and human resources management software used by the BEA's Secretary General's office. As a result, some of these staff members were obliged to travel to their usual place of work.

The IT Section's workload was particularly heavy throughout the period, consisting notably in:

- ◊ Supporting users: 176 tickets were processed during the lockdown period with most issues being resolved remotely, either because no action was required on the user's computer or due to the user's computer being taken over via the TeamViewer software, in conjunction with telephone communication. In very rare cases, a member of IT staff and the staff member with the computer issues were required to travel (notably due to a suspected computer virus).
- ◊ Configuring loan laptops: to provide laptops to staff who were without one on 17 March, loan laptops were prepared and configured at the BEA, then on-site appointments were made - on different days and at staggered times - for the staff concerned to collect the laptops.
- ◊ Monitoring and supervising activities: with the lockdown period being very conducive to cyber crime, particular focus was placed on maintaining the integrity of the BEA's IT equipment (hardware and software) through daily monitoring and the application of updates and security patches as required. Specific focus was placed on e-mail servers, files, databases, as well as the backup system. Several operations (replacements of storage bay disks, resumption of the transfer of the monitoring of temperatures from the computer rooms to the duty desk) required travel to the site.
- ◊ Fighting against cyber crime: the number of phishing attempts rose nationally by 400% during the first week of the lockdown (source cybermalveillance.gouv.fr), and the BEA was not spared. There was also a resurgence in the number of spam e-mails and the number of fraud and blackmail scam attempts. More than 80 domains sending spam e-mails were blocked, along with the IP addresses and/or URLs of more than 60 phishing sites. Illegal attempts to access the e-mail system forced us to block access to e-mails from work phones throughout the period of lockdown. This measure may have had an unintended positive impact by encouraging staff to separate work time from downtime during the lockdown. The installation of a VPN protection on work phones has since enabled the messaging system to be accessed again.
- ◊ Continuing software development activities at the BEA: the development of the BEA Tython software for the management of staff training was continued, in liaison with the IT section and the BEA's training manager via phone and e-mail.

1. OVERVIEW OF ACCIDENTS, INVESTIGATIONS INITIATED IN 2020 BY THE BEA

Accident to the Cessna T303 registered HB-LUV on 4 December 2020 at Annecy-Meythet (Haute-Savoie).
Investigation in progress

1.1 GENERAL CONTEXT

The obligations of the Member States of the European Union in terms of Civil Aviation safety investigations are defined in European regulation No 996/2010.

The general principle of this regulation is that every accident or serious incident in the field of civil aviation shall be the subject of a safety investigation in the Member State of Occurrence. This requirement applies to all manned and unmanned aircraft (drones), except those listed in Annex I of regulation (EU) No 1139/2019 (the aircraft listed in this Annex are mainly non-certificated aircraft: microlights, aeroplanes of historic interest, etc.).

Exemptions are however provided for: "the responsible safety investigation authority may decide, taking into account the expected lessons to be drawn for the improvement of aviation safety, not to initiate a safety investigation when an accident or serious incident concerns an unmanned aircraft for which a certificate or declaration is not required [...] or concerns a manned aircraft with a maximum take-off mass less than or equal to 2 250 kg, and where no person has been fatally or seriously injured. "

Furthermore, Annex 13 of the International Civil Aviation Organization (ICAO) specifies that, when a safety investigation is conducted by a State (usually the State of Occurrence), the State of the Operator, the State of Registry and the State of Design and Manufacture of the aircraft involved are invited to participate in this investigation, by naming an accredited representative (ACCREP).

In France, the BEA is the authority responsible for safety investigations. Its procedures stipulate that, in addition to the investigations it has an obligation to conduct in accordance with the European regulations, it also investigates the following events:

- ◊ certain reported incidents, which are of particular interest for safety;
- ◊ fatal accidents involving aircraft listed in Annex 1 of regulation (EU) No 1139/2019;
- ◊ accidents involving certified aircraft weighing less than 2,250 kg, including those where no person was fatally or seriously injured;
- ◊ drone accidents which have resulted in significant consequences for third parties on the ground.

1.2 ACCIDENT DATA AND INVESTIGATIONS OPENED

1.2.1 ACCIDENTS IN FRANCE IN 2020

The data in the table below mainly comes from two sources:

- ◊ investigations conducted by the BEA;
- ◊ information provided by Field Investigators[1] with respect to "Annex 1" aircraft accidents that are not the subject of a BEA investigation.

Accidents in France in 2020				
	Number of accidents[2]		Number of injured people	
	Total	of which fatal	fatal	serious
COMMERCIAL AIR TRANSPORT				
Aeroplanes	0	0	0	0
Helicopters	1	1	1	0
Balloons	1	0	0	0
Commercial Air Transport Total	**2**	**1**	**1**	**0**
AERIAL WORK / SPECIALISED ACTIVITY[3]				
Aeroplanes	5	0	0	2
Helicopters	2	0	0	0
Microlights	2	1	1	1
Aerial Work / Specialised Activity Total	**9**	**1**	**1**	**3**
GENERAL AVIATION				
Aeroplanes	83	15	33	8
Helicopters	4	1	5	1
Gliders (including powered gliders)	14	2	2	4
Balloons	3	0	0	2
Microlights (including microlight helicopters)[4]	82	12	15	17
General Aviation Total	**186**	**30**	**55**	**32**
OTHER OR UNDETERMINED				
Aeroplanes	2	1	1	2
Microlights	1	0	0	0
Other or Undetermined Total	**3**	**1**	**1**	**2**
TOTAL	**200**	**33**	**58**	**37**

[1] See § 1.2.5.

[2] The number of accidents recorded may differ from the number of damaged aircraft or aircraft involved in accidents, in particular because an accident may involve several aircraft.

[3] Accidents occurring during the aerial activities listed under GM1 SPO.GEN.005 associated with Regulation (EU) No 965/2012 are counted under the "aerial work/specialised activity" heading even if the flights involved do not formally meet the requirements of PART SPO of this Regulation.

[4] Local microlight flights for remuneration are included in the "general aviation" category.

Comments about accidents in France in 2020

In terms of commercial air transport, we note a fatal accident involving a helicopter and a balloon accident resulting in material damage. The number of commercial transport aeroplane accidents observed each year is usually very low. The occurrence of zero accidents of this type in 2020 is consistent with this observation, and with the context of the very marked decline in air traffic due to the pandemic (70% fewer commercial air transport passengers).

In terms of other types of operation (aerial work and general aviation), the number of accidents on French territory was down 12% versus 2019. This slight decline arguably corresponds to a sustained light aviation activity (general aviation and aerial work) despite the health situation and despite this activity only being partially measured. It is noted that despite the reduction in the number of accidents, the number of fatal accidents rose by 11% and the number of victims rose by 51%.

A more detailed description of the types of accident in general aviation, which includes almost all victims in 2020, is included in chapter 3.

More information about the distribution of accidents per aircraft category and operation type

Regarding classification of accidents into different aircraft categories and types of operation in the table above, we will note that:

- The accident to the EC135 registered F-HJAF operated by SAF, which occurred on 8 December at Bonvillard (Savoie), during a winching training flight at night, was included in the "general aviation" section. Five people were fatally injured and one was severely injured.
- The in-flight collision between the DR400 registered F-BXEU and the Pioneer 300 identified 37-AHH on 10 October was included in the category of "aeroplanes" operated under "general aviation". Five people were fatally injured (the three occupants of the aeroplane and the two occupants of the microlight).
- Four accidents occurred during glider towing operations (two of them by aeroplanes and the other two by microlights). In a configuration of this kind, the towing aircraft is operated in the scope of aerial work, whilst the towed glider is operated in the scope of general aviation. We note that, for each accident, only one of the two aircraft was damaged. The BEA therefore recorded these accidents as per the aircraft category and the operation type of the damaged aircraft, i.e.:
  - an "aeroplane" in "aerial work" (accident with serious injuries);
  - a "microlight" in "aerial work" (fatal accident);
  - two "gliders" in "general aviation".
- Among the occurrences which did not come under the conventional types of operation is the fatal collision with the ground of the PA44 registered F-GCJE on the night of 26 February at Elne (Pyréneés-Orientales). The person at the controls of the aeroplane - who was the only person on board - held no aeronautical licences and illegally entered the aerodrome before getting into the unlocked aeroplane, then taking off.

1.2.2 INVESTIGATIONS OPENED BY THE BEA IN 2020

Investigations opened by the BEA in 2020						
Type of event	**Commercial Air Transport**	**General Aviation**	**Aerial Work**	**Other**	**Total**	***(Reminder of total in 2019)***
Accidents	1	96	8	2	**107**	*(124)*
Serious incidents	2	5	1	0	**8**	*(10)*
Incidents	4	1	0	0	**5**	*(3)*
TOTAL	**7**	**102**	**9**	**2**	**120**	*(137)*
(Reminder of total in 2019)	*(14)*	*(112)*	*(9)*	*(2)*	*(137)*	

The number of investigations opened by the BEA indicated above is significantly less than the number of accidents, due in particular to the fact that "Annex 1" non-fatal aircraft accidents are only investigated in certain specific cases.

Accident to the Cessna 401 registered N517HC on 30 October 2020 near Toussus-le-Noble (Yvelines).
Investigation in progress

More information about variation compared with the previous year

The reduction in the number of investigations opened is consistent with the recorded decline in the number of accidents.

More information about delegated investigations

Of the investigations opened by the BEA, three correspond to accidents that occurred abroad and that were delegated to the BEA by the investigating authority in the country of occurrence, i.e.:

- ◊ The accident to the Piper PA28 registered F-OGKO operated by a French flying club, which occurred on 16 February at take-off from Dominica and resulted in the death of the four persons on board.
- ◊ The serious incident to the Cessna - 172 registered HB-TEA on 3 September 2020 at Ecuvillens (Switzerland).
- ◊ The incident involving the Airbus A330 registered F-GZCJ operated by Air France, which occurred on 31 December, en route between Brazzaville (Republic of Congo) to Paris, that was diverted to N'Djamena (Tchad).

Conversely, we will note that the investigations into three events occurring on French territory or in French air space were delegated to a foreign authority by the BEA:

- ◊ The serious incident to the Airbus A220 registered YL-AAU and operated by Air Baltic, which occurred on 12 February during cruise flight between Riga (Latvia) and Malaga (Spain), associated with the failure of an engine. The investigation was delegated to the American investigation authority (NTSB) as the United States was the State of manufacture of the Pratt & Whitney PW1521G engine. In 2019, the BEA had already delegated three investigations to the NTSB pertaining to similar incidents involving this type of engine.
- ◊ The fatal accident involving the AS 350 B3 registered I-AMVV on 7 January at Mont Miravidi (Haute-Savoie) near the French-Italian border during the setting down of passengers. The investigation was delegated to the Italian investigation authority (ANSV).
- ◊ The incident to the Cessna 680 A registered CS-LTC operated by Netjets, which occurred on 8 November during cruise flight between Frankfurt (Germany) and Palma (Spain), probably over French territory, associated with a pressurisation failure. The crew were forced to divert to Geneva (Switzerland). The BEA delegated the investigation to the Swiss investigation authority (STSB), who had begun the investigation before knowing the location of the occurrence.

More information about investigations into incidents and serious incidents

The BEA investigated five incidents and eight serious incidents in 2020. These incidents included:

- ◊ Six that occurred within the context of commercial air transport, of which five occurred during the final approach or a missed approach. These commercial air transport incidents and serious incidents are detailed in paragraph 3.1.
- ◊ Seven occurred within the context of another type of operation. They concern:
  - a sudden loss of altitude in instruction flight;
  - an in-flight collision between two gliders;
  - a bird strike on approach;
  - a failure of several screens at take-off, with inconsistent altimeter display;
  - an in-flight fire;
  - a near-collision with a drone during an aerial photography operation;
  - a runway excursion at landing (investigation delegated to the BEA by Switzerland).

More information about different categories of investigation carried out by the BEA

The BEA adapts its investigative resources and the type of report issued based on the perceived level of risk, the envisaged lessons to be learnt and the target public. On this basis, the BEA has established three categories for investigations and associated reports. The classification criteria were redefined in 2020 and are described in detail in the appendix.
The investigations opened by the BEA in 2020 were broken down as follows:

- ◊ Category 1 (major investigation): 0 investigations;
- ◊ Category 2 (adapted investigation, that can give rise to a simplified report): 76 investigations;
- ◊ Category 3 (investigation "by correspondence"): 44 investigations.

However, this breakdown could change based on the information obtained during investigations, many of which are still in progress in relation to the accidents and incidents which occurred in 2020.

More information about the decision not to investigate a fatal accident involving an "annex I" aircraft

The BEA decided not to open an investigation into the fatal accident that involved the amateur-built aeroplane registered F-PPSA on 17 March 2020, the first day of the national lockdown due to COVID-19. This decision was compliant with the regulations, which do not oblige the BEA to investigate this type of occurrence. However, it was contrary to its general policy regarding the investigation of uncertified general aviation accidents. This decision was driven by the health measures coming into force at the time of the occurrence. It is to be noted that this flight contravened the COVID-19 health restrictions that had just been implemented.

1.2.3 INVESTIGATIONS OPENED BY A FOREIGN BODY FOR WHICH THE BEA HAS BEEN OFFICIALLY NOTIFIED

Foreign investigations opened in 2020 for which the BEA has been officially notified							
Type of event	**Commercial Air Transport**	**General Aviation**	**Aerial Work**	**State aircraft**	**Other**	**Total**	***(Reminder of total in 2019)***
Accidents	18	52	15	6	10	**101**	*(115)*
Serious incidents	67	7	5	3	6	**88**	*(136)*
Incidents	13	0	0	1	1	**15**	*(19)*
TOTAL	**98**	**59**	**20**	**10**	**17**	**204**	*(270)*
(Reminder of total in 2019)	*(180)*	*(44)*	*(18)*	*(7)*	*(21)*	*(270)*	

The number of occurrences abroad notified to the BEA in 2020 largely followed the same trends as the number of occurrences on French territory: the decline in the number of occurrences notified was particularly noticeable in commercial air transport. Conversely, the number of occurrences notified in aerial work and State flights was stable, and even increased in general aviation.

For several years now, the BEA has adapted the allocation of its resources to foreign investigations based on the stakes associated with the reason for the proposed accredited representation. Further information about the classification criteria of foreign investigations for which a BEA Accredited representative (ACCREP) has been appointed is given in the appendix. The participation of the ACCREP is:

- ◊ major for category 1 ACCREP cases;
- ◊ active depending on the needs of the foreign authority for category 2 ACCREP cases;
- ◊ on standby, pending a request from the foreign authority for category 3 ACCREP cases. This category mainly includes occurrences with no safety priorities identified for the French organisations involved.

Of the 204 occurrences notified to the BEA by foreign bodies, two were category 1:

- ◊ The collision with the ground of the Boeing B737-800 registered UR-PSR operated by Air Ukraine International, which occurred on 8 January 2020, shortly after it took off from Tehran (Iran), following the firing of a missile.
- ◊ The non-stabilised approach of the Airbus A320 registered AP-BLD operated by Pakistan International Airlines, which occurred on 22 May 2020 at Karachi (Pakistan), following which the landing was undertaken with the landing gear retracted before the crew aborted it. Both engines, which were substantially damaged during the contact with the runway, shut down during the second approach, resulting in the collision of the aeroplane with the ground in a residential area.

Other occurrences notified to the BEA that were the subject of an investigation by a foreign organisation included:

- ◊ 126 category 2 ACCREP cases;
- ◊ 76 category 3 ACCREP cases.

1.2.4 GO-TEAMS

In the case of a particularly serious accident (in France or abroad), the BEA sends a team of investigators to the site without delay. The size and composition of this "Go-Team" are defined on a case-by-case basis.

In 2020, 44 Go-Teams were dispatched, including two abroad.

Accident to the Airbus A320 registered AP-BLD and operated by PIA on 22 May 2020 at Karachi.
*(**Investigation conducted by AIB / Pakistan**)*

Go-Teams abroad

The two Go-Teams sent abroad concerned the following occurrences:

- The accident to the Piper PA28 registered F-OGKO operated within the context of a French flying club, which occurred on 16 February at take-off from Dominica for which the investigation was delegated to the BEA (see paragraph 1.2.2).
- The accident to the Airbus A320 registered AP-BLD operated by Pakistan International Airlines, which occurred on 22 May in Karachi, just 10 days or so after the end of the lockdown period. A Go-Team had to be sent in unusual conditions: the absence of scheduled international flights required the chartering of an Airbus test aeroplane to transport the team of three BEA investigators and the advisors from Airbus (the manufacturer) and Safran (the engine manufacturer). The Pakistani investigation authority decided to send the flight recorders (CVR and DFDR), which were partially damaged during the accident, to the BEA to be analysed. This operation, which required specific measures due to the presence at the BEA's premises of people from different countries involved in the investigation, enabled a preliminary report to be published by the Pakistani investigation authority on 17 June 2020. The BEA published communication about the occurrence, firstly about the investigation work carried out on site with all stakeholders, then about the technical work performed in the BEA's laboratory.

Go-Teams on French territory

The 42 Go-Teams sent out on French territory included the following occurrences (this figure is exactly the same as for the previous year):

- ◊ accident to the Mooney 20J registered F-OIAT on 4 January at Lifou (New Caledonia);
- ◊ accident to the Airbus EC135 registered F-HJAF operated by SAF, which occurred on 8 December at Bonvillard (Savoie).

