

ACCIDENT

Aircraft Type and Registration:	Extra EA 300/L, G-ZXEL
No & Type of Engines:	1 Lycoming AEIO-540-L1B5 piston engine
Year of Manufacture:	2006 (Serial no: 1224)
Date & Time (UTC):	19 June 2022 at 1555 hrs
Location:	Near Duxford Airfield, Cambridgeshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to vertical tail, rudder and elevator
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	46 years
Commander's Flying Experience:	4,641 hours (of which 524 were on type) Last 90 days - 39 hours Last 28 days - 22 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

During a formation display routine the aircraft's elevator trim tab detached at its hinges. The tab was still attached to the aircraft via control cables, and this caused it to flap in the slipstream causing the elevator to move up and down and causing a loud banging noise as it repeatedly struck the side of the rudder. The pilot was able to control the aircraft and make a successful landing.

The elevator trim tab had detached due to a combination of the wrong hinge type being fitted (with only one third of the glue bonding area compared to the type of hinge that should have been fitted) and insufficient glue having been applied. Other aircraft with cracked hinge tabs were found which indicated that insufficient glue had also been applied between the hinges and the tab structure. The aircraft manufacturer has since published a Service Bulletin to mandate more frequent visual detailed inspections of the trim tab hinge areas and has advised the trim tab manufacturer to ensure that sufficient glue is used when bonding the hinges.

History of the flight

The pilot had departed from Duxford Airfield to conduct a public aerobatic display routine in a formation with three other Extra aircraft. About seven minutes into the routine, as the aircraft started to pull up into a formation loop, the pilot heard a loud banging noise from the rear, and his aircraft started to oscillate in pitch by about $\pm 20^\circ$. The control stick was

being moved fore and aft without the pilot's input, in sync with the pitch oscillations. The control forces were sufficiently low that he was able to control the stick and to manoeuvre the aircraft away from the rest of the formation. The pilot stated that he was alarmed by the banging noise, and it got progressively worse. The pilot suspected a structural failure of some part of the elevator control system, but he could not see the elevator. He put the aircraft into a climb and manoeuvred away from the display site in anticipation of a loss of control and needing to bail out.

About 25 to 30 seconds after the incident had started, the banging and the pitch oscillations stopped. The pilot requested that one of the other Extra pilots inspect his aircraft and they reported that the elevator trim tab had detached and had embedded itself into the right side of the rudder. They also reported damage to the rudder and vertical tail.

The pilot carried out a low-speed handling check at 4,000 feet and found that the aircraft was fully controllable at normal approach speeds, so he positioned for a long straight in final approach to Duxford and landed without further incident.

Aircraft examination

The elevator trim tab of the Extra 300 is attached to the inboard trailing edge of the right elevator with two hinges. The trim tab is actuated via two control cables attached to a pitch horn on the lower side of the trim tab (Figure 1).



Figure 1

Intact elevator trim tab shown in the full up position

The elevator trim tab on G-ZXEL was found to have detached from the elevator at the hinge points, but it was still attached to the aircraft via the cables; this had allowed the tab to flap in the slipstream, repeatedly strike the side of the rudder, and pull the elevator up and down. The flapping stopped when the trim tab tip became lodged in the side of the rudder (Figures 2 and 3).



Figure 2

G-ZXEL lower side of right elevator showing trim tab detached at the hinge points but still connected via the control cables

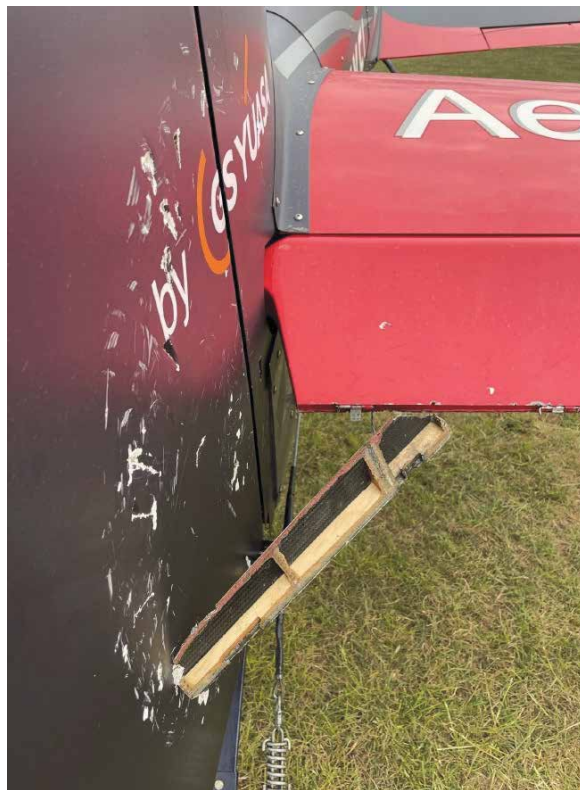


Figure 3

G-ZXEL damage to the rudder and vertical tail

The top half of the trim tab had detached in flight and was not recovered. The inboard hinge had de-bonded from the wooden tab structure, while the outboard hinge had snapped and was not recovered.

