

Technical report

ULM A-012/2021

Accident on 12 June 2021, involving a
TECNAM P-92 ECHO aircraft, registration EC-FK6,
operated by Ignagua Center, S.L., at
Casarrubios del Monte Aerodrome (Toledo, Spain)

Please note that this report is not presented in its final layout and therefore it could include minor errors or need type corrections, but not related to its content. The final layout with its NIPO included (Identification Number for Official Publications) will substitute the present report when available.



Notice

This report is a technical document that reflects the point of view of the Civil Aviation Accident and Incident Investigation Commission (CIAIAC) regarding the circumstances of the accident and its causes and consequences.

In accordance with the provisions in Article 5.4.1 of Annex 13 of the International Civil Aviation Convention; and with articles 5.6 of Regulation (UE) nº 996/2010, of the European Parliament and the Council, of 20 October 2010; Article 15 of Law 21/2003 on Air Safety and articles 1 and 21.2 of Regulation 389/1998, this investigation is exclusively of a technical nature, and its objective is the prevention of future civil aviation accidents and incidents by issuing, if necessary, safety recommendations to prevent from their reoccurrence. The investigation is not pointed to establish blame or liability whatsoever, and it's not prejudging the possible decision taken by the judicial authorities. Therefore, and according to above norms and regulations, the investigation was carried out using procedures not necessarily subject to the guarantees and rights usually used for the evidences in a judicial process.

Consequently, any use of this report for purposes other than that of preventing future accidents may lead to erroneous conclusions or interpretations.

This report was originally issued in Spanish. This English translation is provided for information purposes only.

INDEX

Notice	i
INDEX	ii
Abbreviations	iii
Synopsis	5
1. THE FACTS OF THE INCIDENT	6
1.1. Overview of the accident	6
1.2. Injuries to persons	7
1.3. Damage to the aircraft	7
1.4. Other damage	7
1.5. Information about the personnel	7
1.6. Information about the aircraft	8
1.6.1. General information	8
1.6.2. Maintenance information	12
1.6.3. Airworthiness status	13
1.7. Meteorological information	13
1.8. Aids to navigation	13
1.9. Communications	13
1.10. Information about the aerodrome	14
1.11. Flight recorders	14
1.12. Information about the aircraft's trajectory and wreckage	15
1.13. Medical and pathological information	18
1.14. Fire	18
1.15. Survival aspects	18
1.16. Tests and research	18
1.16.1. Inspection of the main landing gear attachment system	18
1.17. Organisational and management information	20
1.18. Additional information	21
1.19. Useful or effective investigation techniques	21
2. ANALYSIS	21
2.1. Analysis of the meteorological conditions	21
2.2. Operational analysis	21
2.3. Analysis of the aircraft wreckage	23
2.4. Analysis of the aircraft's maintenance	23
2.5. Analysis of the organisation	24
3. CONCLUSION	25
3.1. Findings	25
3.2. Causes/contributing factors	25
4. RECOMMENDATIONS	26
5. ANNEXES	27
5.1. Applicable TECNAM Service Bulletins	27

Abbreviations

° ‘ “	Sexagesimal degrees, minutes and seconds
°C	Degrees Celsius
AEMET	Spain's State Meteorological Agency
AENA	Spanish Airports and Air Navigation
AESA	Spain's National Aviation Safety Agency
AMM	Aircraft maintenance manual
CPL	Commercial pilot license
CPL(H)	Commercial helicopter pilot license
FH	Flight hours
FI	Flight instructor rating
ft	Feet
h	Hours
HP	Horsepower
RH	Relative air humidity
kg	Kilogrammes
KIAS	Knots indicated airspeed
km	Kilometres
km/h	Kilometres/hour
kt	Knots
l, l/h	Litres, Litres/hour
LAPL	Light aircraft pilot license
LEMT	ICAO code for Casarrubios del Monte Aerodrome- Toledo
m	Metres
mm	Millimetres
m/s	Metres/second
m ²	Metres squared
MAF	Multi-axis fixed-wing aircraft rating
MHz	Megahertz
MTOW	Maximum take-off weight
N	North
Nm	Nautical miles
Nm	Newton metre
p/n	Part number
s/n	Serial number
O	West
ICAO	International Civil Aviation Organisation
PPL	Private pilot license