1.2.5 FIELD INVESTIGATORS

The BEA frequently uses the services of Field Investigators, who are DGAC staff posted in the different Inter-Regional divisions, or in the DSAC Delegations, and in overseas services.

These field investigators are trained by the BEA and have been approved by the BEA director in accordance with the provisions of the Code of Transport.

On request by the BEA and under its authority, they carry out the initial investigation actions (often on site) immediately after the accident and exclusively on French territory. They are mainly called on for general aviation occurrences, but sometimes they are also called on for commercial air transport occurrences, particularly in overseas territories.

According to the occurrence, BEA investigators will join them on-site, or not. In all cases, the rest of the investigation is carried out by BEA investigators.

Around 150 Field Investigators are currently available. A tripartite service contract between the BEA, the DSAC and the DGAC Secretary General specifies the terms of their training, approval and use by the BEA.

Forty-one operations by Field Investigators were recorded by the BEA in 2020.

REPORT ON LOCKDOWN FROM 17 MARCH TO 10 MAY 2020 (2/10)

Occurrences reported to the BEA, opening of investigations

The significant drop in commercial air traffic, aerial work and recreational aviation activity, not only in France but also in most of the world, resulted in a drop in the number of occurrences (accidents and incidents) reported to the BEA, and consequently, in the number of investigations opened either by the BEA or by foreign bodies, to which the BEA contributes as an accredited representative, in compliance with international rules.

Accidents occurring in France and investigations opened by the BEA

There were five accidents throughout the entire lockdown period, i.e.:

- Three aerial work/SPO (spraying) accidents:
  - two aeroplane accidents resulting in material damage (these two aeroplanes were engaged in a formation flight during a spraying mission and the flights were voluntarily aborted and nobody was injured);
  - one helicopter accident (one person severely injured).

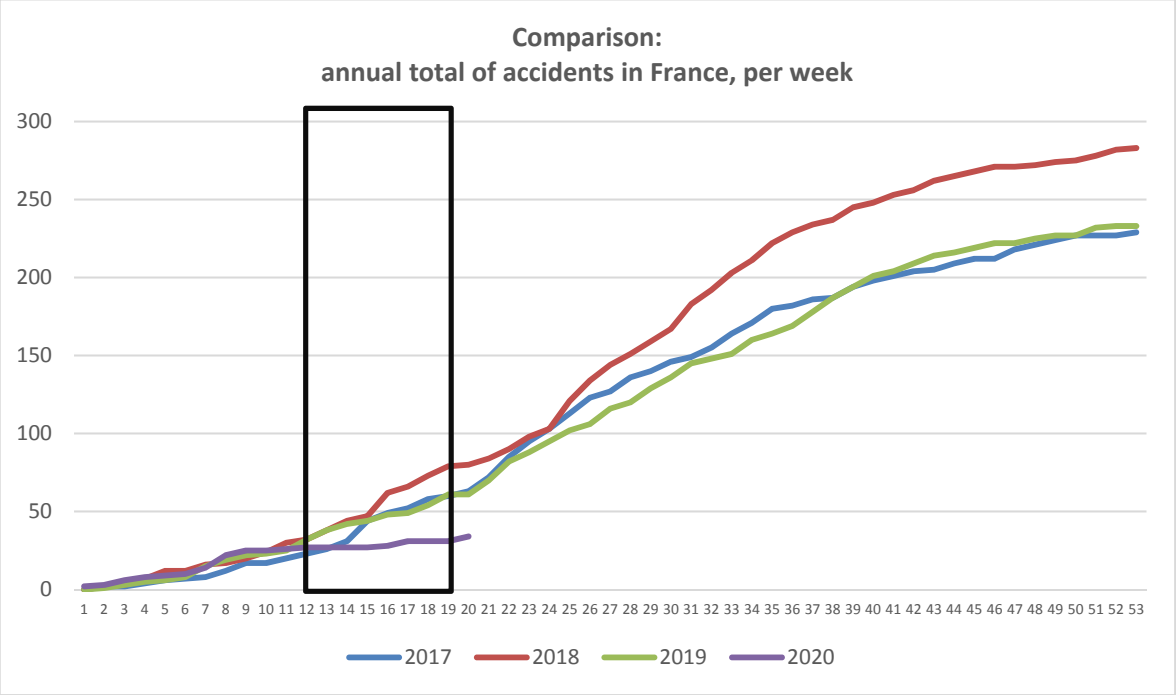
- Two accidents that occurred during non-commercial flights (both accidents occurred during flights that did not comply with the lockdown restrictions in place):
  - a fatal accident to an amateur-built aeroplane,
  - an accident to a powered paraglider that severely injured one person.

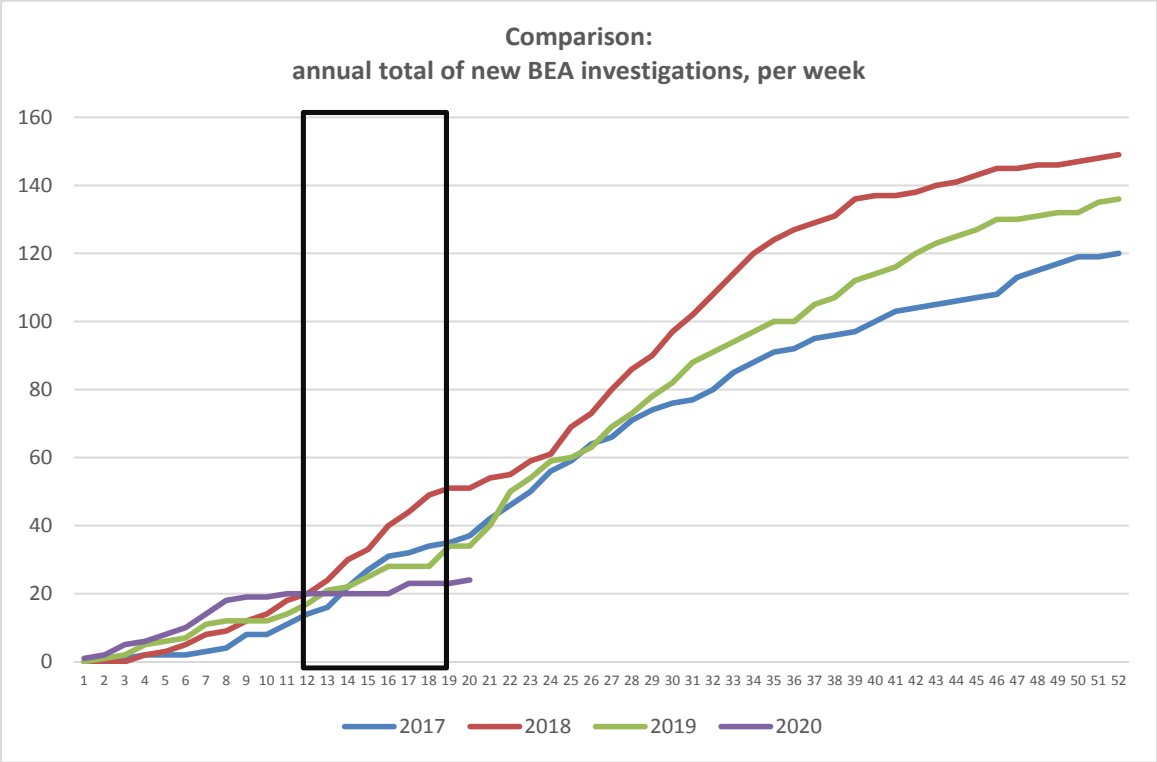
In view of the circumstances, and in compliance with regulations and the BEA's procedures, the decision was made not to open an investigation into the events that occurred within a non-commercial context.

The BEA therefore opened a total of three investigations during the entire lockdown period. These three investigations pertain to the aforementioned aerial work occurrences. One of them required the sending out of a Go-Team (travelling in the service vehicle, adhering to social distancing rules, and completing outward and return journey the same day). These investigations were classified as category 2[(5)]. They will be the subject of a simplified report.

The graphs below can be used to compare the number of accidents observed and investigations opened by the BEA during the lockdown period with those of the same periods in previous years.

[(5)] See further information pertaining to the classification of investigations (paragraph 1.2.2).

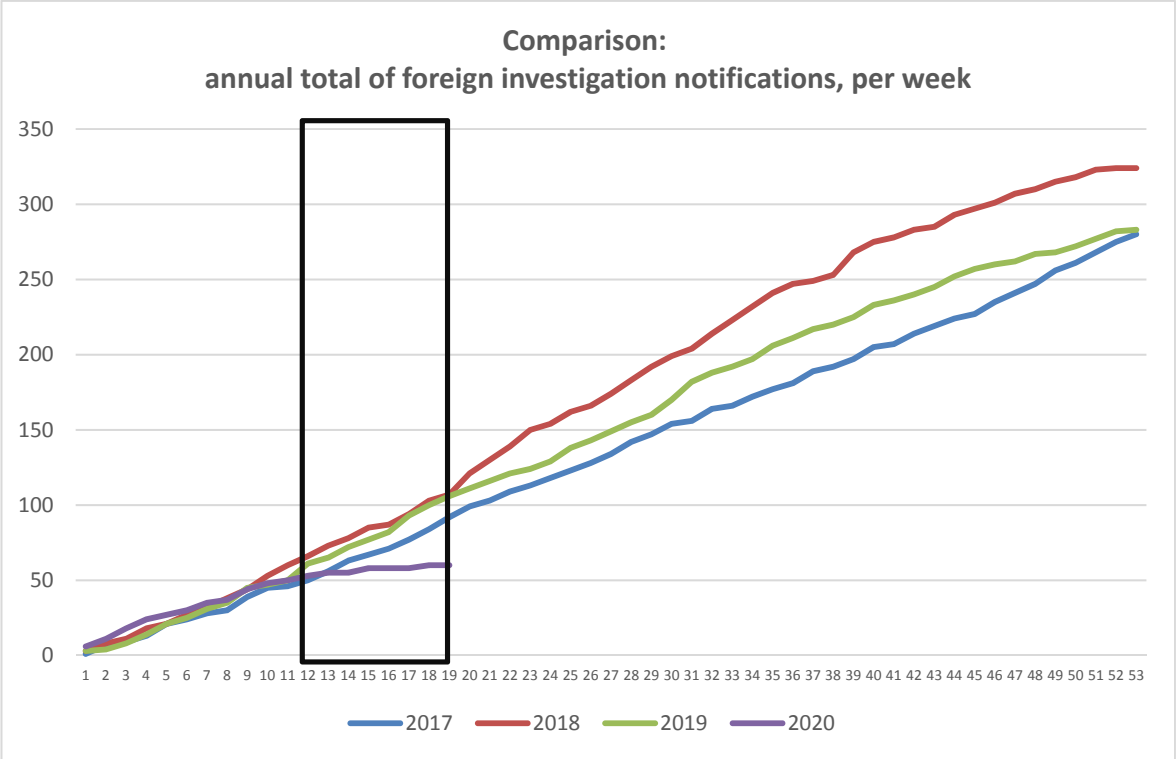

Comparison:
annual total of accidents in France, per week
300
250
200
150
100
50
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53
2017
2018
2019
2020


Comparison:
annual total of new BEA investigations, per week
160
140
120
100
80
60
40
20
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52
2017
2018
2019
2020

Investigations opened by foreign bodies, appointment of BEA accredited representatives during the lockdown period

In compliance with the international rules, the BEA is notified by ICAO Member States of the opening of all safety investigations pertaining to an occurrence involving a French designed or registered aircraft or a French operator, and is given the opportunity to take part in the investigation by appointing an accredited representative.

The drop in air traffic due to the pandemic was observed worldwide and resulted in a significant drop - in relation to the same period in previous years - in the number of occurrences reported to the BEA by foreign bodies, and therefore the number of accredited representatives that it appointed.



There were:

- ◊ four notifications of accidents or incidents to commercial air transport aeroplanes (two of these did not give rise to the appointment of an accredited representative);
- ◊ a helicopter accident within an aerial work context;
- ◊ two accidents that occurred within a non-commercial context (a fatal helicopter accident and a light aeroplane accident);
- ◊ two events that occurred within a context to be determined (an aeroplane accident and a helicopter incident).

In total, eight accredited representatives were appointed during the lockdown period. None of these appointments required the sending out of a Go-Team to the site.

The accident to the A320 registered AP-BLD in Karachi (Pakistan) did however result in the appointment of an accredited representative and the sending out of a Go-Team to the site. Nevertheless, this occurred on 22 May 2020, 12 days after the end of the lockdown period.

2. INVESTIGATIONS CLOSED, REPORTS PUBLISHED IN 2020

Accident to the Piper PA-28 registered F-ODSM on 19 June 2019 at Pointe-à-Pitre le Raizet (Guadeloupe).
Report published in June 2020

2.1 INVESTIGATIONS CLOSED AND INVESTIGATION REPORTS PUBLISHED

European regulation No 996/2010 specifies that each safety investigation must be concluded with a report in a format suitable for the type of occurrence. The BEA has defined three investigation categories (cf. paragraph 1.2.2).

In 2020, the BEA published 189 investigation reports broken down as follows:

Number of investigations closed / reports published by the BEA in 2020				
	Category 1	Category 2	Category 3	Total
	(figures in brackets: with safety recommendations)			
Commercial air transport	**0**	**19**	**0**	**19**
	(0)	*(6)*	*(0)*	*(6)*
Aerial work / Specialised activity	**0**	**10**	**1**	**11**
	(0)	*(1)*	*(0)*	*(1)*
General aviation	**0**	**103**	**55**	**158**
	(0)	*(2)*	*(0)*	*(2)*
State Operation	**0**	**1**	**0**	**1**
	(0)	*(0)*	*(0)*	*(0)*
Total	**0**	**133**	**56**	**189**
	(0)	*(9)*	*(0)*	*(9)*

Category 1 investigations systematically give rise to ICAO format reports.
Category 2 investigations are the subject of simplified reports or ICAO format reports whilst category 3 investigations are systematically the subject of simplified reports.

Nine of the reports published in 2020 contain safety recommendations.
These all concern category 2 investigations. They relate to the following occurrences:

◊ The accident to the Airbus A380 registered F-HPJE operated by Air France, which occurred on 30 September 2017 during cruise flight over Greenland (Denmark): uncontained failure to engine 4 during cruise flight followed by a diversion. The report contains four safety recommendations pertaining to:

- the design and sizing criteria of rotor-grade parts made of the incriminated titanium alloy;
- the manufacturing processes;
- the required maintenance programmes.

◊ The accident to the Airbus AS 350 registered F-GKMQ operated by Airplus Hélicoptères, which occurred on 7 January 2019 at Puylaurens (Tarn): loss of control during the setting down of a slung load. The report contains three safety recommendations pertaining to:

- the taking into account of cardiovascular risk factors in the medical fitness evaluation of pilots;
- the coordination between medical fitness examiner and medical practitioner.

◊ The incident to the Embraer ERJ 190 registered CS-TPV operated by TAP, which occurred on 6 November 2017 in Nice (Alpes Maritimes): night take-off started on a taxiway. The report contains two safety recommendations pertaining to:

- the characteristics of the ground radar and the appropriateness of updating them;
- air navigation control procedures.

◊ The incident to the Bombardier CRJ 700 registered F-GRZL operated by HOP!, which occurred on 17 March 2017 in Lyon (Rhône): clearance given to the crew to cross the runway during the take-off of another aircraft. The report contains two safety recommendations pertaining to:

- the air navigation work tools and methods to, in particular, reinforce the physical indication of the runway's occupancy;
- the implementation of alert systems and runway protection tools.

◊ The accident to the Pilatus PC12 registered OO-PCI operated by European Aircraft Private Club, which occurred on 25 February 2017 at Courchevel (Savoie): collision with the embankment before the runway during landing at a mountain airfield. The report contains two safety recommendations pertaining to:

- the definition of a training programme for mountain airfield access authorisations in the regulations.

◊ The incident involving the Bombardier CRJ 700 registered F-GRZG operated by HOP! and the Boeing 717 registered EI-EXB operated by Volotea, which occurred on 12 April 2019 in Strasbourg (Bas-Rhin): loss of separation between an aeroplane at take-off and the other in go-around. The report contains one safety recommendation pertaining to:

- the prevention of conflict between aircraft in the event of a missed approach at low height.

◊ The accident to the Robin DR400 registered F-GFXE on 28 July 2018 at Charleville-Mézières (Ardennes): loss of control following a reduction in engine power at take-off during an introductory flight. The report contains one safety recommendation pertaining to:

- the provision of support to flying clubs regarding their safety management process, which is required to be able to offer introductory flights.

◊ The accident to the Airbus AS 350 registered F-HLBT operated by Héliberté, which occurred on 26 August 2017 at Guérande (Loire-Atlantique): incapacitation of the pilot during a passenger commercial air transport flight. The report contains one safety recommendation pertaining to:

- the declaration of health events that the pilots have experienced, the knowledge of which might be useful in the assessment of their fitness.

◊ The serious incident to the Boeing 737-800 registered EI-EMK operated by Ryanair on 29 January 2015 in Bergerac (Dordogne): descent below the minimum safe altitude during the approach, activation of ground proximity alerts, missed approach The report contains one safety recommendation pertaining to:

- the validity and relevance of part of the AIP concerning entry into holding pattern of some approach procedures.

