BEA
Bureau d'Enquêtes et d'Analyses
pour la sécurité de l'aviation civile
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SAFETY INVESTIGATION REPORT

Serious incident to the MUDRY – CAP 232 registered F-HERA on Wednesday 7 June 2023 at Montluçon - Guéret

Time	Around 10:50[1]
Operator	Amicale de Voltige Aérienne (AVA)
Type of flight	Aerobatic
Persons on board	Pilot
Consequences and damage	Aeroplane slightly damaged, pilot slightly injured
This is a courtesy translation by the BEA of the Final Report on the Safety Investigation. As accurate as the translation may be, the original text in French is the work of reference.	

Shattering of canopy during aerobatic manoeuvres

1 HISTORY OF THE FLIGHT

The pilot took off at 10:40 from runway 35[2] to carry out aerobatic manoeuvres at around 3,000 ft overhead Montluçon - Guéret aerodrome. After carrying out a few figures from the 2023 *Excellence Connu* aerobatic programme, the pilot carried out a new sequence of figures, levelled off, and then started a vertical climb to carry out an additional figure. At around 45°, the Plexiglas bubble canopy separated from the aeroplane frame and shattered. Several shards wounded the pilot in the face. The pilot reduced power, allowed the aeroplane to climb for a few seconds and then levelled off to observe the condition of the tail unit. After these checks, without contacting the AFIS[3] officer, the pilot adapted his aerodrome circuit and carried out a final approach at 170 km/h. He landed on runway 35 at 10:58.

2 ADDITIONAL INFORMATION

2.1 Aircraft information

The Cap 232 is a single-seat training and competition aerobatic aircraft. It is equipped with a side-opening one-piece canopy. Its certification envelope is +/-10 g. The maximum absolute load factor recorded during the day's flights was 7.2 g.

In 2013, the canopy had been replaced to prevent it from separating due to wear.

[1] Except where otherwise indicated, the times in this report are in local time.
[2] Paved runway 35 measuring 1,900 m x 45 m.
[3] The glossary of abbreviations and acronyms frequently used by the BEA can be found on its web site.

Nearly all of the Plexiglas bubble canopy shattered when the aeroplane started climbing. Around ten fragments were found on the ground. Only two pieces of Plexiglas remained integral with the frame around three positioning screws which were still screwed in place. The five other screws were not found. The airframe of the aeroplane was not damaged by the Plexiglas shards.

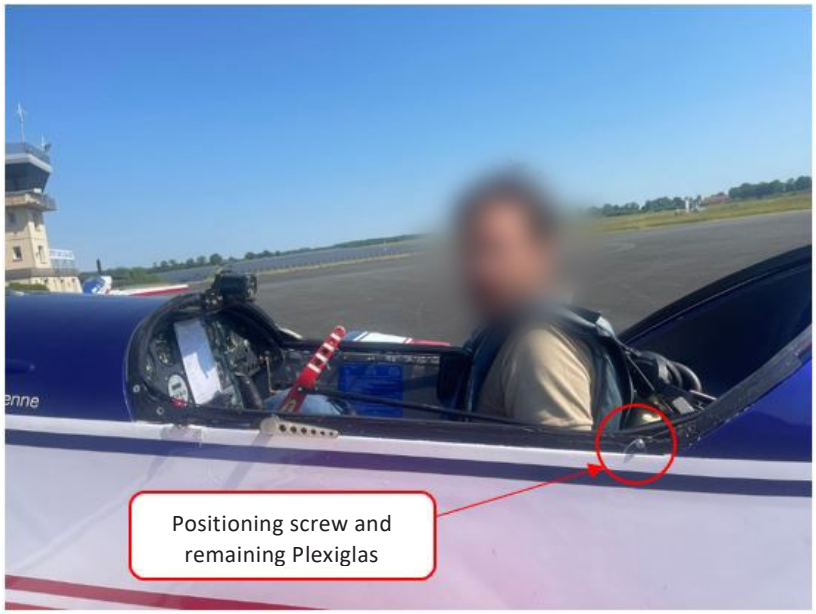

Figure 1: photo of F-HERA after the event (Source: pilot)

The CAP232 type certificate had been held in succession by several companies including Mudry, CAP aviation, Apex aircraft, Dyn'Aviation and CEAPR (holder at the time of the serious incident).

2.2 Canopy bonding information

The initial maintenance programme for the CAP232 has not been modified since its creation.