RTC	National radio operator
rpm	Revolutions per minute
TULM	Ultralight aircraft pilot license
ULM	Motorised ultralight aircraft
UTC	Coordinated universal time
VFR	Visual flight rules
W	West

Technical report

ULM A-012/2021

Owner and Operator:	Ignagua Center, S.L.
Aircraft:	TECNAM P-92-ECHO, registration EC-FK6 (Spain)
Date and time of accident:	12 June 2021, 14:30 local time
Site of accident:	Casarrubios del Monte Aerodrome (Toledo)
Persons on board:	1 (crew member) / 1 (passenger)
Type of operation:	General aviation - Others
Phase of flight:	Landing - Landing roll-out
Flight rules:	VFR
Date of approval:	24/11/2021

Synopsis

Summary:

On Saturday, 12 June 2021, the TECNAM P-92-ECHO aircraft, registration EC-FK6, operated by Ignagua Center, carried out a flight with an instructor and passenger on board. The aircraft experienced a runway excursion after landing on runway 08 at Casarrubios del Monte Aerodrome (LEMT) when the retaining nut of a bolt on the left main landing gear leg detached on braking during the landing roll-out. This caused the leg to bend backwards, damaging the horizontal stabiliser, the left wing and the main landing gear.

The pilot and passenger were unharmed and able to exit the aircraft without assistance.

The probable cause of the accident was the collapse of the main landing gear's left leaf spring after the pilot applied the brakes on landing due to the detachment of the self-locking nut that secures its central bolt.

The self-locking nut probably became loose as a result of the incorrect torque being applied due to maintenance malpractice.

The report contains an operational safety recommendation addressed to the Ignagua Center, S.L. flight school, to ensure the correct execution of maintenance tasks involving tightening torque to the main landing gear attachment elements, and another addressed to AESA, recommending it provide a regulatory framework for ULM experience flights.

1. THE FACTS OF THE INCIDENT

1.1. Overview of the accident

On 12 June 2021, the Ignagua Center, S.L. pilot involved arrived at Casarrubios del Monte Aerodrome (Toledo) - LEMT, intending to make several flights in the TECNAM P-92-ECHO aircraft with registration EC-FK6, owned by the school. The flights commenced at 09:00 hours¹.

The pilot made four flights that lasted for a total of 3:15 flight hours and involved 13 landings, the first as an instructor and the second, third and fourth as pilot-in-command. The accident occurred during the landing of the fifth flight, a 45-minute long ultralight experience flight, which began at 13:45 h. The pilot has stated he carried out pre-flight inspections before commencing each flight, none of which identified any anomalies in the aircraft.

The incident occurred at around 14:30 h after landing on runway 08 of the LEMT aerodrome. According to his statement, the pilot had configured the aircraft with flaps at 15° and a speed of between 90 and 100 km/h, with a headwind. According to the pilot, he touched down on the first third of the runway, and then, after applying the brakes and while moving at a low speed with all three wheels on the ground, he noticed a vibration that he thought came from the landing gear, although he could not identify from where exactly.



Photograph 1. Aircraft at the accident site

¹ All times indicated are local time.

When he released the brake, despite his efforts to keep the aircraft on as straight a path as possible, it began to veer gently to the left. According to the pilot, the aircraft continued to move slowly before coming to a complete stop without the brakes being applied again. The aircraft stopped near the windsock towards the middle of the left-hand side strip running alongside runway 08, after making a turn of more than 90°.

In his statement, the pilot claimed he shut down the engine before the aircraft's left wing hit the ground.

Pilot and passenger, both uninjured, exited the aircraft by their own means and observed that the left underside of the horizontal stabiliser was eroded and the left main landing gear leg was bent under itself.

Personnel from the aerodrome removed the aircraft from the runway and transferred it to a hangar for inspection.

1.2. Injuries to persons

Injuries	Crew	Passengers	Total in the aircraft	Others
Fatal				
Serious				
Minor				
Unharmed	1	1	2	
TOTAL	1	1	2	

1.3. Damage to the aircraft

The aircraft sustained significant damage to the anchor point of the left main landing gear leaf spring, the underside of the left wing, and the attachment and underside of the left horizontal stabiliser.

1.4. Other damage

There was no further damage of any kind.