It is also worth mentioning the publication of the investigation report relating to the serious incident involving the Airbus A320 registered EC-HQJ operated by Vueling, which occurred on 17 November 2017 in cruise flight. The two pilots suffered from a partial incapacitation resulting in them making an emergency diversion to Marseille (Bouches-du-Rhone). Different investigation actions, often innovative, were implemented by the BEA. If no safety recommendation was issued within the context of this investigation, the report explicitly asks the aeronautical community to make arrangements to be able to implement, as quickly as possible, adapted biological sampling means, notably to detect potentially incapacitating substances that may be absorbed by crew members.

2.2 COMMENTS ON BEA ACTIVITIES AND PERFORMANCE IN 2020

The BEA published 189 reports in 2020 (compared with 164 in 2019 and 137 in 2018). For the second consecutive year, the number of reports published is greater than the number of new investigations opened. This result rewards the effort made by the BEA to reduce the stock of investigations in progress, whilst endeavouring to maintain a high level of quality.

Regulation (EU) No 996/2010 specifies that an investigation report should be published rapidly and, if possible, within twelve months of the date of the occurrence. For the BEA, this duration of twelve months for each investigation is thus a general objective and a monitoring indicator. This indicator is defined as the percentage of investigations closed within one year among the investigations opened the previous year.

In 2020, the global result of this indicator is 67% (compared with 56% in 2019 and 38% in 2018).

It can be seen that if a distinction is made between investigation categories (as defined in paragraph 1.2.2 above), the indicator varies substantially, as shown in the following table: indeed, the volume of factual items of information to be obtained, the time spent collecting and then analysing this information, the need to conduct complementary and potentially time-consuming work, and the duration of validation and consultation processes, may widely vary depending on these investigation categories. In addition, issuing recommendations - naturally more frequent for category 2 investigations, and especially for category 1, is – except in the case of urgent recommendations - a demanding process with various validation phases, which may significantly extend the duration of investigations.

Breakdown of indicator for 2020				
Investigation categories	**Category 1**	**Category 2**	**Category 3**	**Total**
Investigations opened in 2019	0	95	41	**136**
Closed in less than one year	-	52	39	**91**
Indicator 2020	**-**	**55%**	**95%**	**67%**

The stopping of practically all air activity for several weeks in 2020 due to the COVID-19 health crisis enabled us to temporarily concentrate our efforts on making headway with investigations in progress and on the writing of reports. However, the analysis of the number of reports published during the first three months of 2020 shows that the pace was already higher than that of the previous years during the same period. This would suggest that the good results of 2020 are not solely down to the circumstances associated with the period of lockdown in the spring, but also down to structural improvements in the production process.

In addition, it is worth noting that whilst the overall number of investigations opened by the BEA during the year was slightly down (-12%) versus 2019, the number of fatal accidents investigated by the BEA remained stable. As previously seen, the number of victims increased significantly due to the high number of occupants involved in several accidents. The specific operating contexts of these accidents (specified in paragraph 3.2.2) led to the examination of some systemic components within the context of more complex investigations.

Internationally, the BEA had to appoint fewer accredited representatives due to the global decline in air activity but invested a lot of resources into two major investigations (described in paragraph 1.2.3).

The following table indicates, for each category, the year of the investigations closed in 2020.

Year in which the investigations were opened for all reports published by the BEA in 2020					
Investigation categories		**Category 1**	**Category 2**	**Category 3**	**Total**
Year of occurrence	2020	0	5	28	**33**
	2019	0	61	17	**78**
	2018	0	28	3	**31**
	Previous	0	39	8	**47**
Total		**0**	**133**	**56**	**189**

A total of 59 investigations were opened more than one year ago on 31 December 2020 (compared with 125 in the previous year and 148 in 2018). The following table gives details for each investigation category [6] [7].

Number of BEA investigations opened more than one year ago on 31 December 2020				
Investigation categories	**Category 1**	**Category 2**	**Category 3**	**Total**
Commercial air transport	0	13	0	**13**
Aerial work / Specialised activity	0	3	0	**3**
General aviation	0	37	6	**43**
Total	**0**	**53**	**6**	**59**

The BEA has set itself the target over the coming years of closing 80% of its investigations in less than one year. More precisely, this target is broken down as follows:

- 100% of category 3 investigation reports should be published in less than one year, most of these reports must be published in less than four months.
- 70% of category 2 investigation reports should be published in less than one year. No category 2 investigation should take longer than two years.

The decreasing stock of investigations in progress should gradually enable these targets to be reached in the years to come.

[6] Despite the lack of publication of a category 1 investigation report in 2020, the stock of investigations in this category does not match that published in the 2019 activity report. This apparent inconsistency can be explained by the adoption by the BEA of a more restrictive definition for category 1 (see paragraph 1.2.2). Investigations that no longer meet the criteria of this definition are now classified as category 2 and notably include investigations that gave rise to or shall give rise to IACO format reports but which do not concern major accidents in the sense of the retained definition.

[7] In addition to the 189 reports published in 2020, the BEA "administratively" closed 16 investigations in the database. It had been decided several years ago not to continue with them. These investigations concerned occurrences between 2005 and 2015 that were not associated with a regulatory obligation (incidents or accidents to uncertified aircraft) or that now would be the subject of category 3 investigations.

Investigations closed

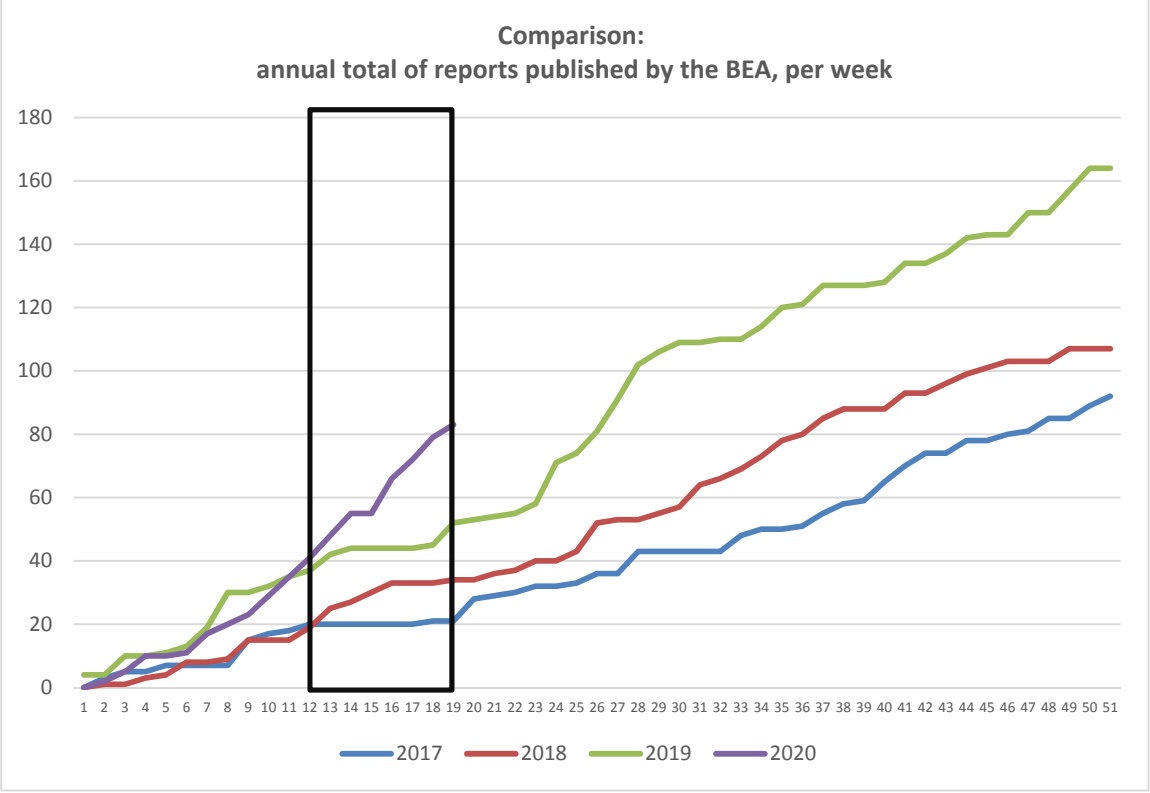
Investigations closed - reports published

BEA investigations are considered to be closed as of the date of publication of the investigation report (French version, if the report is to be published in several languages).

Forty-three investigations were thus closed during the lockdown period, i.e.:

- Thirty-three category 2 investigations which gave rise to the publication of a simplified report. These included:
  - 31 investigations into general aviation occurrences;
  - 2 investigations into commercial air transport occurrences that each resulted in the issuance of 2 safety recommendations.
- Ten category 3 investigations.

These figures are significantly higher than those observed over the same period in previous years.



Moreover, 74 cases for which the BEA had appointed an accredited representative were closed during the lockdown period.

Changes to the stock of investigations in progress

The low number of investigations opened during the lockdown period enabled resources to be focused on progressing with, and in a number of cases, finalising investigations in progress. This considerably reduced the stock of investigations in progress, as shown in the table below.

Changes to the stock of investigations in progress				
	Category 1	**Category 2**	**Category 3**	**Total**
New investigations	0	3	0	**3**
Reports published	0	33	10	**43**
Changes during the lockdown period	**0**	**-30**	**-10**	**-40**

3. GENERAL CONSIDERATIONS ON AIR SAFETY IN FRANCE IN 2020

Accident to the Stampe SV4 registered F-PTTL on 4 July 2020 at Angers-Marcé (Maine-et-Loire).
Investigation in progress

3.1 COMMERCIAL AIR TRANSPORT

3.1.1 COMMERCIAL AIR TRANSPORT ACCIDENTS

No French operator holding an AOC was involved in an accident in 2020, either on French territory or abroad. It is to be noted that the only accident involving a French commercial air transport operator was a balloon accident. This type of operation does not require an AOC.

Naturally, the impact of the health and economic crisis on the level of commercial air transport activity means that this nonetheless positive observation needs to be put into perspective.

3.1.2 COMMERCIAL AIR TRANSPORT INCIDENTS

Six investigations were opened into incidents that occured within the context of commercial air transport operation.

It should be noted that, excluding serious incidents for which the BEA must open an investigation, the criteria leading the BEA to open an investigation into an incident can be based on different circumstantial or subjective factors. These factors include workload and the associated availability of investigators, safety lessons hoped to be learnt from the investigation, etc. The extraordinary drop in traffic observed in 2020 can in this sense be considered as a particularly significant circumstantial factor. In addition to the fact that there were less investigators engaged in opening investigations into accidents, the question of the possible consequences of this drop in traffic on safety was raised very early on. Lack of training, changes to the environment (airport closures, etc.) and work methods are for example likely to put operators in new and potentially accident-provoking situations that may be looked into in some investigations.

The review of commercial air transport incidents below must therefore not be considered as having a statistical value. Moreover, a decision was made to firstly present investigations opened before Europe was hard hit by the health crisis, followed by those opened after.

◊ Incidents for which an investigation was opened before Europe was hard hit by the health crisis.

- The first incident involved the deviation from the horizontal path of a Bombardier CRJ 700 during an ILS CAT IIIA approach performed in LVP conditions. The investigation notably focuses on the crew's familiarisation with the HUD used during the approach and on the sequence of the missed approach during which the aeroplane flow over the airport buildings at low height along a path that deviated from the runway centreline.
- The second incident concerns the missed ILS approach of an Airbus A350 following a "PREDICTIVE WINDSHEAR" warning at 1,350 ft, during which a cognitive incapacitation of the FO (PF), several deviations from the path in relation to the published missed approach altitude, an activation of the "LOW ENERGY" warning and proximity with an aircraft departing from another runway were observed.

◊ Incidents for which an investigation was opened after July, when activity was gradually being resumed following the grounding of practically all aircraft.

● A serious incident occurred during the missed approach of an Embraer ERJ 170 following a "WINDSHEAR" warning. During the manoeuvre, in strong crosswinds, a loss of separation was recorded with an aeroplane taking off from the parallel runway.

The following three incidents may lead to links being drawn with the health and economic context:

● A serious incident to a Boeing 787 on approach to one of two parallel runways, mistakenly cleared to land on the runway parallel to the runway initially planned for landing, whilst an Airbus A320 was entering the runway to line up. The B787 initiated a dog leg to align with the runway for which it had received clearance to land. The situation was first detected by the crew of the A320 during a final visual check of the aeroplane on final after entering the runway. The crew subsequently attempted to alert the controller then, due to the lack of response from the latter, directly asked the crew of the B787 to fly a missed approach. The crew of the B787 had just detected the presence of the A320 (the QFU was facing into the rising sun) and was preparing to initiate the manoeuvre. The minimum recorded height of the B787 during the missed approach was 60 ft, 250 m from the runway threshold. It is worth noting that, although it is not possible to evaluate the exact level of contribution, the reduction in air traffic during the first months of the year was spontaneously mentioned in the controller's statement as an under-training factor that could have resulted in him being less attentive to the reading back of the B787 crew.

The context of low traffic can also allow room for freedom of movement enabling, for example, the choice of shorter approach paths, or manoeuvres at greater speeds than normal:

● An incident involving an Airbus A318 occurred when a short circuit was suggested by the controller to intercept an ILS: the approach, at high speed, was not stabilised, which triggered the "GLIDE SLOPE" warning on board and the "MSAW" warning on the air traffic controller's screen. The investigation seemed to show that from a nominal situation, the crew were rapidly overwhelmed. This had a negative impact on crew cooperation and, notably, resulted in a possible misunderstanding on the part of the FO (PM) of the captain's (PF) intentions and actions. The crew's capacity to monitor the parameters or to decide to fly the missed approach was significantly impaired. Without being aware of it, the crew were probably then more vulnerable to any other unforeseen event.

This underlines that, in a context of little training and often low traffic, sticking strictly to the operational procedures remains the key to safety.

● The investigation in 2020 into an incident to the Airbus A330 backs up this notion. During cruise flight, the crew detected a major fuel leak on one of the engines. The abnormal "fuel leak" procedure requires shut-down of the engine but the discussion between the crew members resulted in the engine remaining in operation. The leakage rate was estimated to be slow enough to enable them to reach the diversion airport without risk of engine shut-down due to lack of fuel supply. The engine was finally shut down on the ground after the turn-around on runway. The crew were not fully aware of the heightened risk of fire as the result of their decision.

3.2 GENERAL AVIATION

3.2.1 OVERVIEW FOR ALL TYPES OF GENERAL AVIATION ACTIVITIES

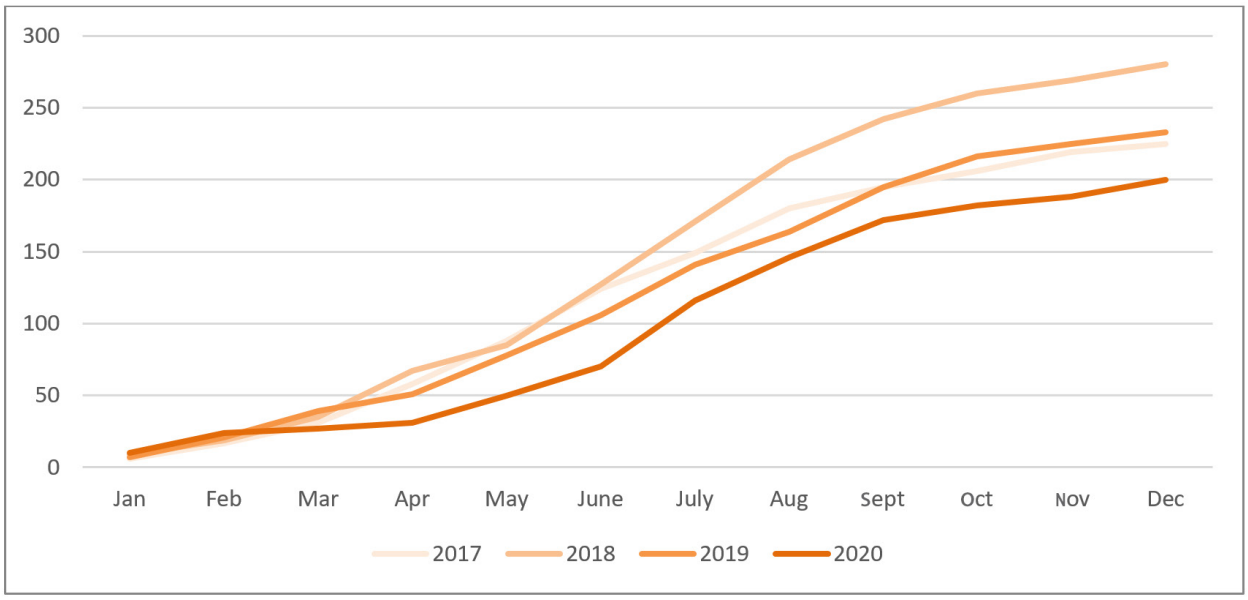
Accident to the Robin DR400 registered F-HKZZ and the Schleicher KA6 registered F-CDRM on 2 September 2020 at Bagnères de Luchon (Haute-Garonne).
Investigation in progress

As noted above, the health situation certainly influenced the total number of general aviation accidents, which was down 13% versus 2019.

This decline may seem relatively insignificant given the air traffic situation in 2020. However, it is important to note that the volume of traffic that is actually measurable principally comprises commercial air transport.