The trim tab and the inboard hinge were sent to the aircraft manufacturer for examination. They determined that the inboard hinge was the incorrect size, with only one third of the glue bonding area compared to the type of hinge that should have been fitted (Figure 4). The correct hinge has part number EA-33203.1. The fitted hinge could not be identified. The aircraft manufacturer stated that it was not a part used in any of their aircraft.



Figure 4

Left: inboard hinge found on G-ZXEL. Right: correct size and shape hinge

The inboard hinge bonding surface revealed the remains of the glue that had been bonded to the incorrect sized hinge, but it also revealed the presence of glue on either side which showed that the correct sized hinge had been previously fitted (Figure 5). There was also evidence of dirt or soot in the bonding surfaces.



Figure 5

G-ZXEL trim tab bonding surface of the inboard hinge

The outboard trim tab bonding surface revealed that the correct type of hinge had been fitted, but the lower bonding surface was only partially (less than 40%) covered with glue.

Aircraft information

The incident aircraft, G-ZXEL (serial number 1224), was manufactured in 2006 and had accumulated 1,983 hours at the time of the incident.

The aircraft manufacturer's maintenance schedule had a 50-hour check to '*Inspect elevator trim system for proper operation and rigging*'. It also had a 1,000-hour check to carry out a '*Detailed visual of trim tab hinges, actuator lever for damage, cracks, excessive wear and proper bonding to the laminate. Detailed visual for delamination*'.¹

G-ZXEL's last maintenance check was an annual inspection which included 50-hour check items; this had been carried out 39 hours before the incident at 1,944 hours on 23 February 2022. The aircraft's last 1,000 hour inspection had been carried out 139 hours before the incident, at 1,844 hours.

The horizontal tail assembly, including the elevator and trim tab, was originally manufactured by Extra, but since 2003 it has been manufactured by a sub-contracted external organisation. This organisation checked its paperwork for the trim tab supplied for G-ZXEL and there were no deviations from the type design noted, and they stated that they were not familiar with the type of hinge that was found fitted on G-ZXEL. The aircraft manufacturer also checked its paperwork and there were no deviations noted for the trim tab, and they concluded that the incorrect hinge was fitted during a repair after the aircraft was delivered in 2006.

The aircraft operator had purchased G-ZXEL in 2006 and had been its sole operator. Their maintenance worksheets for this aircraft did not show any elevator trim tab repairs. They also checked the worksheets for their similarly named G-ZEXL aircraft (in case there had been a paperwork mix-up) but there were no trim tab repair items for it either. A discussion with their maintenance organisation did not reveal any information about a trim tab hinge repair to G-ZXEL.

Additional trim tab examinations

After the incident to G-ZXEL the aircraft operator inspected its four other Extra EA 300/L aircraft. Two of these aircraft, G-ZEXL and G-OFFO, were found to have cracks at the trim tab hinges. Their maintenance organisation then inspected the tab of an Extra EA 300LT (G-GEJS) that was undergoing an annual inspection and found that its trim tab also had a cracked hinge, and it was very loose. The build year, total hours and maintenance history for the examined aircraft, including G-ZXEL, are summarised in Table 1.

The top four aircraft in the table have the same build year and sequential serial numbers. All the aircraft in the table had smoke systems fitted although the system had rarely been used on G-GEJS.

Footnote

¹ Extra Service Manual Extra 300L, version 25 February 2022.