1.5. Information about the personnel

The 50-year-old pilot had an ultralight pilot license (TULM) issued by Spain's National Aviation Safety Agency (AESA) on 18/07/2008, with the multi-axis fixed-wing aircraft (MAF) and instructor FI (MAF) ratings, valid until 31/10/2021.

He had class 1 and 2 medical certificates valid until 10/02/2022 and an LAPL medical certificate valid until 10/02/2023.

He had a total of 355:55 hours of flying time, of which 35:15 hours were in the type of aircraft involved in the incident. He also had experience flying under other types of flight licenses, such as 440:20 hours with a PPL and 2,604:45 hours with a CPL(H).

On the day of the event, in addition to the flight affected by the accident, he made four other flights with the same aircraft. These flights accounted for a total of 3:15 flight hours and included 13 landings. On the first flight, which included 6 landings, he was the instructor, and during the subsequent flights, he was the pilot-in-command with a passenger. On the day of the incident, he had not flown an ultralight aircraft for over a year, specifically since 11/03/2020.

1.6. Information about the aircraft

1.6.1. General information

The Italian-designed TECNAM P92-ECHO aircraft, manufactured by Aero Empurdá S.L. in 2008 with s/n: P92-E-034 is a single-engine, two-seater, ultralight monoplane with a braced high wing, fixed tricycle-type landing gear and steerable nose wheel.

Structure:

- Wingspan: 9.6 m
- Length: 6.3 m
- Wing area: 13.2 m²
- Maximum height: 2.50 m
- Empty weight: 282 kg
- MTOW: 450 kg
- Flaps: 0°- 35°

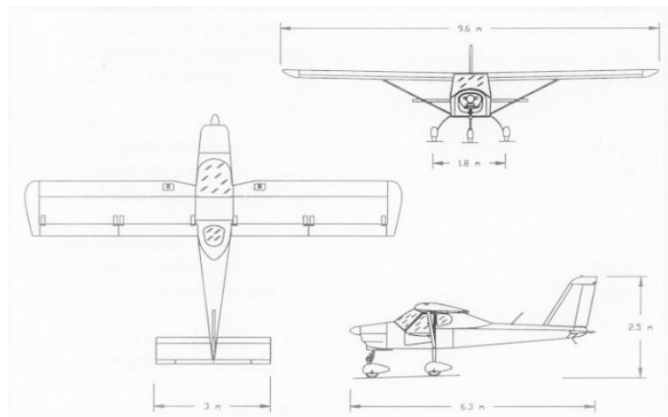


Figure 1. TECNAM P92-ECHO aircraft

Performances:

- Never-exceed speed: 260 km/h
- Maximum structural cruising speed: 200 km/h
- Maximum flaps-extended speed: 110 km/h
- Manoeuvring speed: 150 km/h
- Stall speed:
 - flaps 0°: 69 km/h
 - flaps 15°: 65 km/h
 - flaps 35°: 61 km/h

Power plant:

The aircraft was equipped with a ROTAX 912 UL piston engine, s/n: 4408714.

Its main properties are:

- Four-stroke, four horizontally opposed cylinders
- Double carburettor
- Electric start
- Mixed water and air cooling.
- Maximum power: 81 Hp at 5,800 rpm, maximum during 5 minutes.

Fuel:

The fuel authorised and used was unleaded petrol 95. The aircraft had two built-in 35-litre fuel tanks on the leading edge of each wing, with a drainage valve on the engine bulkhead.

Propeller:

The aircraft was fitted with a GT-ECHO 2 fixed-pitch, two-blade, wooden tractor propeller made by manufacturer F.lli Tonini Giancarlo & Felice S.n.c, measuring 1,660 mm in diameter. It was installed in 2008.

Instrument panel:



Photograph 2. Instrument panel of the TECNAM P92-ECHO registration EC-FK6

Main landing gear

As the landing gear system was the main system involved in the accident, its composition is detailed below.

Each main landing gear leg has a special curved steel plate (1) or leaf spring positioned crosswise to the fuselage to cushion the aircraft from the loads produced during landing.

The leaf spring is attached to the underside of the fuselage through the main beam with three bolts and stop-nuts, two lateral bolts (5) to secure the plate to the edge of the beam, and one central bolt (6), which secures the inner end, closest to the axis of the plane.