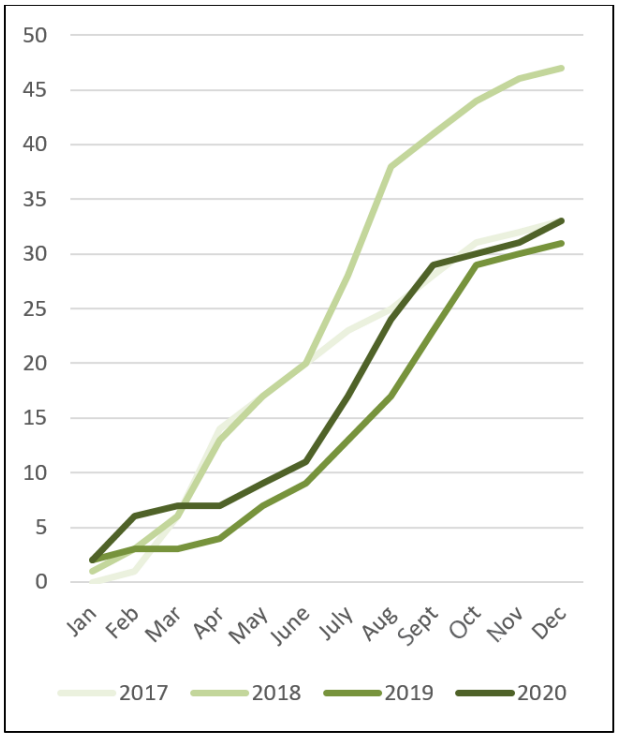
In fact, it is probable that general aviation activity was globally sustained in 2020. The temporary lifting of health restrictions over the summer months probably helped to sustain the average level of activity for the year.

The graphs below clearly show that, following a relative plateau during the spring lockdown, the variation in the number of accidents resumed with a level relatively similar to that in previous years.

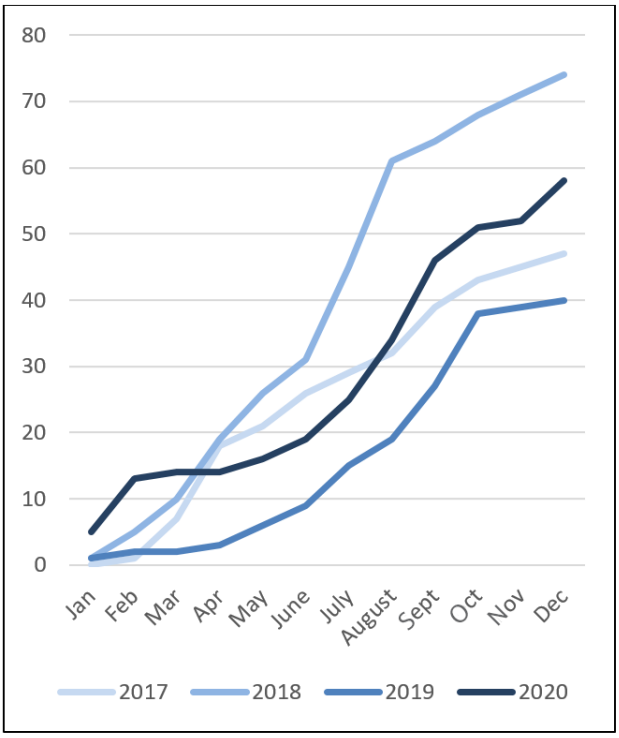


Variation in the number of accidents over the year - Comparison with previous years

It should be noted that despite the reduction in the total number of accidents, the number of fatal accidents in general aviation rose by 15% in relation to 2019 and, more markedly, the number of victims rose by 57%.



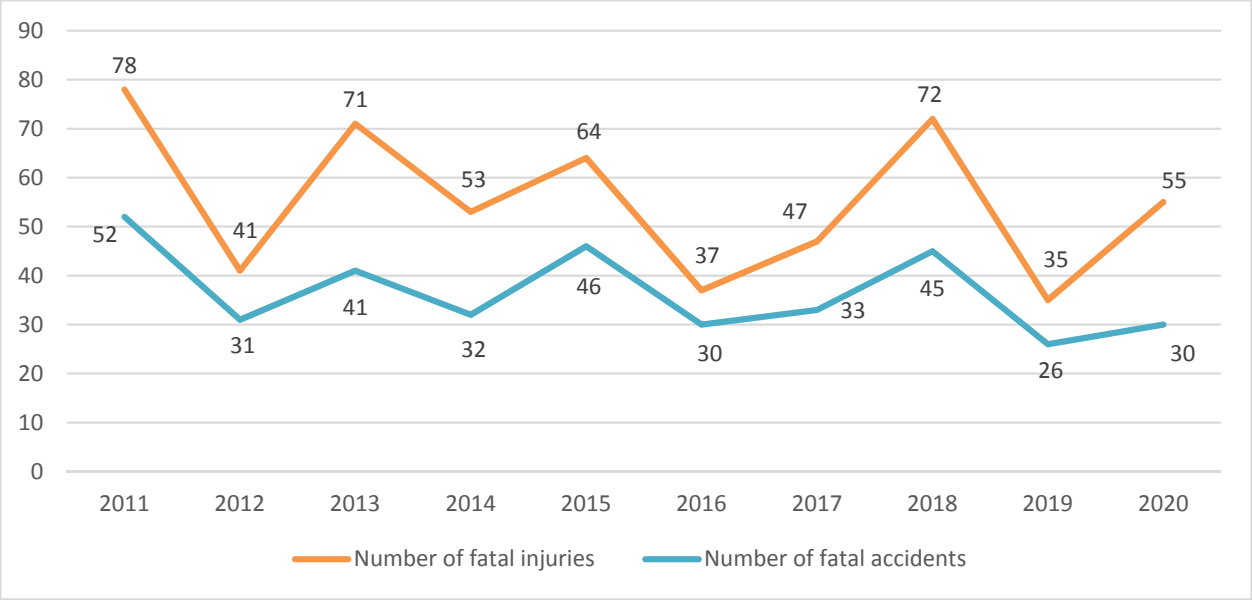
Variation in the number of fatal accidents over the year
Comparison with previous years



Variation in the number of fatalities over the year
Comparison with previous years

These graphs may lead us to think that if the air traffic had not stopped in the spring, the 2020 results would have been comparable with those of 2018 in number of fatal accidents and victims, making it one of the worst years in the past decade.

Whilst this analysis is based partly on speculation which should not be pursued, it primarily leads us to cautiously observe that there is no really marked trend in terms of level of safety in general aviation: the main indicators - such as variations year on year - appear to be relatively unpredictable, even cyclic.

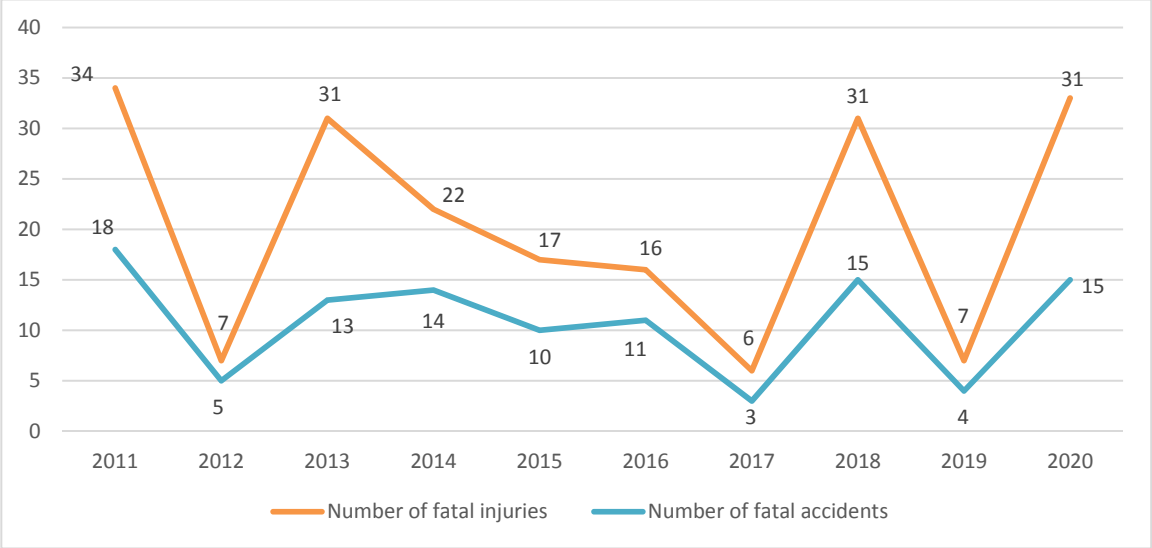


Variation in fatal general aviation accidents (all aircraft categories) over the 2011-2020 period

It should be noted that one of the striking unpredictable elements in 2020 is the particularly high ratio between the number of fatalities and the number of fatal accidents in 2020 (1.83), significantly higher than those observed over the last ten years. The year was actually marked by several general aviation accidents which resulted in three, four or even five people being killed.

3.2.2 OVERVIEW FOR GENERAL AVIATION - AEROPLANES [8] [9]

In 2020, aviation activity experienced one of its worst years of the decade in number of deaths, similar to 2018[10].



Variation in fatal general aviation accidents (aeroplanes only) over the 2011-2020 period

If we include the accident that occurred off the coast of Dominica, seven aeroplane accidents resulted in three or more victims. Five of these accidents involved aircraft operated by flying clubs. Figures aside, the contexts of the flights during which these accidents occurred have been the subject of further lines of investigation:

◊ Accidents comparable to sightseeing flights in various forms

Three fatal accidents occurred within this operating context:

- Accident to a Robin DR400-120 resulting in four victims, associated with a loss of control during take-off. The pilot, who was a member of the flying club, was accompanied by three members of an association to whom this flight was offered as a gift.
- Accident to a Robin DR400-140 resulting in three victims during a flight in a mountainous region. The pilot, who was a member of the flying club, was accompanied by two students from an educational establishment run by the Air Force, completing a BIA course independent of the FFA.
- Accident to a Robin DR400-140 involved in the in-flight collision with a microlight. The accident killed five people including three occupants of the aeroplane. The aeroplane was operated as part of a cost sharing scheme by the pilot: the formula was offered on the flying club's website as an alternative to the introductory flight.

Moreover, two non-fatal accidents were reported within the context of an introductory flight and a BIA introductory flight: a forced landing in a mountainous region following a fuel management error and a collision with a tree in final.

The links between these operating contexts and the resulting accidents are not (and should not be) systematically made. However, these flights differ in a number of ways from the flying club pilots' conventional activity, which is generally focused on training and approval. In terms of the passengers who are not club members, possibly new to the world of flying and unknown to the pilot, the latter may adopt a specific attitude during the flight and outside of it (giving of safety instructions, compliance with schedules, logistical management of unforeseen events, comfort, appeal).

Some of these cases correspond to individual initiatives on the part of flying club members. The association structures may find it difficult to identify and provide support for these initiatives.

(8) Unless otherwise indicated, the data below only relates to accidents that occurred on French territory. In particular, it does not take into account the accident that occurred at take-off from Dominica during which four people died.

(9) Please note that the figures given in paragraphs 3.2.2 and 3.2.3 represent numbers of accidents and not accident rates. They shall not therefore be interpreted as a comparison of levels of safety of aeroplane and microlight activities (a comparison of this kind should notably consider fleets, the number of flights or the flight hours for each activity).

(10) Contrary to the way of representing figures in the table of accidents that occurred in France (paragraph 1.2.1), the in-flight collision between a DR400 and a microlight that occurred on 10 October 2020, is included in the two paragraphs 3.2.2 and 3.2.3 of this report relating to aeroplane activities on the one hand, and to microlight activities on the other. The number of victims of this accident was split between both activities (three deaths in the aeroplane and two deaths in the microlight).

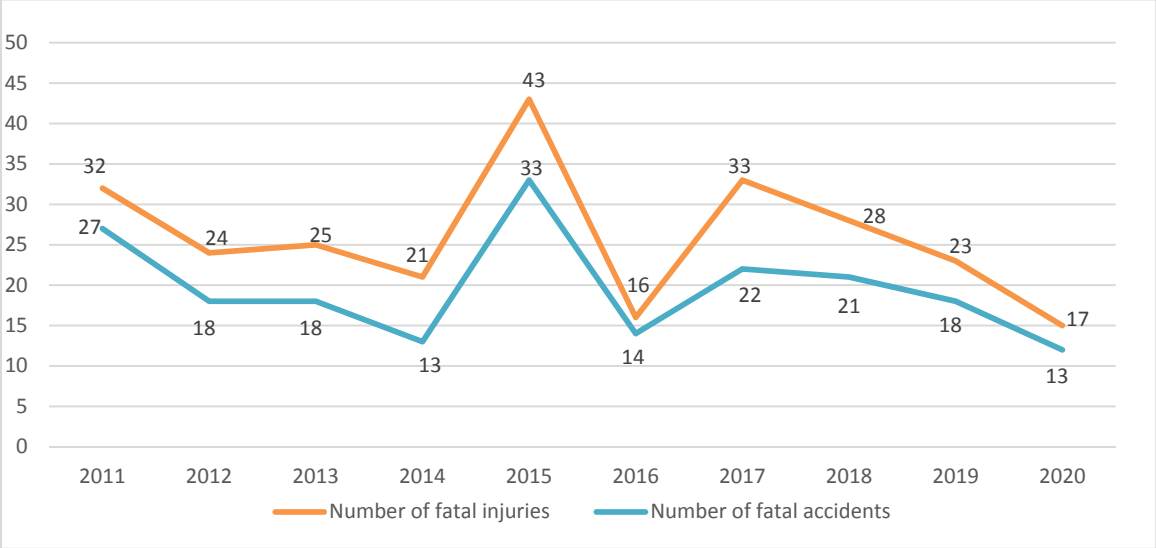
Conversely, in the case of introductory flights or BIA introductory flights, the pilot provides a service for which the flying club is paid. This can accentuate the adoption of a different attitude. Moreover, the regulatory framework applicable to introductory flights imposes operational limitations (distance and duration) which the pilot must ultimately comply with. Therefore, this activity is characterised by the exposure of paying passengers to the risks inherent in non-commercial light aircraft and by the pilot's increased workload. In exchange for the option to carry out an activity similar to passenger commercial air transport, the regulatory framework pertaining to introductory flights contains some requirements, in particular in terms of the minimum and recent experience of pilots and risk management. Within the context of the investigation into the fatal accident of the DR400-180 registered F-GFXE on 28 July 2018 at Charleville-Mézières (Ardennes), for which the report was published in 2020, the BEA recommended to the DGAC, in collaboration with user federations, the implementation of safety information and promotion actions aimed at recreational aviation establishments concerning the organisation of introductory flights, in order to help these establishments to meet this risk management objective.

◊ Accidents during organised excursions

In terms of flying club activities, two other aeroplane accidents resulting in more than two victims occurred during organised group excursions. One occurred in poor meteorological conditions, the other during a take-off for an unforeseen night return with no external visual references. The investigations focused in particular on the conditions in which these excursions were organised by the establishments concerned.

3.2.3 OVERVIEW FOR GENERAL AVIATION - MICROLIGHTS[11]

The number of fatal microlight accidents and associated victims was down for the third year in a row.[12]



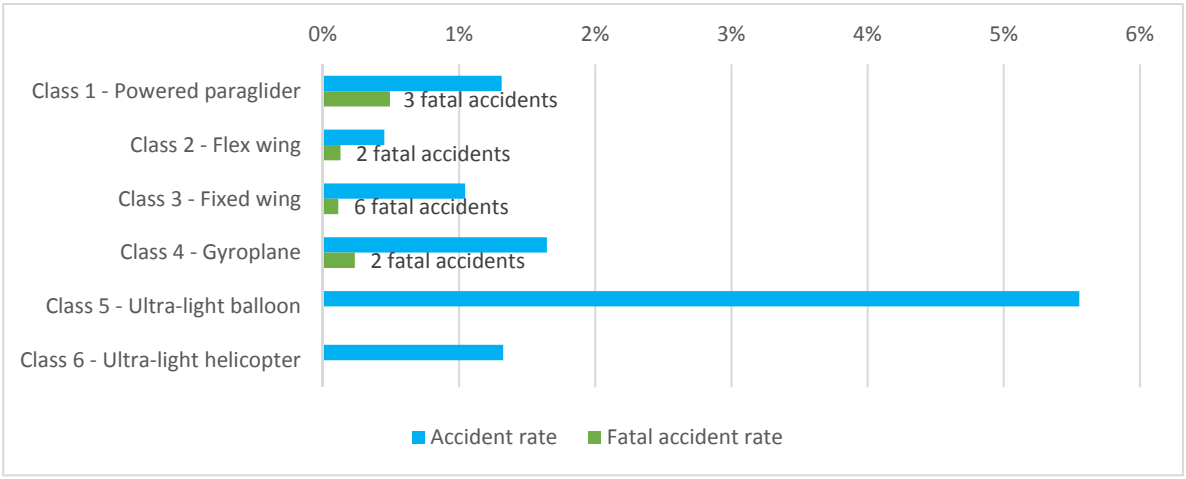
Variation in fatal general aviation accidents (microlights only) over the 2011- 2020 period

[11] Cf. note 1 in paragraph 3.2.2.

[12] Cf. note 2 in paragraph 3.2.2.