Aircraft	Build Year	Total Hours	Trim tab state	Maintenance
G-ZXEL, EA 300/L, sn 1224	2006	1,983	Separated in flight	39 hours since annual; 139 hours since 1,000 hr inspection
G-ZEXL, EA 300/L, sn 1225	2006	2,276	Cracked	41 hours since annual; 541 hours since 1,000 hr inspection
G-OFFO, EA 300/L, sn 1226	2006	2,055	Cracked	15 hours since annual; 217 hours since 1,000 hr inspection
G-ZXCL, EA 300/L, sn 1223	2006	2,049	No cracks	42 hours since annual; 261 hours since 1,000 hr inspection
G-ZXLL, EA 300/L, sn 1319	2011	1,326	No cracks	34 hours since annual; 377 hours since 1,000 hr inspection
G-GEJS, EA 300LT, sn LT032	2015	278	Cracked and loose	36 hours since annual

Table 1

Details of G-ZXEL and other aircraft inspected after the incident

Examinations revealed that all the aircraft in the table, apart from G-ZXEL, had the correct size hinges fitted. Photos of these tabs are shown in Figures 6 to 8.

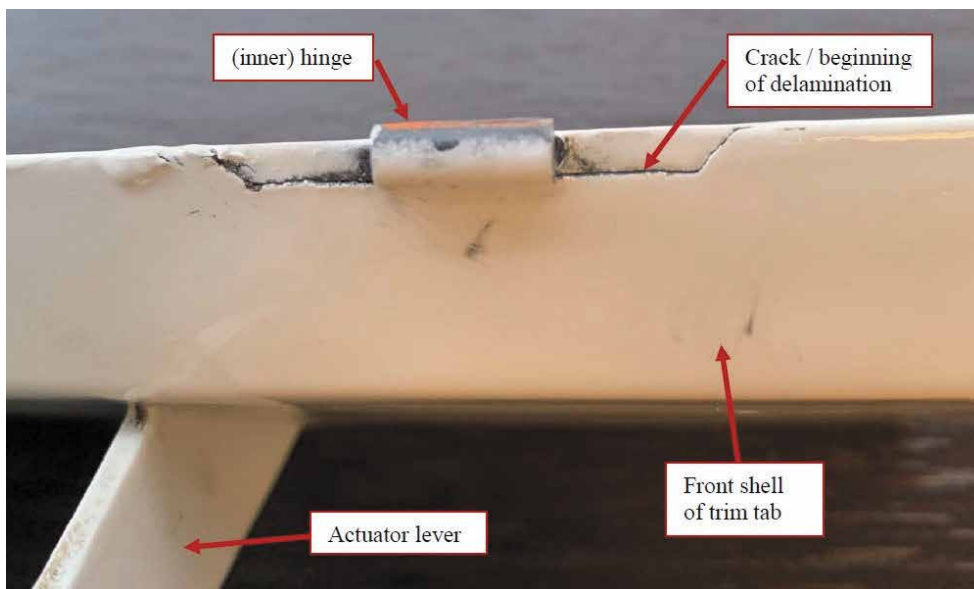


Figure 6

Cracked tab inner hinge from G-OFFO



Figure 7

Cracked tab inner hinge from G-ZEXL
– shown with pressure applied to lift the hinge

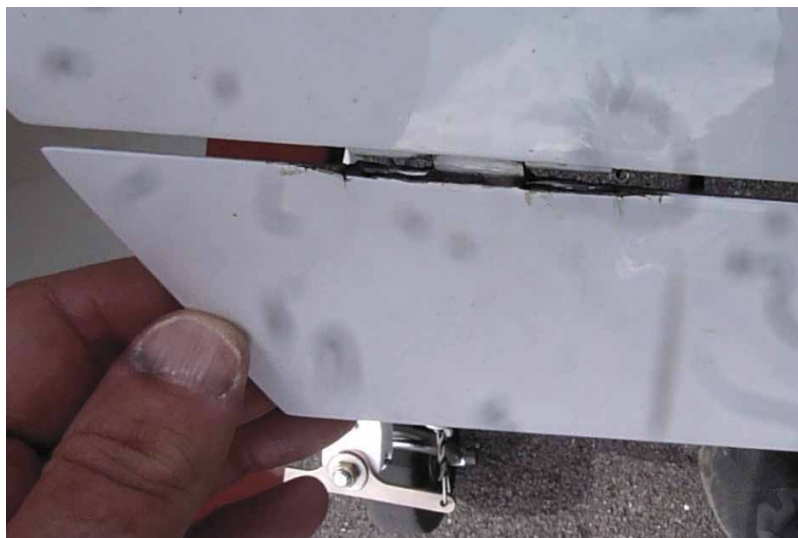


Figure 8

Cracked and loose tab inner hinge from G-GEJS
– shown with aft pressure applied to tab

All the failed and cracked trim tabs identified in this report were visually examined by the aircraft manufacturer in conjunction with an investigator from the German Federal Bureau of Aircraft Accident Investigation². The tabs from G-ZEXL and G-GEJS were also taken apart to assess the bonding areas. The bonding surfaces of these revealed the use of insufficient glue resulting in a reduced bonding area.