The wheels are cantilevered over the landing gear's sprung leg and have hydraulic disc brakes controlled by a lever positioned between the two seats in the cabin. A shut-off valve for the hydraulic circuit is located in the same place.

The brakes work simultaneously on both wheels via a T-Shaped joint.

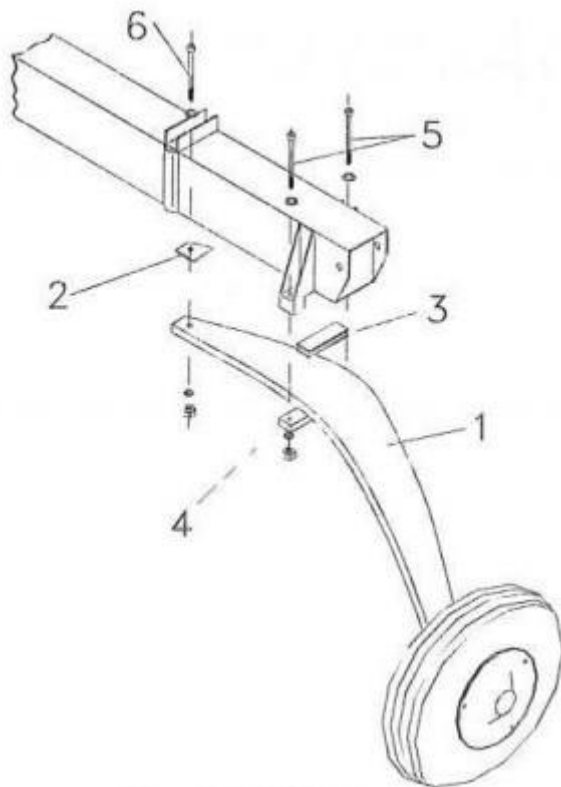


Figure 2. Leaf-spring attachment

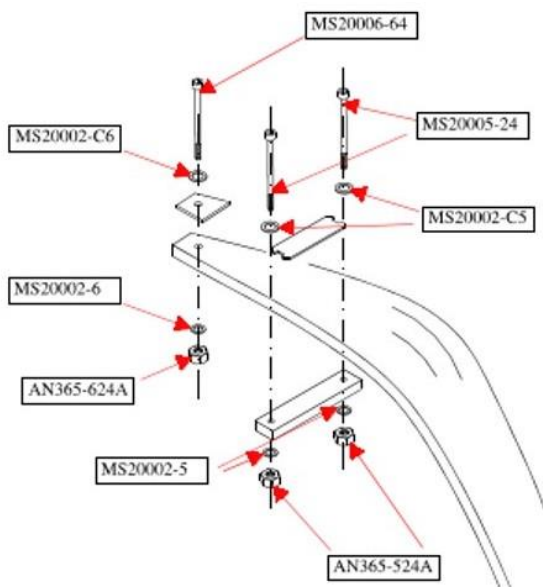


Figure 3. Part numbers of the main landing gear attachment system

The control lever activates the master cylinder and its corresponding brake fluid reservoir. The system is equipped with a non-return valve, which ensures the braking action is always effective, even if the parking brake circuit has been accidentally closed.

The system for securing the leaf springs to the fuselage has been improved over time by the aircraft manufacturer by modifying the type of self-locking nuts and bolts used.

The current valid part numbers, quantities and required tightening torques are shown in Figure 3 and the table in Figure 4.

<i>Description</i>	<i>Part number</i>	<i>QTY</i>	<i>Torque value</i>
Central bolts	MS20006-64	2	//
Lateral bolts	MS20005-24	4	//
Stop nut for lateral bolts	AN365-524A	4	15 +/- 1 Nm
Stop nut for central bolts	AN365-624A	2	25 +/- 2 Nm
Washer under Lateral bolts	MS20002C-5	4	//
Washer under Central bolts	MS20002C-6	2	//
Washer under Lateral Stop Nuts	MS20002-5	4	//
Washer under Central Stop Nut	MS20002-6	2	//

Figure 4. Description of the part numbers that make up the main landing gear attachment system

It should be noted that in addition to applying the recommended tightening torques to ensure the correct attachment of the leg to the fuselage, the manufacturer also recommends the nuts be replaced one by one, without applying the final torque until they have all been replaced. Thus, the correct torque should be applied after fitting all the nuts. This practice has been proven to reduce the risk of the main landing gear leg detaching.