The following graph shows the breakdown of the rate of accidents and fatal accidents per type of microlight.

Note: these rates, expressed in number of accidents per number of identified aircraft, were established based on the number of microlights with a valid identification card as of 15 December 2020.



Number of accidents and fatal accidents per type of microlight in 2020, based on the number of identified microlights

Of the 13 fatal microlight accidents, we will focus on one accident that occurred during a dangerous manoeuvre not necessary for normal flight. This was a collision with an obstacle when flying over it at low height in a fixed wing microlight. Moreover, it should be noted that the elements already gathered suggest that an in-flight loss of control occurred in at least 10 cases (two at take-off, three en route, three on approach, one in go-around and one coming out of a steep-angle climb following take-off in a gyroplane).

4. SAFETY RECOMMENDATIONS

Accident to the Hughes 269C registered F-HAGO on 12 January 2021 at Bastelica (Corse-du-Sud).
Investigation in progress

4.1 GENERAL CONTEXT

According to the ICAO, a safety recommendation is a proposal made by an investigation authority on the basis of information gathered from an investigation or a study, in order to prevent accidents or incidents.

The BEA sends most of its recommendations either to the civil aviation authority of a State or to the European Aviation Safety Agency (EASA). Some recommendations may also be sent to operators or manufacturers. They must relate to the measures to be taken to prevent occurrences which would arise in similar circumstances.

Follow-up of safety recommendations

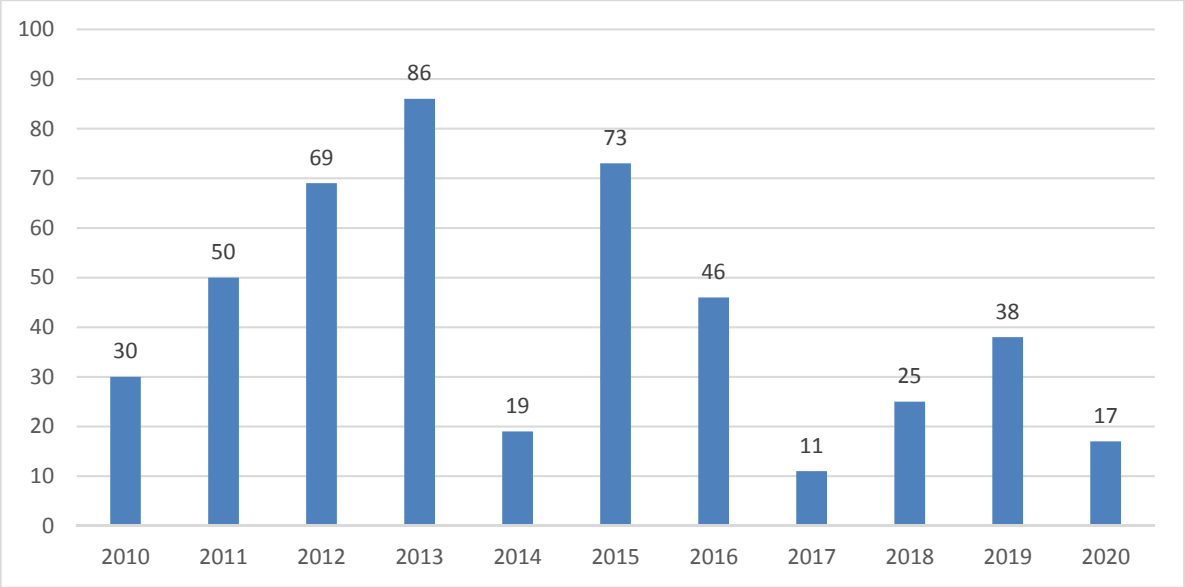
The provisions of Regulation (EU) No 996/2010 of the European Parliament and Council on the investigation and prevention of accidents and incidents in civil aviation require, for Member States, that recipients of safety recommendations acknowledge receipt and inform the issuing authority, responsible for investigations, of the measures taken, or under consideration.

This response must be addressed to the issuing authority within 90 days of receipt of the Safety Recommendation letter.

The investigation authority then has 60 days to inform the recipient of the Safety Recommendation if it considers its response as adequate or, if it disagrees with the response, to give reasons.

4.2 SAFETY RECOMMENDATIONS ISSUED

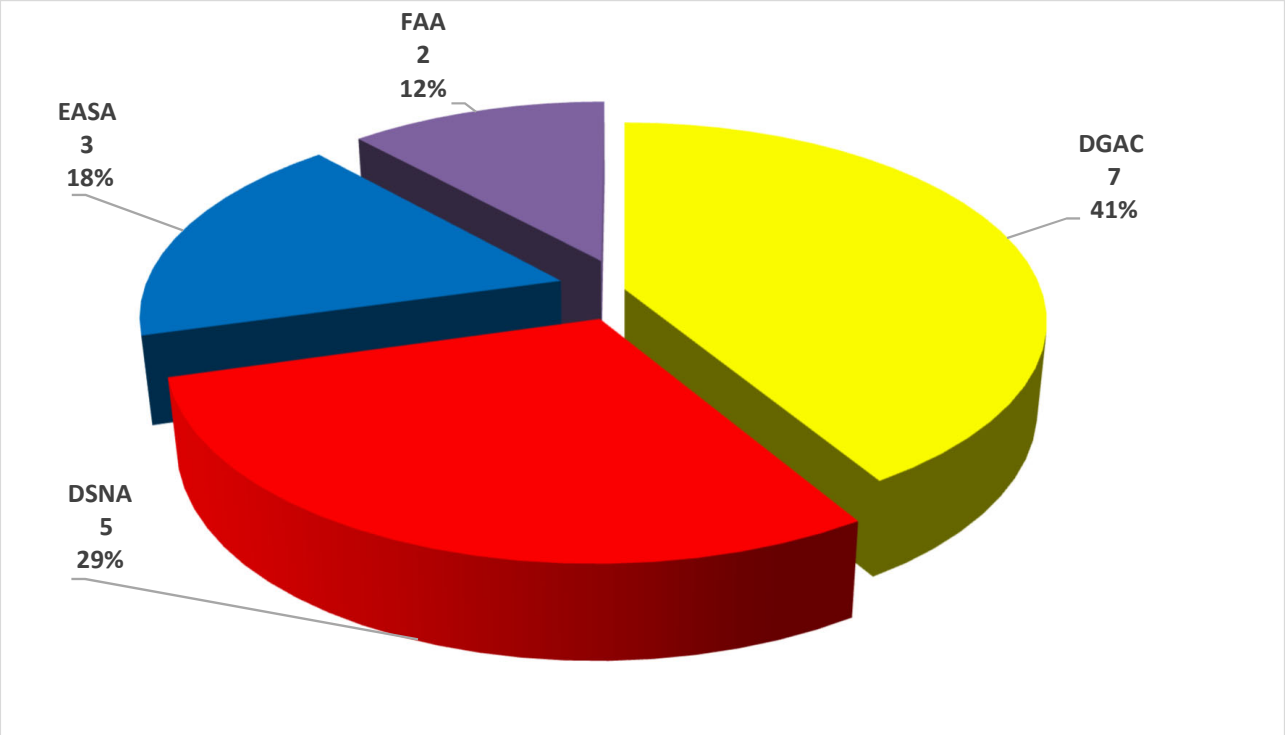
The BEA issued 17 recommendations in 2020.



Recommendations issued

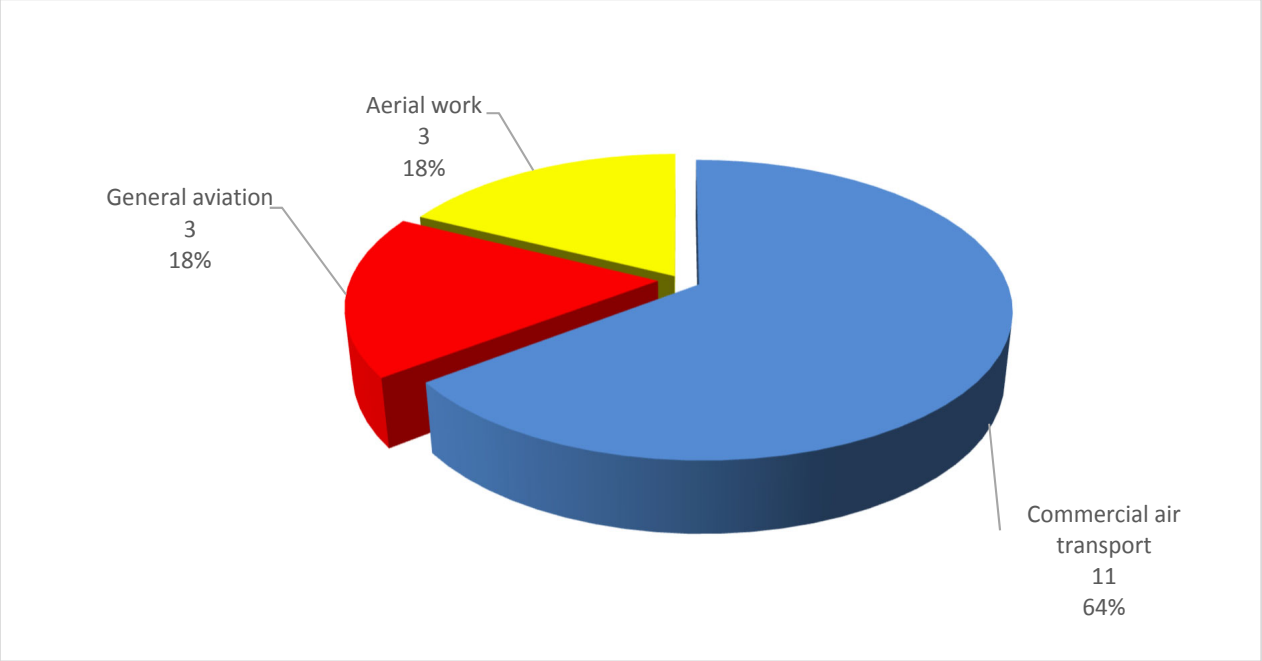
Breakdown by recipient

The DGAC, the DSNA, EASA and the FAA were the main recipients of recommendations in 2020.



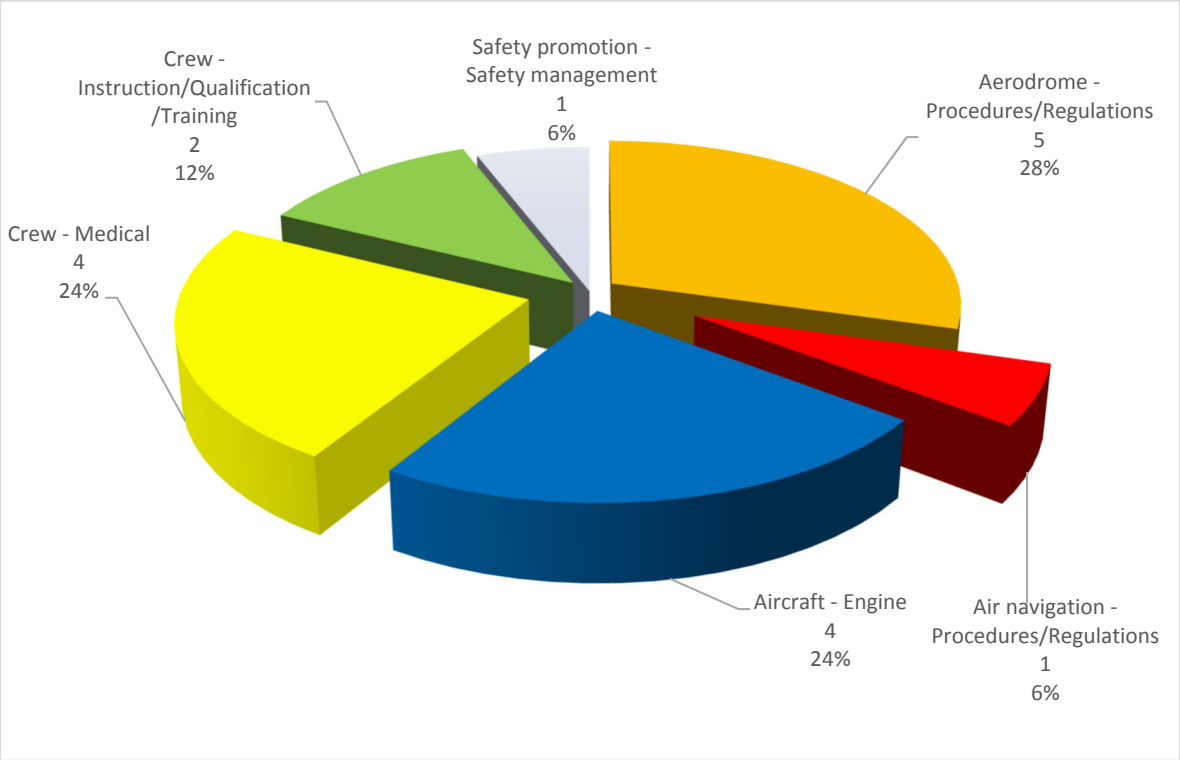
Recipients of recommendations

Breakdown by type of operation



Themes of recommendations

The breakdown of recommendations issued in 2020, by theme, includes six areas in which safety actions were recommended. The breakdown is as follows:



Breakdown of recommendations by theme

4.3 RESPONSES TO SAFETY RECOMMENDATIONS

As regards the follow-up to the 17 recommendations issued by the BEA in 2020:

- ◊ four recommendations received a favourable response; none of these recommendations were closed by the recipient;
- ◊ one recommendation was closed by its recipient with an unfavourable response;
- ◊ four recommendations received a response from the recipient indicating that action was under way;
- ◊ as at 31 March 2021, two safety recommendations published in December 2020 are still awaiting a response from the recipient authority.

4.4 PERFORMANCE INDICATOR FOR SAFETY RECOMMENDATIONS

The BEA has established a recommendation performance indicator. The indicator reflects a qualitative evaluation of the appropriateness of the action envisaged or actually taken by the recipient in comparison with the action expected by the BEA.

For each recommendation issued, the BEA recommendations board (Corec) will assign a performance indicator (between 0 and 1):

- ◊ either when it decides to close the recommendation;
- ◊ or when receiving the final response from the recipient.

The recommendation general performance indicator is then determined by calculating the mean value of the indicators of each recommendation evaluated.

In 2020, the BEA closed 35 recommendations and the overall value of the indicator was 0.82, slightly up on last year's figure of 0.75. The following table shows the breakdown of the appropriateness of the responses to these recommendations for each of the main recipients:

Appropriateness of responses to the BEA's recommendations in 2020 for the main recipients

Recipients	Level
EASA	0.37
DGAC	1
DSAC	1
DSNA	0.80
FAA	0.64

REPORT ON LOCKDOWN
FROM 17 MARCH TO 10 MAY 2020 (4/10)

Issuance and follow-up of recommendations

The Recommendations board (COREC) is an internal BEA body which meets to:

- ◊ approve recommendation projects prior to consultation with the stakeholders;
- ◊ approve recommendations to be issued following consultation with the stakeholders;
- ◊ ensure the follow-up of the recommendations issued (examination of responses given by the recipients with regards to the recommendations issued).

It was possible to schedule the COREC meetings according to the principle established by the BEA, namely to hold one or two meetings per month depending on the number of draft safety investigation reports containing safety recommendations to be examined. The BEA organised via videoconference between 16 March and 11 May 2020:

- ◊ two COREC meetings during which five draft safety investigation reports containing a total of 10 recommendations were examined before being submitted for consultation, along with 16 responses received from the recipients of recommendations;
- ◊ one special COREC meeting that was more specifically dedicated to the review of 11 responses received from the recipients of recommendations.

Within the context of these COREC meetings, the BEA issued a total of 27 notification letters in response to letters received from the recipients of recommendations. The writing, approval, signature by the BEA's director, recording and sending operations were exclusively electronic.

Six further reports published in the week following the lifting of lockdown restrictions are to be added to the figures above.

5. ENGINEERING DEPARTMENT ACTIVITIES

Accident to the Piper PA28 registered HB-PNP on 23 July 2020 at Bâle-Mulhouse (Haut-Rhin).
Investigation in progress

5.1 OVERVIEW OF ENGINEERING DEPARTMENT ACTIVITY IN 2020

The volume of activity of the Engineering Department in 2020 was lower than in 2019, with a total of 392 examinations of all types (versus 561 the previous year). This decline is arguably linked to the health situation but varies according to the type of examinations considered.

Occurrences generating particularly high workloads or complex or highly technical work within the Engineering Department include:

- ◊ Important search work into the cause of a fire that broke out during a flight of the Piper PA28 registered HB-PNP on 23 July 2020 in the region of Bâle-Mulhouse.
- ◊ The closure of the investigation into the loss of an engine of the Airbus A380 registered F-HPJE which occurred in 2017 over Greenland (Denmark), and actions to inform the aeronautical community (see focus section at the end of this document).
- ◊ The accident to the Airbus A320 registered AP-BLD in May 2020 in Karachi (Pakistan), for which the BEA carried out a readout of the flight recorders and other technical examinations.
- ◊ The readout by the BEA in July 2020 of the flight recorders on board the Boeing 737 registered UR-PSR, shot down in January 2020 after taking off from Tehran (Iran).