The current maintenance programme for F-HERA is based on the programme distributed in 2001 by CAP Aviation and supplemented by AVA to take into account STC 10030118 approved by EASA in 2010. The modifications to the programme arising from the STC did not change the part concerning the inspection of the canopy. It is specified in the programme that the canopy must be inspected as follows:

- functional test of release system;
- removal of canopy for detailed examination (the CAP232 maintenance manual does not give dedicated canopy assembly and disassembly procedures);
- check of seal condition;
- check of locking and ejection systems;
- lubrication of hinges.

These examinations must be carried out at each annual inspection and at each major inspection (every four years).

The visual examination of the frame carried out by the BEA found that the adhesive used to bond the Plexiglas bubble canopy to the frame had an aged appearance. The analysis of the surface identified that the rupture between the adhesive seal and the Plexiglas was an adhesive failure.

An examination of the canopy frame carried out by CETIM[4] identified that this adhesive (TECNITE MSP15) has a skin formation time of 10 min. According to CETIM, as the bonding surface was 900 cm^2, it is probable that the parts were not joined together within the restricted time.

In order to have optimal adhesive characteristics for bonding the canopy, the adhesive has to be applied to a prepared Plexiglas. This preparation implies lightly sanding the Plexiglas surface with grit-1200 sandpaper. The examination carried out by CETIM found that the edges of the Plexiglas canopy in contact with the adhesive had not been prepared.

The adhesive used for this bonding was not in the list of adhesives recommended by CEAPR and was not the one used by the manufacturer when initially bonding the bubble canopy. However, according to CEAPR, it has the adhesive characteristics required for this type of bonding, although the adhesive's rather rapid skin-forming time is not clearly stated in its instructions for use.

For a workshop to have access to CAP232 maintenance and servicing documentation, it must subscribe to CEAPR. The adhesives recommended by CEAPR do not appear in the documents made available.

2.3 Pilot information

The pilot held a PPL(A) obtained in 2003 and the FI(A) rating obtained in 2015. He had logged approximately 2,100 flight hours including approximately 100 hours in the 90 days preceding the serious incident, all as pilot-in-command. The pilot had flown three hours on the CAP10 and twenty minutes on the CAP232 in the three days preceding the serious incident.

He obtained his aerobatic rating in 2017 and had taken part in aerobatic competitions since 2018 (Advanced level and higher). The pilot had totalled around 50 flight hours on the CAP232 since 2020. He regularly flew the CAP10.

2.4 Statements

2.4.1 Pilot's statement

The pilot indicated that his initial intentions, on losing the canopy, was to check the speed of the aeroplane and the condition of the tail unit. As the aeroplane was still controllable, he decided to carry out an adapted aerodrome circuit and to land quickly. The pilot was wearing sunglasses during the flight, he lost them shortly after the canopy shattered. He indicated that without these sunglasses, he might have been more seriously injured by the Plexiglas debris.

He added that he had already observed two loose frame positioning screws during pre-flight checks for previous flights on F-HERA.

[4] Centre Technique des Industries Mécaniques (Technical Centre for Engineering Industries)

2.4.2 Statement from mechanic in charge of maintenance of F-HERA

The BEA spoke to one of the mechanics who replaced the F-HERA canopy in 2013. He held a PART-66 license obtained in 2016, but had been a mechanic on the flying club's aerobatic fleet since 1980. According to him, the complete assembly of the canopy took one day and was carried out in a heated room. He added that the bonding time for the two parts was one hour, isolated from the cold and humidity.

The mechanic stated that he had been carrying out the required checks on the canopy since 2013 (see paragraph 2.2). These checks had never led him to question the condition of the bonding. He did, however, specify that he had regularly tightened one of the canopy's positioning screws (front left), which tended not to stay in place.

Regarding the adhesive used, he indicated that he had not contacted CEAPR to find out whether it was suitable. According to him, the adhesive was that usually used for bonding light aircraft parts.

2.5 Meteorological information

The weather conditions at the time of the accident were CAVOK, no wind, and a temperature of around 20°C.

3 CONCLUSIONS

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

Scenario

The almost total loss of the properties of the adhesive between the canopy and the frame junction, which went undetected, resulted in the adhesive failing. During an aerobatic training flight, the canopy separated from the frame and shattered. After quickly checking that the controls were effective and the condition of the elevator, the pilot flew an adapted circuit and landed.

Contributing factors

The following factors may have contributed to the in-flight separation and shattering of the canopy:

- no preparation of the Plexiglas surface before the installation of the canopy;
- use of an adhesive with a shorter application time than the adhesives usually recommended for this type of bonding and this not being specified;
- exceeding, when bonding, the skin formation times of the adhesive used;
- the lack of information made available to the maintenance workshop concerning the type of adhesive to be used;
- not taking into account the loosening of positioning screws on several occasions, likely to indicate the adhesive failure between the Plexiglas and the frame.