According to the aircraft manufacturer, the use of any bolts other than those recommended may result in vibrations at the landing gear attachment point and cause the nuts to become loose, compromising the connection.

Operational procedures

The following operating procedures from the aircraft’s flight manual are relevant to the investigation.

- **Pre-flight inspection**

The external aircraft inspection tasks corresponding to the landing gear are a follows:

- Left and right main gear: check tyre pressure (1.4 bar), tyre condition and corresponding alignment, condition of the fuselage skin.
- Nose wheel leg: check tyre pressure (1.0 bar), condition of tyre and shock absorber.

- **Approach**

Flaps..... (final) 38° FULL
 Speed..... 0° flaps 70 KIAS
 Speed..... 15° flaps 65 – 70 KIAS
 Speed..... 38° flaps 60 KIAS

- **Pre-landing**

Seats and belts Adjusted and secured
 Landing light ON position
 Fuel valve..... ON position

Fuel pump..... ON position
 Carburettor heater..... ON position
 Power..... 1,400 – 1,500 rpm
 Flaps..... 15°
 Speed..... 65 – 70 KIAS

- **Before landing**

Landing light..... ON position
 On downwind leg: speed and flaps according to traffic.
 Traffic..... check
 Flaps..... as required
 Optimal touchdown speed with full flaps..... 39 kt

- **Exiting the runway after landing**

Carburettor heater..... OFF position
 Flaps..... Up
 Fuel pump..... OFF position
 Landing light..... OFF position
 Transponder..... STAND BY

1.6.2. Maintenance information

The aircraft was built in 2007 with serial number: P92-E-034. It is owned and operated by the ultralight pilot school Ignagua Center S.L.

Its maintenance programme, approved on 07/02/2020, establishes the following maintenance overhauls:

- Pre-flight inspection.
- Basic inspection every 100 flight hours or 12 months.
- Periodic inspection every 200 flight hours.
- Special inspection every 600 flight hours.

According to the AMM, the tasks to be carried out on the main landing gear during the 100-hour flight inspections include a review of the general condition of all its components and attachments, including a structural inspection of the leaf springs, as well as the brake and hydraulic systems, wheels and tyres.

In addition to the inspections included in the approved programme, the AMM establishes another special inspection of several of the main landing gear components every 1,200 hours, during which the leaf springs must be removed to check their integrity, curvature and general condition.

According to the aircraft's logbook issued on 13/02/2020, it had a cumulative record of 849:28 flight hours at the time of the accident. The flight recorded immediately prior to the accident was made on the same day at 09:50 hours, lasted for 53' and included two landings. The two flights prior to 12/06/2021 took place on 11/06/2021 and 07/06/2021, lasting 29' with 3 landings and 45' with 1 landing, respectively. According to the pilot's

logbook, the flights made on the day of the event had not been added to the aircraft's logbook.

The aircraft's last maintenance overhaul, recorded as a standard overhaul (basic 100-hour inspection), was carried out in the pilot school's workshop on 17/05/2021 when the aircraft had 824:53 flight hours. The overhaul immediately before this was carried out on 30/03/2021 when the aircraft had 775:30 flight hours. According to the school's maintenance personnel, the landing gear attachment bolts were replaced during this overhaul in compliance with the requirement to change them every 1,200 hours of flight. As a result, around 74 flight hours had passed since the main landing gear leaf spring attachment bolts were last replaced.

According to the current engine logbook issued on 13/02/2020, the mandatory engine overhauls correspond to the periodic inspections that must be carried out every 100 flight hours and the general inspection that must be carried out every 2,000 hours. The most recent engine overhaul was a 100-hour inspection carried out on 17/05/2021 when the engine had 824:53 flight hours.

1.6.3. Airworthiness status

According to the registration certificate issued by AESA on 11/12/2019, the incident aircraft was registered as owned by the Ignagua Center, S.L. on 20/06/2008, with registration number 1221.

The aircraft had a special restricted certificate of airworthiness No.1221, issued on 07/02/2020 by AESA. The certificate states the manufacturer as "Aero Emporda, S.L.", and the aircraft type as a "P-92-ECHO" in the "Private (3) Special ULM" category.