5.2 WORK BY PESA (FLIGHT RECORDERS AND AVIONIC SYSTEMS SECTION)

5.2.1 FLIGHT RECORDERS

In 2020, 25 CVR recordings and 54 flight data recordings were read out and used at the BEA, representing a total of 79 recordings. This activity was stable in relation to that of the previous year (78 recordings). Over two-thirds of these recordings concerned investigations in which the BEA participated as an accredited representative, or work carried out as part of the provision of technical assistance to third party countries.

	BEA investigation	BEA Accrep	Technical assistance	Total
CVR recordings read out at the BEA	4	16	5	**25**
FDR recordings read out at the BEA	10	37	7	**54**

5.2.2 AVIONIC SYSTEMS

In 2020, the BEA's avionics lab read out 112 computers*, to which can be added work on photo and video recordings as well as on laptops and smartphones. With a total of 161 examinations, this activity has substantially dropped off, following several years of strong growth: 254 examinations in 2019, 231 in 2018, 189 in 2017, 152 in 2016 and 137 in 2015.

	BEA investigation	BEA Accrep	Technical assistance	Total
Computers	73	32	7	**112**
Laptops/Smartphones	21	0	5	**26**
Photo/video recordings	16	7	0	**23**

* The term "computer" groups various types of avionic and GNSS (Global Navigation Satellite System) equipment.

5.2.3 ATM RECORDINGS

In 2020, 48 occurrences led to work on Air Traffic Management (ATM) data, based on radar data or Air Traffic Control (ATC) exchanges. The level of this activity remained stable with respect to the previous year, in which there were 50 examinations. This type of work related essentially to investigations led by the BEA.

ATM work by type of investigation was split as follows:

	BEA investigation	BEA Accrep	Technical assistance	Total
Number of events	44	3	1	**48**

5.2.4 DEVELOPMENT WORK

Several projects were conducted at PESA for the build-up of equipment or the development of analysis tools.

In the avionics laboratory, the desoldering machine was fitted with a high-definition camera to better control the process of desoldering electronic components to extract data from damaged systems. Equipment to check the ESD (Electrostatic Charge Dissipation) standards was also deployed.

In the audio laboratory, a complete CVR acquisition system (notably including a cockpit area microphone, an amplifier unit and cables to the CVR) was developed. This equipment is used to make recordings on board aircraft, on the ground or in flight, without necessitating removal of the CVR. This technique is used in particular to relatively easily acquire noise references in cockpits. Within the context of future investigations, it will therefore be more easy to identify noises heard when listening to CVRs. The system modules differ from one aeroplane to another and require the acquisition of different types of microphones and amplifier units; the system has already been successfully tested on ATR aeroplanes to record different noises in the cockpit.

Within the context of photogrammetric work, the BEA has implemented a calibration polygon at its premises to calibrate cameras. This technique should improve the analysis of different kinds of video sources, which is being increasingly used in investigations. Flight path reconstruction using videos taken on board an aircraft is one way in which photogrammetric techniques are used. Moreover, within the context of image processing work, the BEA has equipped itself with a 3D scanner that was used to produce a 3D model of flight recorders for illustrative and training purposes.

Since January 2018, the laboratory has also been working on adapting an automatic speech transcription system to be used to support CVR transcription work. In 2020, focus was placed on adapting models to the CVR domain and the assessment of performance gains. An intermediate deliverable comprising a version of the system with a minimalist graphic interface was deployed on a dedicated server and made available to expert investigators in the audio laboratory. Further developments need to be made to improve the process of segmenting the audio recording (automatic identification of the speakers' speech segments) and to reduce the number of errors.

Lastly, within the context of a quality process, the section implemented a harmonization of its procedure models and laboratory equipment monitoring sheets, as well as a standardised referencing of all procedures.

5.3 WORK BY PSEM (STRUCTURE, EQUIPMENT AND ENGINES SECTION)

5.3.1 EXAMINATIONS CARRIED OUT

In 2020, the PSEM performed 109 examinations. Most of the work was carried out within the context of investigations led by the BEA, with some also being carried out within the framework of accredited representations. Activity dipped significantly in relation to 2019 (184 examinations).

The examinations performed can be broken down as follows:

	BEA investigation	BEA Accrep	Technical assistance	Total
Wreckage examinations	41	1	0	**42**
Engine and propeller examinations	13	0	0	**13**
Fluid examinations	2	0	0	**2**
Equipment examinations	37	14	1	**52**

5.3.2 PSEM DEVELOPMENT WORK

Acquisition of a Scanner

The BEA is making plans to renew its X-ray analysis and scanning (3D visualisation of parts) capabilities through the acquisition of a scanner to replace a radioscope that was equipped, over time, with scanning options. This operation will increase its capabilities in terms of the examination of larger and denser parts. In 2020, in coordination with the PESA, which will also use the equipment, the PSEM prepared the technical specifications that should enable procurement in 2021.

Work carried out as part of the "Icing" study in 2020

For a number of years, the BEA, and more specifically the PSEM, committed to a study aimed at consolidating the investigation process with regards to the phenomenon of icing that can initiate in the air intake systems of piston engines. This phenomenon crops up regularly in safety investigations as a cause of or a factor contributing to an occurrence, in particular when no other hypothesis is available and, in most cases, without there ever being certainty regarding the appearance of this phenomenon.

During 2020, the following work was carried out as part of this study:

- ◊ Summary of data identified during the bibliographical search initiated in 2019:

This bibliographical search focused on publications by authorities concerning this phenomenon, on the approach of the different investigation bodies, on information issued by manufacturers and on scientific articles relating to this phenomenon. The summary highlighted the small amount of specific and clearly referenced data in this field. The way in which the phenomenon is considered in the reports of the different investigation bodies essentially consists of hypotheses focusing on the most common symptoms (reduction in power and presence of vibration) and recommendations on the use of a device to heat the carburettor.

- ◊ Measuring the temperature and relative humidity in flight on six aircraft equipped with a Rotax 912 series engine:

The aim was to gain a better understanding of the operating conditions of carburettors equipping these engines. During the flights, the phenomenon was not observed despite conditions conducive to icing according to the diagram published by EASA.

- ◊ Preparation of a ground testing campaign on a TB10 powerplant installation in partnership with and using the resources of the DGA.

An overall summary report of this study will be drafted in 2021.

Quality process

The PSEM undertook a quality process involving the harmonisation of job descriptions, safety sheets and equipment monitoring sheets.

REPORT ON LOCKDOWN FROM 17 MARCH TO 10 MAY 2020 (5/10)

Engineering Department activities

The BEA's Engineering department's activities, which had to be adapted to varying degrees during the lockdown period, can be categorized as follows:

- ◊ laboratory-based examinations;
- ◊ examinations at non-BEA centres (private or public partners);
- ◊ data analysis work resulting from examinations;
- ◊ writing of technical documents;
- ◊ assistance with shared actions with the Investigations Department to make progress on and draft investigation reports;
- ◊ project progress meetings including meetings with external partners;
- ◊ quality process in the laboratory and, more generally, within the BEA.

During lockdown, the only Engineering Department activity that was stopped completely concerned examinations conducted at non-BEA centres. A few examinations of an urgent nature were carried out in the avionics laboratory and the materials and failure analysis laboratory. This small number of examinations carried out during lockdown -in compliance with the health rules in place- meant that the investigations in progress were not held up and provided material to be analysed and written up by staff working from home.

The writing of technical documents and the submitting of content for investigation reports continued nominally throughout the lockdown period. The reduction in new investigation activity and travel allowed staff to devote a lot of their time to analysing and writing and to significantly shorten the list of pending documents. This, combined with the few examinations carried out during the lockdown period, enabled the avionics laboratory to work its way through practically all of the work for which results were pending.

Making use of various teleconferencing platforms, management meetings, working groups, and meetings to discuss progress on technical matters took place pretty much as normal. Some meetings were also held with external partners.

The relative decline in investigation activity enabled staff to focus on long-term projects and on improving quality processes at the laboratory and with other BEA entities (definition of the avionics laboratory redevelopment project, management of sensitive data, WIKI and GED architecture, considerations of the implementation of quality processes at the laboratory).

In terms of WFH, some analysis work could only be conducted by the local use of specific software. Use of the LEA software designed to analyse flight recorder parameters was therefore made possible using a "stand-alone" version. Different from the version used at the laboratory and dependent on the Matlab software, this version came with a limited number of licences. Other work could not be performed on staff laptops. Therefore, work on some audio data of a sensitive nature was carried out using dedicated Go-Team PCs, onto which information was temporarily loaded from the BEA network before being deleted once the work was completed.

6. INTERNATIONAL ACTIVITIES, COMMUNICATION & TRAINING ACTIONS, INFORMATION FOR FAMILIES

The BEA undertakes many activities on the European and international scene: communication activities through its participation in international conferences, the setting up of cooperation agreements with foreign investigation authorities, organising training seminars in France and abroad and participating in working groups in international organisations (in particular the European Union, ECAC and ICAO).

In addition, the BEA has a duty to provide information to victims of aviation accidents, or their families. This duty is mentioned in European regulation No 996/2010.

6.1 COMMUNICATION ACTIVITIES IN PROFESSIONAL FIELD

Every year, the BEA participates in several conferences and expert meetings. This allows the BEA not only to spread safety messages based on investigations that it has led or participated in, but also to make its investigation expertise more widely known abroad. This reputation and keeping in close contact with its counterparts are essential tools for the success of its work during investigations abroad.

A lot of international conferences were however cancelled due to the pandemic whilst some were able to take place "virtually", in particular:

- The Middle East and North Africa Society of Air Safety Investigators (MENASI): during this conference of the Middle East and North Africa branch of the ISASI, the BEA presented its experience of a safety investigation as an accredited representative in a major accident during the pandemic.
- The EASA Rotorcraft Symposium: this European forum on rotorcraft safety for authorities, operators and industries is held annually. In 2020, a BEA investigator worked on placement at the EASA for several weeks. During his placement, he actively prepared and took part in this symposium.
- GADSS & SAR Symposium: a series of three webinars on the Global Aeronautical Distress and Safety System (GADSS) was organised. The aim of this initiative was to increase awareness of the GADSS and to present the practical implications of its implementation. More than 350 people attended the webinars organised by EUROCONTROL in partnership with the Irish Aviation Authority (IAA), the BEA and the ICAO's EUR/NAT regional office. The expectations of search and rescue (SAR) organisations are extremely high. The performance of search and rescue operations largely depends on the organisation of services and the implementation of the cooperation and collaboration between services in the different ICAO regions. The implementation of new standards pertaining to the GADSS concept at ICAO and European level will not only help to improve aviation safety but will also provide the opportunity to review and improve existing SAR procedures.

6.2 COLLABORATION WITH FOREIGN INVESTIGATION ORGANISATIONS

Through its experience and know-how, the BEA is recognised as one of the most important safety investigation authorities. As such, it is regularly consulted by many States for assistance in the monitoring of the implementation of the standards and practices recommended by ICAO. It was in this context that in 2020, the BEA signed two Declarations of Intent for Cooperation in investigations into civil aviation accidents, with Cyprus and Pakistan respectively.

Declarations of Intent for Cooperation have been signed with a total of 56 countries. This document proposes assistance, within the bounds of reasonable limits, in case of a major investigation. One of the main outcomes of this cooperation is the provision of technical assistance by the PSEM and PESA sections of the Engineering Department (this technical assistance activity is described in chapter 5 above).

It should be noted that, with regard to Cyprus, this principle of cooperation is in keeping with the assistance procedures promoted by ENCASIA (see paragraph 6.3.2) and mentioned in article 7 of Regulation (UE) No 996/2010.

6.3 PARTICIPATION IN THE WORK OF INTERNATIONAL ORGANISATIONS

6.3.1 INTERNATIONAL CIVIL AVIATION ORGANISATION (ICAO)

The BEA plays an active role in several of the ICAO's groups of experts. The operation of some of these groups was impacted by the health situation, although, generally, activity continued albeit to a lesser extent:

- Accident Investigation Group Panel (AIGP): a BEA staff member chairs this group of experts, which is mandated to study amendments to Annex 13. Another BEA expert also chairs a sub-group responsible for analysing the reasons why some investigation authorities do not make all final investigation reports public after accidents involving commercial air transport aeroplanes. The plenary session of the AIGP was cancelled in 2020 due to the pandemic, but the work of the sub-groups continued as normal with meetings held via video conferencing.

◊ ICAO's Flight Recorder Specific Working Group (FLIREC-SWG): this group of experts is responsible for proposing amendments to ICAO Annex 6 and in particular, with respect to the carrying of flight recorders. The plenary session was cancelled due to the pandemic.

◊ Safety Information Study Group (SISG): this group reviews accidents and incidents which occurred the previous year to establish statistics per occurrence category. This group's operation was not impacted by the pandemic, and the BEA was able to continue to contribute as normal to the establishment of the database of accidents and incidents used by the ICAO to establish general statistics regarding global aviation safety.

◊ ICAO's GADSS-AG Working Group: the aim of this group is to update the actions to be taken as part of the GADSS concept, particularly taking into account the lessons learnt from the AF 447 accident (over the Atlantic in 2009) and the MH 370 disappearance (over the Indian Ocean in 2014). The BEA participated in six video conferences that were organised in 2020. In addition to this work, the BEA attended the aforementioned GADSS & SAR webinars hosted by EUROCONTROL that were organised to assess the concrete benefits linked to the development of documents produced by the GADSS-AG.

◊ ICAO's RASG-EUR (Regional Aviation Safety Group - Europe): under the umbrella of this group, the BEA is actively involved in the European Aviation System Planning Group (EASPG), which replaced the IE-REST (ICAO Europe Regional Experts Safety Team) mentioned in previous versions of the activity report and which brings together 52 European States. The group primarily focuses on developing methods and implementing shared tools for occurrence reporting and data analysis. The EASPG also offers an opportunity to strengthen ties, in particular with authorities in Eastern European countries (Russia, Georgia, Ukraine, etc.).

6.3.2 EUROPEAN UNION (ENCASIA)

Regulation (EU) No 996/2010 created the European Network of Civil Aviation Safety Investigation Authorities (ENCASIA) to coordinate the work of and feedback from the EU's various investigation authorities. The BEA's Director has been the chairman of ENCASIA since 2017.

In the context of ENCASIA's work, the BEA is a key player in the various permanent working groups. The BEA is very involved in the following working groups:

- ◊ Peer reviews between European investigation authorities. Phase one of these reviews was completed in 2019. This meant that the writing of the summary report could be finalised in 2020, and the foundations of a phase two set up.
- ◊ Promotion of mutual support between all European investigation authorities. The main aim is to guarantee that all air transport accidents, throughout Europe, are the subject of a suitable investigation and that lessons are learnt and shared to avoid any repeat occurrences. This ENCASIA Mutual Support System (EMSS) provides one example of the BEA's extensive involvement in a medium to long-term project.
- ◊ Relations between the ENCASIA and EASA. In 2020, the group reported its findings aimed at improving relations. These findings will be incorporated in operational procedures by another group of the ENCASIA.
- ◊ Development of the new version of the ECCAIRS. This new version notably comprises a module concerning safety recommendations: the monitoring of these developments is deemed particularly important by the ENCASIA to ensure the sustained availability of safety lessons.

6.3.3 EUROPEAN CIVIL AVIATION CONFERENCE (ECAC)

The BEA's Director is the vice-chair of the Group of Experts on Air Accident and Incident Investigation (ACC) bringing together the 44 Member States of the European Civil Aviation Conference (ECAC), a forum for exchanging feedback. The ACC holds meetings every six months and these were held via video conference in 2020. These provided an opportunity for the BEA to give an update on the investigations opened in 2019 to its European counterparts. We also note the publication in 2020 by the ACC of a guidance memo on the best practices for safety investigations during a pandemic.

6.3.4 EUROPEAN ORGANISATION FOR CIVIL AVIATION EQUIPMENT (EUROCAE)

EUROCAE is a European organisation that publishes reference documents on specifications for onboard systems. EUROCAE works in close coordination with the RTCA, its American counterpart, in many fields. EUROCAE and RTCA documents are written by representatives of the aeronautical community.

The work of the EUROCAE concerning the BEA was not affected by the pandemic: meetings of the working groups (WG) it participates in were organised by video conference from March 2020 onwards.

The BEA has chaired various EUROCAE working groups over the last 20 years, and in particular WG-98, a joint EUROCAE-RTCA group. In June 2020, this working group published an amendment to a document which, in particular, defines the specifications for new generation Emergency Locator Transmitters (ELT), which are activated in flight when an emergency situation is automatically detected by the aircraft systems. These specifications are based on recommendations issued by the BEA as part of the investigation into the accident to flight AF 447 from Rio to Paris. These documents are now referenced by ICAO standards and all international regulations (FAA, EASA, etc.). They are an essential component of effective regulatory changes to improve aviation safety.

A sub-group of the WG-98, which the BEA actively contributes to, is currently developing the specifications for the Return Link Service for ELTs. This functionality will, in particular, inform people in distress that the ELT signal has been picked up and that the emergency services are on their way. This sub-group now plans to publish RLS specifications in 2021.

A new group, the WG-118, was created in 2020 to review the specifications concerning flight recorders (ED-112A) and light flight recorders (ED-155) and to develop new specifications for the recordings of unmanned aircraft systems (UAS[16]) and Remotely Piloted Aircraft Systems (RPAS). Several BEA investigators actively take part in the working groups and were able to attend all of the scheduled video conferences.