Footnote

² Bundesstelle für Flugunfalluntersuchung (BFU).

According to the aircraft manufacturer the bonding of the lower surface of the hinge normally fails first in overload which leads to visible cracks, while the upper bonding will remain secure for longer because the upper surface is larger and more elastic. They stated that this should ensure that a debonding of the hinge is detectable before it fails completely.

In the case of G-GEJS both the lower and upper bonding surfaces had failed, but the tab was still able to take load due to three remaining glue joints which pass through the three holes in the hinge bonding surface.

Until the incident to G-ZXEL the aircraft manufacturer was not aware of any previous in-flight elevator trim tab failures and was not aware of any cracked hinge issues. There were no repair instructions for a de-bonded trim tab hinge and therefore the manufacturer would have expected to be contacted if an operator experienced such cracks. More than 700 Extra 300 aircraft have been manufactured since early 1990.

Safety Actions

As a result of this accident, the aircraft manufacturer published Mandatory Service Bulletin SB-300-2-22³ on 10 August 2022 which explains the issues identified during this investigation and requires a detailed visual inspection of the elevator trim tab hinges within 25 hours, and a recurring detailed visual inspection as part of the normal 50-hour inspection programme.

The CAA and EASA reviewed the Service Bulletin and decided that an accompanying Airworthiness Directive was not required.

The aircraft manufacturer also advised the external trim tab manufacturer to ensure that sufficient glue is used when bonding the hinges to the tabs.

As of 22 December 2022 the aircraft manufacturer has received results from 17 aircraft which have been inspected in accordance with the Service Bulletin and none had evidence of cracks.

Analysis

The elevator trim tab detached in flight due to a combination of the wrong hinge type being fitted at the inboard location and insufficient glue having been applied to the outboard hinge. Because the tab was still attached to the aircraft via its control cables, it flapped in the slipstream causing it to move the elevator up and down which resulted in the pitch oscillations. The pilot was able to control the aircraft, but he was very alarmed by the loud banging noise caused by the trim tab striking against the side of the rudder. The banging noise stopped when the trim tab tip lodged itself into the side of the rudder.

The pilot found that the aircraft was controllable with the detached trim tab and did not have any difficulties landing. However, if the banging noise had not stopped then this would have provided a significant distraction to the pilot during the landing phase.

Footnote

³ https://www.extraaircraft.com/docs/service/S300222A_20220712.pdf accessed on 6 January 2023.

The aircraft had undergone an annual inspection just 39 hours prior to the failure. Although the detailed visual inspection of the area that was required every 1,000 hours was not required at the time, an annual inspection would normally uncover cracks of the type seen in Figures 6 to 8. It is possible that 39 hours previously the cracks had not yet formed or were not as perceptible, or the inspection of the area was not sufficiently thorough to detect them.

How, when and where the incorrect hinge was fitted to G-ZXEL could not be determined, but the evidence indicated that a repair had probably been carried out.

Following this incident, five other Extra 300 aircraft were examined and three had cracked inboard hinges due to debonding, but these all had the correct type of hinge fitted. These revealed that the issues were caused by insufficient glue being applied during manufacture. These aircraft had all accumulated less than 50 hours since their last annual inspection.

The aircraft manufacturer has taken safety action, in the form of a Service Bulletin, to mandate a detailed visual inspection of the elevator trim tab hinges within 25 hours and then subsequently every 50 hours. This time interval is greater than the time between the cracked trim tabs being detected and their previous annual inspection for the three aircraft identified. However, the aircraft manufacturer is confident that the 50-hour interval is appropriate given the long service history of the Extra 300, and that cracks do not immediately lead to failure. Also, there are no other known in-flight failures of elevator trim tabs with the correct hinges fitted.

Conclusion

The elevator trim tab detached in flight due to a combination of the wrong hinge type being fitted (with only one third of the glue bonding area compared to the type of hinge that should have been fitted) and insufficient glue having been applied. How, when and where the incorrect hinge was fitted to G-ZXEL could not be determined. Other aircraft with cracked hinge tabs were found which indicated that insufficient glue had also been applied between the hinges and the tab structure. The aircraft manufacturer has published a Service Bulletin to mandate more frequent visual detailed inspections of the trim tab hinge areas and has advised the external trim tab manufacturer to ensure that sufficient glue is used when bonding the hinges.