1.7. Meteorological information

The accident occurred at Casarrubios del Monte Aerodrome (Toledo) - LEMT, which does not have a meteorological station. Therefore, in order to characterise the meteorological conditions at the time of the accident and their possible contribution to the event, AEMET has provided the information recorded at three of its most representative observation points (Robledo de Chavela, Aranjuez and Toledo).

According to that information, no significant meteorological phenomena was reported in the area at the time of the accident.

1.8. Aids to navigation

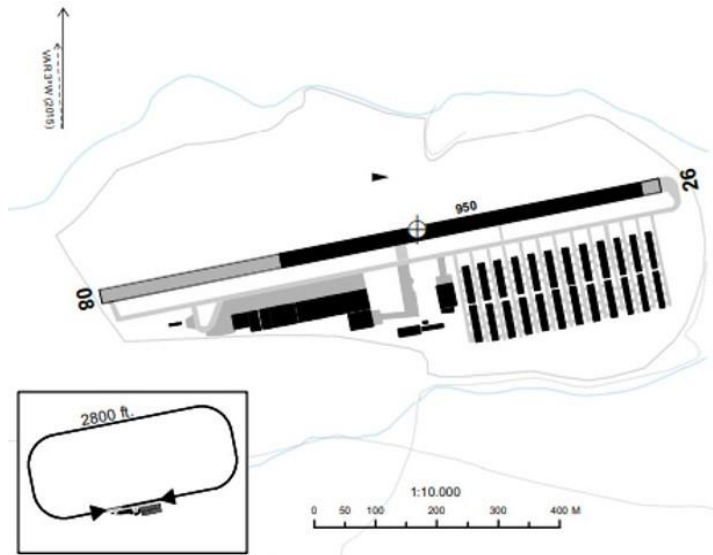
Not applicable.

1.9. Communications

There were no communications.

1.10. Information about the aerodrome

The Casarrubios del Monte Aerodrome in the province of Toledo (ICAO callsign LEMT and GPS coordinates 40° 14' 06" N; 04° 01' 35" W) is a privately-owned restricted aerodrome. It has an asphalt runway with a 08/26 orientation measuring 950 x 26 m at an elevation of 625 m, characterised by a threshold at 400 m on runway 08. Air-to-air communications are made on the 123,500 MHz frequency.



The traffic pattern for general aviation and ultralights is to the north of the airfield at 2,800 ft. The entrance point is 4 Nm to the southeast of Navalcarnero. There is another pattern for gyroplanes to the south of the airfield.

The aerodrome is surrounded by a track road approximately 10 m below the runway level, which gives rise to a significant drop off at the end extension of runway 26.

Figure 5. Plan of Casarrubios del Monte Aerodrome



Photograph 3. Casarrubios del Monte Aerodrome

1.11. Flight recorders

The aircraft was not equipped with a flight data recorder or a cockpit voice recorder, as the aeronautical regulations in force do not require any recorders on these types of aircraft.

1.12. Information about the aircraft's trajectory and wreckage

The accident occurred after the aircraft landed on runway 08 when it was level with the windsock approximately halfway along the runway, where the exit to the apron is located. When the pilot braked, the aircraft began to veer to the left. According to the pilot's statement, he intended to use this intermediate runway exit to taxi to the parking stand.



Photograph 4. Trajectory of the aircraft during the accident at Casarrubios del Monte Aerodrome

The aircraft veered off course and came to a stop, as shown in photograph 4. According to the aerodrome's video recordings, it touched down almost at the end of the first third of the runway and travelled approximately 175 m in 8", which means its speed was approximately 75 km/h.

Furthermore, according to the images captured by the aerodrome's video cameras, at the time of the event, the windsock virtually in front of the aircraft when it stopped indicated a wind of approximately 10 or 12 kts from a 190 or 200° direction.

On exiting the aircraft, the pilot observed that the left leaf spring had partially detached and was bent backwards in the direction of travel. The central attachment bolt and its nut had come loose. The bolt was retrieved, but the nut could not be located. The lateral attachment bolts were deformed but still attached to the fuselage, and there were signs of material wear in their threads.