6.4 INVESTIGATOR TRAINING ORGANISED BY THE BEA AND BEA PARTICIPATION IN ENAC TRAINING

The investigator training organised by the BEA generally comprises each year:

- Two courses in Basic Investigation Techniques: these courses, which last two weeks, are mainly intended for investigators recently recruited by the BEA and for Field Investigators. Two places are systematically reserved in each session for the air transport gendarmes (GTA). In 2020, the training course initially scheduled for March was cancelled. October's course went ahead on site and was attended by ten new Field investigators, four BEA staff (three investigators and one member of the administrative personnel), and two gendarmes.

[13] UA designating a drone.

- One advanced training course for investigators (two-week, phase-three training course intended for experienced investigators). This training course was cancelled in 2020.

Furthermore, each year, the BEA participates in different training courses provided at the ENAC in the form of safety investigation information modules:

- ENAC Engineers' Course (IENAC): two days per year (one day for full-time students and one day for sandwich-course students).
- Control Engineers' Course (MCTA - Air Traffic Control and Management): two half-days per year.
- Senior Technicians' Course (GSEA): two half-days per year.
- MS-SMA Master (Safety Management in Aviation): one day per year.
- MS-AM Master (Airport Management): one half-day per year.
- MS-ASAA Master (Aviation Safety / Aircraft Airworthiness): one half-day per year.
- NAVIG training course (Aircraft Airworthiness): one half-day per year.

With the exception of the NAVIG training course and one of the MCTA course talks, all of these training courses went ahead in 2020, the majority via teleconferencing.

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FROM 17 MARCH TO 10 MAY 2020 (6/10)

International activities

European activities

The activity programme of the European Network of Civil Aviation Safety Investigation Authorities (ENCASIA) was established during its plenary meeting in February 2020. The programme was significantly impacted by the lockdown measures implemented in most European countries. In particular, the European workshop concerning interactions with judicial authorities scheduled for spring 2020 had to be postponed.

However, the ENCASIA working group on peer reviews (WG5), in which the BEA is highly involved, was able to finalise its report establishing its summary of the 30 reviews conducted over the last few years.

ICAO work

Three BEA staff actively contribute to the work of the AIGP. They chair this panel as well as two working groups (WG) set up by the panel. A plenary meeting scheduled to take place from 12 to 15 May 2020 was postponed without a new date being fixed.

With the drafting of the working group work documents remaining in line with the initial schedule, it should be possible to organise the plenary meeting as soon as possible. These documents notably concern the following working groups:

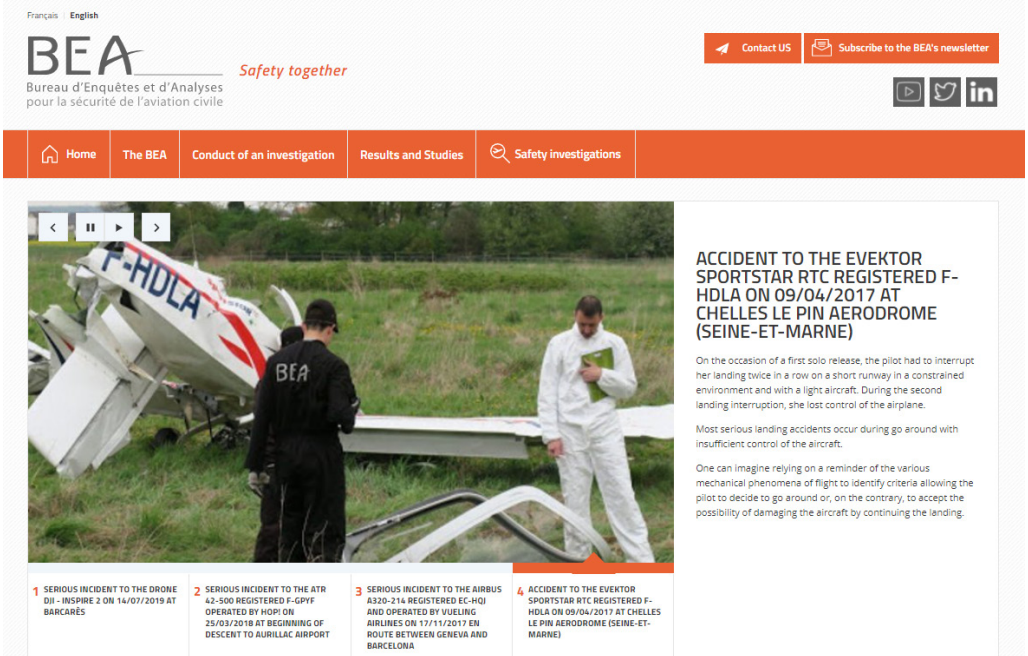
- ◊ safety investigator training;
- ◊ safety investigation responsibilities - relations between investigation authorities and civil aviation authorities;
- ◊ safety recommendations global coverage (SRGC);
- ◊ availability and protection of flight data in association with the GADSS concept (in particular regarding the transmission in real flight time of flight data and the retrieval of ejectable recorders);
- ◊ reasons for which final safety investigation reports are not made public. This WG conducted a high volume of work into the analysis of the publication of the investigation reports into 1,159 fatal accidents of aeroplanes of more than 5.7 t worldwide;
- ◊ underwater searches during safety investigations.

EUROCAE work

Alongside work at ICAO level, the BEA actively participates (as Chair) in the EUROCAE working group responsible for drafting specifications for new generations of Emergency Locator Transmitters (ELT). This work was able to continue as normal due to the organisation of two meetings in which the production of the group's and one of its sub-group's final documents was finalised. These documents should be published shortly.

6.5 PUBLIC COMMUNICATIONS

6.5.1 WEBSITE



A new version of the website was developed in the first half of the year and underwent extensive testing with the BEA's data management section in order to ensure the consistency of its content. This work enabled this new version to be put on line on 1 October 2020.

This version is an update of version 3 launched in June 2016 and includes, in addition to technical and software updates, the following functions:

- integration of the BEA's Twitter thread on the home page as a News section;
- deletion of the search engine from the home page and deletion of the search engine from the institutional section of the website;
- new faceted search engine with customisable filters and new functionalities such as the distinction between BEA investigations and ACCREP investigations, the distinction between open investigations and closed investigations, the distinction between different types of human consequences, etc.;
- simplified and improved newsletter feature;
- greater visibility of safety recommendations issued by the BEA via specific tabs on the occurrence pages concerned and via direct access to the European Central Repository for Safety Recommendations in aviation, SRIS.

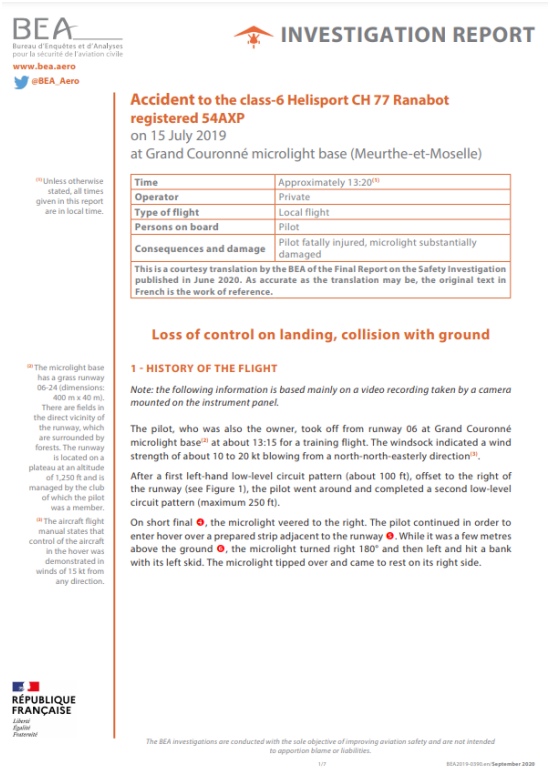
6.5.2 PUBLICATION AND TRANSLATION OF REPORTS

A new process for publishing reports was adopted in 2020 with all documents published by the BEA now published in French and English. This will optimise the visibility of publications (technical reports, final investigation reports, recommendations, etc.) and extend their international reach. Until 2019, only reports classified as "major" were translated. Whilst most reports are translated in-house, some are outsourced depending on the workload of the in-house translators.

Due to the application of this process in 2020, 139 investigation reports of the 189 published were translated (a further five translations of investigation reports that were published in French in 2019 must be added to this number). The English version is, on average, published on line three weeks after the initial French report is published.

Of the 139 investigation reports published in French and in English in 2020:

- ◊ three were ICAO reports;
- ◊ ten were category two commercial air transport reports;
- ◊ seventy-eight were category two general aviation reports;
- ◊ forty-eight were category three reports.



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INVESTIGATION REPORT

Accident to the class-6 Helisport CH 77 Ranabot registered 54AXP
on 15 July 2019
at Grand Couronné microlight base (Meurthe-et-Moselle)

Time	Approximately 13:20[1]
Operator	Private
Type of flight	Local flight
Persons on board	Pilot
Consequences and damage	Pilot fatally injured, microlight substantially damaged

This is a courtesy translation by the BEA of the Final Report on the Safety Investigation published in June 2020. As accurate as the translation may be, the original text in French is the work of reference.

[1] Unless otherwise stated, all times given in this report are in local time.

Loss of control on landing, collision with ground

1 - HISTORY OF THE FLIGHT

Note: the following information is based mainly on a video recording taken by a camera mounted on the instrument panel.

The pilot, who was also the owner, took off from runway 06 at Grand Couronné microlight base[2] at about 13:15 for a training flight. The windsock indicated a wind strength of about 10 to 20 kt blowing from a north-north-easterly direction[3].

After a first left-hand low-level circuit pattern (about 100 ft), offset to the right of the runway (see Figure 1), the pilot went around and completed a second low-level circuit pattern (maximum 250 ft).

On short final ❶, the microlight veered to the right. The pilot continued in order to enter hover over a prepared strip adjacent to the runway ❷. While it was a few metres above the ground ❷, the microlight turned right 180° and then left and hit a bank with its left skid. The microlight tipped over and came to rest on its right side.

[2] The microlight base has a grass runway 06-24 (dimensions: 400 m x 40 m). There are fields in the direct vicinity of the runway, which are surrounded by forests. The runway is located on a plateau at an altitude of 1,250 ft and is managed by the club of which the pilot was a member.

[3] The aircraft flight manual states that control of the aircraft in the hover was demonstrated in winds of 15 kt from any direction.

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

1/7 BEA2019-0390.en/September 2020

Feedback from the entire aeronautical community on this new policy has been very positive. Bolstered by this feedback, the BEA is planning new operations to enhance its work that it aims to implement in 2021.

6.5.3 FORUM WITH THE FRENCH ASSOCIATION OF PROFESSIONAL AEROSPACE JOURNALISTS (AJPAE)

On 29 September, the BEA's Communication Department hosted a forum with members of the AJPAE. This forum provided an opportunity to arrange a visit of the facilities, in particular the laboratory, and to discuss current issues, in particular the investigation into the accident to the Airbus A380 registered F-HPJE operated by Air France, which occurred on 30 September 2017 during cruise flight over Greenland (this investigation is a focus topic in this activity report). This operation made this highly technical investigation more accessible and understandable through the presentation of the investigation process, the methodology and the findings of the final report, carried out in coordination with all BEA staff involved in this major investigation.

6.5.4 INFORMATION FOR FAMILIES OF VICTIMS

In terms of information for families and loved ones of accident victims, the usual meetings organised at the BEA were unable to take place due to the health situation. These were organised remotely if practicable.

REPORT ON LOCKDOWN FROM 17 MARCH TO 10 MAY 2020 (7/10)

External and internal communications

External communication

During the lockdown period, the Communication Department focused both on the publication of investigation reports and on the finalisation of the development of version 4.0 of the BEA website.

The Communication Department used the lockdown period and time freed up due to the slowing down of other tasks to publish an unprecedented number of reports and to finalise the new website ahead of schedule. Therefore, between 16 March and 10 May:

- ◊ forty-three investigation reports (already mentioned earlier) were published in French;
- ◊ seventeen investigation reports were translated into and published in English;
- ◊ one technical report was published in English;
- ◊ the BEA's 2019 activity report was published in French and English.

The new version of the website underwent extensive testing during this final development period in collaboration with the BEA's data management section in order to ensure the consistency of its content. It was scheduled to be commissioned in September 2020.

Internal communication

The BEA paid particular attention to the internal communication to all of its staff, in order to maintain ties between all those working from home:

- ◊ A lockdown-themed newsletter was introduced and sent out weekly by e-mail. This letter incorporated information concerning not only the life and work of the BEA, but also information concerning life at home during lockdown that staff wished to share with colleagues;
- ◊ There was an increase in content published on the intranet.

The objective of these actions was to guarantee comprehensive and quality content to offset the lack of face-to-face meetings and to maintain a social link between all staff.

7. HUMAN RESOURCES & FINANCES

7.1 PERSONNEL

7.1.1 STAFF ON 31 DECEMBER 2020

As of 31 December 2020, the BEA had 92 members of staff divided as follows:

BEA staff	Civil servants	Contractual employees	Workers	Total
Flight crew	-	2	-	**2**
Engineers	42	8	-	**50**
Senior technicians	15	-	-	**15**
Technicians	-	2	5	**7**
Administrative staff	14	3	1	**18**
Total staff	**71**	**15**	**6**	**92**

Note: 2 apprentices and 151 field investigators must be added to the above staff figures. Field investigators are trained by the BEA, and take action at its request, under its supervision and authority, generally as part of general aviation investigations. Most field investigators hold positions in DGAC departments, or to be more precise DSAC Inter Regional departments. They are covered by a service contract concluded between the BEA, the DSAC and the DGAC Secretary General.

7.1.2 REGIONAL BRANCHES

The majority of the BEA's staff work at Le Bourget site but 11 are based at the different regional branches (staffing on 31 December):

- Rennes: 2 investigators.
- Bordeaux: 1 investigator.
- Toulouse: 3 investigators and 1 member of IT staff.
- Aix-en-Provence: 3 investigators.
- Lyon: 1 investigator.

Following the retirement on 1 January 2021 of the investigator at Bordeaux, the decision was made to close the branch at this date. However, a new investigator will be assigned to the Lyon branch.

Regional branches enable the BEA to ensure a better-distributed presence in Metropolitan France and specifically:

- ◊ in regions of high recreational general aviation activity;
- ◊ near the main aeronautical manufacturers.

They are housed in premises made available by the DSAC as part of the service contract between the BEA, the DSAC and the DGAC Secretary General (already mentioned in paragraph 7.1.1).

7.1.3 PERSONNEL TRAINING

The BEA spends a significant part of its budget on professional training in order to guarantee a high level of skills for its personnel in various areas, vital for its activity.

In 2020, the budget devoted to the professional training of 80 staff was €204,596. This represents 12% of the annual operating budget and close to 10% of the overall annual budget. The amount spent on training saw a sharp rise, up 30% on 2019. This is partly due to the 2019 training budget having been reduced to fund wreckage search operations on the operating budget; despite the health crisis, the majority of the training actions scheduled for the year took place after the lifting of the spring lockdown. In the context of the pandemic, the BEA succeeded in maintaining most of its annual training programme.

This training budget financed 200 training actions for 80 staff members. These training actions represented a total of 700 days, which gives an average of 8.75 days of training per staff member.

On a basis of 208 working days each year, the training courses represent 3.36 person-years and were in the following areas: language training (mainly English), technical training courses with specialised organisations related to investigations, manufacturers' training courses and flight training.

The initiative launched in 2016 to enable staff who are type rated on passenger planes to periodically undertake commercial air transport flights as a First Officer was set to continue in 2020. However, the significant drop in commercial air traffic due to the global health crisis did not enable this goal to be achieved. The BEA agreed to ensure the renewal of the ratings of its pilot investigators, in the hope that they will be able to resume activities with airlines as soon as the situation allows. The experience gained has proved to be very useful in conducting some complex investigations in commercial air transport.

REPORT ON LOCKDOWN
FROM 17 MARCH TO 10 MAY 2020 (8/10)

Social and Human Resource aspects

The BEA focused largely on maintaining usual social dialogue and contacts both between the management and staff representatives, as well as between staff and their managers.

Special Technical Committee (STC)

A meeting of the BEA's Special Technical Committee was held by teleconference (WEBEX) on 15 April 2020. This day-long meeting covered general topics as well as hygiene, safety and working condition topics (the BEA does not have a Health, Safety and Working Condition Committee).

Around fifteen people took part: staff representatives, administration representatives, the occupational health physician, a social worker and experts.

The use of teleconferencing enabled remote presentations to be given and documents to be shared, so the meeting was held in near-normal conditions.

This meeting notably led to the issuance of a favourable opinion regarding the following two key documents:

- the Unique Professional Risk Assessment Document;
- the Annual Risk Prevention Programme.

Covid-19 Special Technical Committee

Extraordinary weekly meetings of the STC were organised to exclusively discuss lockdown-related issues.

The following points were discussed with staff representatives during these meetings:

- work organisation during lockdown;
- monitoring of staff (work difficulties, prevention of solitude);
- imposed taking of annual leave during the lockdown period.

Local Monitoring Committee (LMC)

As most of the members of the BEA's Local Monitoring Committee (LMC) also attend Technical Committee meetings, it is usual for these meetings to be held on the same day.

Statistics on days worked, leave days and days present at the BEA and comparison with the same period last year

The situation of BEA personnel was precisely monitored during the lockdown period and the information collected was used to create the following table covering the period from 17 March to 10 May 2020 and the equivalent period the previous year.

	Staff on leave time off for working time reduction, paid leave, TSA, sick leave, etc.	**Staff working** office, mission, training, WFH, etc.	**Staff working from home** percentage of the number of working agents
2020 (lockdown period)	13%	87%	92%
2019 (equivalent period)	15%	85%	4%

Overall, it can be observed that there was very little difference in the number of days worked and the number of leave days or time off for working time reduction year-on-year. The hours worked were mostly worked from home.

We can estimate that, on average, six BEA staff travelled to their place of work each day during the lockdown period. This mostly constituted one-off visits to the workplace (ranging from several minutes to a full day) in order to collect equipment or documents, or to carry out some tasks which required the member of staff to be physically present on site, such as:

- ◊ troubleshooting and maintenance of IT tools, supply of computer equipment to staff;
- ◊ extraction of data from recorders and avionics systems required to continue with certain investigations at home;
- ◊ access to HR management and finance management software only accessible at the workstations at the BEA (specifically the case for some DGAC software);
- ◊ building maintenance and upkeep.

Note: regardless of the length of the visit, the member of staff was counted as working at the office for a full day in the table above.

Contact between staff and their managers

Regular contact (at least weekly) was maintained between staff and their managers in order to:

- ◊ organise the department;
- ◊ identify any specific problems encountered, prevent staff from feeling isolated and prevent psychosocial risks.

REPORT ON LOCKDOWN
FROM 17 MARCH TO 10 MAY 2020 (9/10)

Logistical Matters

Preparations for the lifting of lockdown

Preparations for the lifting of lockdown included the purchase and implementation of different resources, in particular:

- ◊ hand gel dispensers in the building;
- ◊ equipment disinfectant products distributed to staff;
- ◊ installation of microwaves for use by personnel to compensate for the closure of the shared company canteen;
- ◊ signs to remind personnel of the health instructions, limit the number of people in meeting rooms and implement a one-way system in some areas of the building.

In addition, it was necessary to disinfect all water fountains and to replace water containers, in liaison with the service provider.

Availability of personal protective equipment (FFP3 masks) for medical staff

Following the number of calls from medical staff, and in the scope of the application of decree No 2020-247 of 13 March 2020 setting out the requisitions required to fight the Covid-19 virus, the BEA contacted the nearby Gonesse hospital to provide it with personal protective equipment, which included in particular a stock of 500 FFP3 masks, 1,500 surgical masks and approximately 200 disposable gloves and overalls. Stocks were delivered by the Logistics division at the height of the health crisis. A minimum stock was kept to meet needs during the first weeks of the resumption of activity.

Security service, preventive and curative maintenance

The BEA building is continuously manned as part of a security contract. The BEA contacted the service provider to ensure the continuation of this service despite difficulties encountered due, in the main, to the blocking of some employees at their place of lockdown.

The cleaning of the building by a service provider was partially suspended during the lockdown period.

Preventive and curative maintenance of the building was carried out by the Logistics division team:

- ◊ upkeep of green spaces (shifts put in place to ensure watering);
- ◊ twice-weekly check of sanitary facilities to prevent the stagnation of water and check for any leaks.

Support for personnel and maintenance of non-IT equipment provided

The Logistics division provided telephone support for personnel to resolve communication problems encountered on mobile phones, notably when switching to the new operator.

The division also provided guidance to staff and assisted staff with technical problems and BEA vehicle breakdowns.

7.2 BUDGET

7.2.1 ALLOCATIONS

The BEA budget was set in the initial finance law at €3.09 million in commitment authorisations (CA) and payment appropriations (PA).

This budget received an allocation representing a total of €0.02 million in CA and PA. This allocation was from the sale of vehicles and various moveable assets.

The amending finance law of 2020 cancelled €0.31 million in CA and €0.28 million in PA.

This drop in funding was accommodated by saving measures in relation to operating appropriations. It corresponded to a reduction in some of the BEA's operational activities during the lockdown period, which in particular resulted in a significant reduction in travel abroad.

The total consumption of the BEA was €2.09 million in CA and €2.23 million in PA.

7.2.2 EXPENDITURE FOR THE PERIOD

Services	Operation		Investment	
	CA (€)	PA (€)	CA (€)	PA (€)
Logistics	804,255	811,622	337,903	338,360
Travel	288,678	288,678		
Communication	45,072	71,851		
Training	204,716	182,844		
Engineering	213,905	222,903	34,800	95,770
Information Technology	153,638	206,723		
Investigation support	6,314	10,545		
Total (€)	**1,716,578**	**1,795,166**	**372,703**	**434,130**

REPORT ON LOCKDOWN
FROM 17 MARCH TO 10 MAY 2020 (10/10)

Budget and finance matters

The health crisis grounded commercial air traffic from mid-March 2020 leading to a drop in the associated budget revenue which required a rapid reduction in expenses, the BEA's contribution being €350,000 both in CA and PA.

The reduction in budget allowance was accommodated by savings of €250,000 in relation to operating credits. It corresponded to the almost complete cancellation of the BEA's operational activity (missions) for the spring lockdown period.

On the other hand, €100,000 of investment expenses were carried over to the next reporting period.

Budget use as at 30 April 2020

Services	Year 2019		Year 2020		Annual variation	
	CA (€)	PA (€)	CA (€)	PA (€)	CA (€)	PA (€)
General support	759,299	447,320	356,564	190,505	-53%	-57%
Professional travel	186,359	186,359	126,311	126,311	-32%	-32%
Communication and public relations	14,392	15,457	12,746	5,343	-11%	-65%
Professional training	80,584	28,397	82,460	34,912	2%	23%
Recorder processing - Wreckage examination - Studies	442,929	163,211	105,600	131,586	-76%	-19%
Information Technology	72,533	91,348	21,841	63,716	-70%	-30%
Technical investigation support	2,204	1,915	40	4,495	-98%	135%
Total (€)	**1,558,300**	**934,008**	**705,562**	**556,868**	**-55%**	**-40%**

Extension of contracts during the spring lockdown

The Public contracts division was highly engaged from the start of the lockdown period in organising the extension of expiring contracts up to the end of 2020.

Moreover, all tender procedures were suspended.

8. FOCUS
INVESTIGATION INTO THE ACCIDENT TO THE A380 REGISTERED F-HPJE ON 30 SEPTEMBER 2017

Certification and continuing airworthiness of engine rotor-grade critical parts made of titanium

This investigation was focused on in previous issues of the activity report, to describe in particular operations involving the search for engine parts on the Greenland ice sheet, in extreme conditions. These operations led to the retrieval of parts, which, when analysed, showed evidence of the phenomena that led to the failure. The final investigation report, published in 2020, incorporated operational aspects and issues relating to the certification and continuing airworthiness of critical rotating parts made of titanium alloy.

Operational Aspects

On Saturday, 30 September 2017, the Airbus A380-861 operated by Air France, was carrying out scheduled flight AF066 from Paris (France) to Los Angeles (USA). It had taken off at 09:50. At 13:49, while the crew were changing en-route flight level, they heard an explosion and observed asymmetric thrust from the right side of the aeroplane, immediately followed by severe vibrations. The "ENG 4 STALL" and then the "ENG 4 FAIL" messages nearly simultaneously appeared on the ECAM. The crew diverted to Goose Bay airport (Canada) where they landed at 15:42 without any further incident.

The examination of the flight recorders and the crew statements brought to light certain operational aspects which, although they were not the subject of recommendations, are of particular interest for safety.

- ◊ The flight crew noticed that they were unable to hold the driftdown level calculated by the FMS (EOMAX FL) at a constant speed and were not able to estimate the altitude which the aeroplane could hold. They started a step down descent to finally stabilise around 7,000 ft below the expected level. The increased drag resulting mainly from the damage to engine No 4 explains the difference in stabilisation level. The Engine Fail procedure does not refer to possible degraded aerodynamic characteristics in the event of a severe failure.
- ◊ The crew were required by regulations to preserve the CVR. Although they were concerned by this before landing, they were not able to perform this task in a reasonable time frame.
- ◊ The decision making method, called FOR-DEC by Air France, proved to be an effective tool for processing the incident. It ensured, via a shared framework known to all of the crew, the adequate temporal management of the occurrence.

Aspects relating to certification and continuing airworthiness

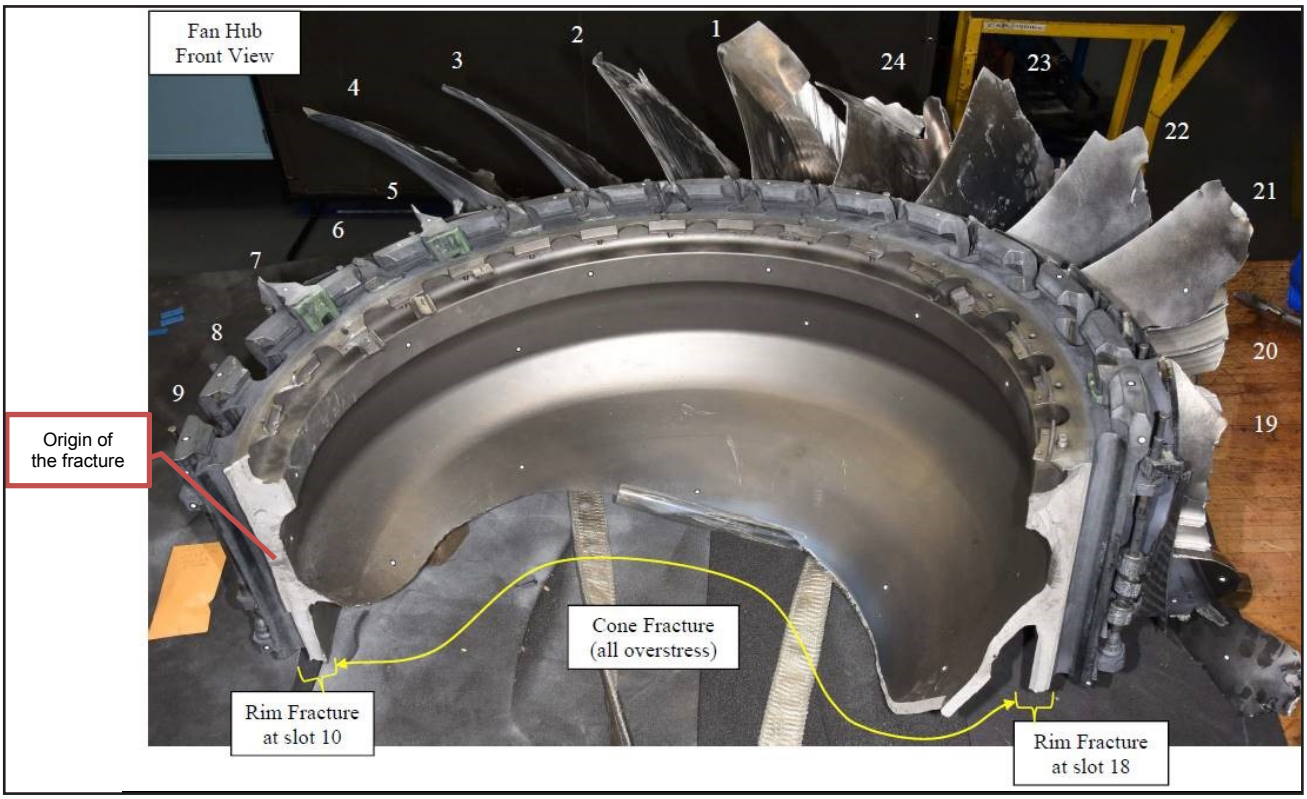
From a technical point of view, a visual examination of the engine rapidly found that the fan, along with the air inlet and fan case had separated in flight leading to slight damage to the surrounding structure of the aeroplane. However, from the examination of the remaining parts it was not possible to identify the cause of the failure.

The search operations on the Greenland ice sheet to try and find the parts took place over a period of nearly two years. A certain number of parts were found during phase I, but the fan hub - the part on which the initial failure occurred - was not located and retrieved until the final phase.

Without waiting to find the fan hub, the engine manufacturer carried out finite element simulations. A fault tree was produced and two scenarios, considered possible, were retained:

- ◊ that of a material defect (although there was no element confirming this);
- ◊ and that of tool damage during a maintenance operation (considered the most likely in view of the manufacturer's in-service experience and the result of the inspections of the engines in service launched after the event).

The examination of this fan hub, when it was finally found, invalidated the above maintenance scenario, which was considered as most likely by the engine manufacturer. Instead, it brought to light a failure resulting from the progression of a crack originating in the part's subsurface. The crack origin was situated in a micro-texture region, also known as a macro-zone, in a slot bottom of the hub (under the blade root). Following a detailed examination of this area it was concluded that the failure was caused by a cold dwell fatigue phenomenon associated with the dwell times under stress during operating cycles.



Fan hub fragment found in Greenland during phase III. The slot numbers are given in white. The fracture surface extends from the bottom of slot No 10 to slot No 18, passing through the conical part of the hub (yellow line).

Titanium alloy Ti-6-4 was not hitherto considered by the industry as sensitive to the cold dwell fatigue phenomenon. Cold dwell fatigue cracks are generally initiated in macro-zones, the presence of which is inherent to the manufacturing process of forged titanium parts. The risk of macro-zones appearing increases with the size of the billets[(14)]. Consequently, large engines are more exposed to this phenomenon than small engines.

[(14)] Titanium alloy cylinder used to forge hubs.

This phenomenon found by the investigation led the BEA to issue two safety recommendations addressed both to EASA and to the FAA. They concern the sizing, manufacturing processes, production checks and monitoring in service of engine rotor-grade critical parts made of titanium and specifically:

- In the long term, the management of the risk of failure due to the cold dwell fatigue phenomenon through the design and sizing criteria and methods along with the manufacturing processes and in-production checks of engine rotor-grade critical parts made of titanium alloy.
- In the short term, a review of engine rotor-grade critical parts made of titanium alloy, as well as an in-service inspection programme to detect incipient cracks which might lead to the failure of the part.

APPENDIX: INVESTIGATION CATEGORIES

Investigations led by the BEA

◊ **Category 1 investigation**: "Major" investigation into an accident to an aircraft operated under an air operator's certificate with a maximum certified take-off weight of more than:

- 5.7 t for an aeroplane, or
- 3.18 t for a helicopter,

during which:

- at least one person on board is fatally injured, or
- an emergency evacuation is required and the aircraft is destroyed, or
- the aircraft is reported missing.

This category is for investigations requiring several areas of organisational and/or systemic analysis and which lead to the writing of a report, using the full structure proposed by ICAO Annex 13. These investigations generally give rise to safety recommendations.

◊ **Category 2 investigation**: This category is for investigations where the areas of in-depth examination and analysis are limited, giving rise to a "simplified report": the structure of these reports may differ from the template provided in ICAO Annex 13 in order to adapt to the circumstances of the occurrence and the priorities of the investigation. These investigations apply for all types of operations. They primarily aim to provide operational feedback, but can also lead to the issue of safety recommendations.

◊ **Category 3 investigation**: Investigation "by correspondence". During these investigations, information is mainly obtained through statements from the parties directly involved. This information is not generally validated by the BEA, and there is no development of an analysis, conclusions or lessons. With this investigation category, the BEA wants above all, to ensure that personal experience is shared throughout the community in question. This investigation category is generally reserved for light aircraft and types of occurrences which do not lead to serious bodily injury, based on past experience.

Investigations opened by a foreign body for which the BEA has been notified

◊ **Category 1 accredited representations**:

- These concern accidents or incidents to aeroplanes with a maximum take-off weight of more than 5.7 t where:
  - o at least one person on board is fatally injured (excluding injuries from natural causes);
  - o an emergency evacuation is carried out and the aircraft is destroyed, or the aircraft is reported missing.
- Or accidents and incidents to helicopters of more than 3.18 t where:
  - o at least one person on board is fatally injured (excluding injuries from natural causes);
  - o an emergency evacuation is carried out and the aircraft is destroyed, or the aircraft is reported missing.

◊ **Category 3 accredited representations**:

- These concern accidents and incidents to aeroplanes of less than 2.25 t:
  - o where the BEA, in theory, does not provide any added value during the investigation;
  - o without a clear link with the reason for accreditation;
  - o where there is no specific request from the authority in charge;
  - o which would be the subject of BEA Category 3 investigations;
  - o listed in Annex 1.
- Or accidents and incidents to aeroplanes of more than 2.25 t
  - o where the BEA, in theory, does not provide any added value during the investigation;
  - o without a clear link with the reason for accreditation;
  - o where, in theory, there are no benefits or stakes for the advisor and/or the BEA;
  - o which would not give rise to the opening of a BEA investigation in France;
  - o where there is no specific request from the authority in charge;
  - o where there is no justified request from the advisor.
- Or helicopter accidents and incidents:
  - o without victim;
  - o where there is no specific request from the authority in charge;
  - o without a clear link with the reason for accreditation;
  - o where there is no justified request from the advisor.
- Or accidents or incidents involving aircraft equipped with engines of French design or manufacture:
  - o if no component manufactured by the French manufacturer contributed to the occurrence;
  - o without a clear link with the reason for accreditation;
  - o where there is no justified request from the advisor.

◊ **Category 2 accredited representations**: concern aircraft accidents and incidents that do not meet the criteria of category 1 and 3 ACCREP.

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