There were no visible signs of the aircraft's trajectory on the runway, nor fragments of rubber from the tyres or any other type of evidence attributable to the incident. However, the aircraft's trajectory and position were recorded by the aerodrome's video cameras and the footage provided to the investigation is shown in the series of photographs below.



Photograph 5. Extract of the video footage showing the aircraft's trajectory.

The only damage identified during the aircraft inspection was to the left underside of the horizontal stabiliser and the underside of the left wing, which displayed wear caused by them dragging along the ground. The aircraft's empennage attachment was also deformed. The tyres and brake system were in good condition with no abnormal wear.



Photograph 6. Left leaf spring with wheel and bracket



Photograph 7. Attachment of bracket to left leaf spring and fuselage



Photograph 8. Left leaf spring to fuselage lateral attachment bolt



Photograph 9. Material wear to left leaf spring to fuselage lateral attachment bolt



Photograph 10. Damage to underside of the left wing



Photograph 11. Damage to the left underside of the horizontal stabiliser



Photograph 12. Damage to the attachment of the left horizontal stabiliser

1.13. Medical and pathological information

Not applicable.

1.14. Fire

There were no signs of fire during the flight or after the impact.

1.15. Survival aspects

The harnesses and restraint systems worked adequately and the cabin interior maintained its structural integrity.

1.16. Tests and research

1.16.1. Inspection of the main landing gear attachment system

The post-accident aircraft inspection carried out in the flight school's maintenance workshop found the left landing gear's leaf spring attachment bolts were in good condition, with no corrosion, cracks or deterioration that could have contributed to the event.

The central bolt that secures the inner end of the leaf spring (closest to the axis of the aircraft) to the fuselage was in good condition but had lost the self-locking nut, which, despite looking for it in the area where the aircraft stopped, was never recovered. The bolt had no visible signs of deformation, cracks or worn material.

The two lateral bolts that keep the leaf spring in a transverse position and secure it to the edge of the fuselage beam were deformed, bent towards the direction of travel, their self-locking nuts had detached and the metal positioning bracket had dislodged.

The bolts showed signs of distortion in various directions, with sectional constriction. These deformities were produced by excessive pulling forces in an axial direction and bending forces at approximately 30° from said direction. The stress caused one of the bolts to break.

According to maintenance personnel from the school's workshop, all the main landing gear attachment bolts had been replaced during the overhaul carried out on 30/03/2021. According to the information they provided, they specifically inspect the attachment system every 100 FH and change the complete hardware kit every 200 FH despite the AMM only requiring their replacement at 1,200 FH. At the time of the event, the aircraft had 849:28 flight hours. Therefore, it had not reached the threshold for replacing the attachment bolts recommended by the aircraft manufacturer.

The inspection found that different bolts had been used. Some were p/n: MS20006, others were NAS6605-23, and in some cases, the bolts were unmarked, and the part number could not be identified.



Photograph 13. Old and new self-locking nuts according to SB No.66



Photograph 14. Old self-locking nut used by the maintenance workshop involved in the incident and new nut used in the accident aircraft



Photograph 15. Main landing gear leaf spring attachment bolts

The self-locking nuts used were the ones recommended by the aircraft manufacturer, which, in its latest service bulletin dated 09/07/2012, SB No.066 ed.2 rev.1, indicated the need to substitute the old nuts for the new, improved ones with p/n: AN365-524A for the lateral bolts with p/n: MS20005-24 and p/n: AN365-624A for the central bolts with p/n: MS20006-64.

According to the aforementioned bulletin, the tightening torque applied to the self-locking nuts differs between the central and lateral bolts. For the lateral bolts with p/n: MS20005-24, a tightening torque of 15 +/- 1 Nm should be applied, and for the central bolts with p/n: MS20006-64, a tightening torque of 25 +/- 2 Nm should be applied.

A torque wrench must be used to ensure the correct fit of the threaded elements on which the torque is applied. The maintenance workshop confirmed that the bolts were tightened without using this tool, which meant the tightening torque could not be guaranteed.

The central bolt should be p/n: MS20006-64, with a length of 12.8 cm including the head and a diameter of 0.95 cm; the lateral bolts should be p/n: MS20005-24, with a length of 5.97 cm and a diameter of 0.79 cm.

Bolts 1 and 3 in Photograph 15 are the bolts used in the accident aircraft. One of them is p/n: MS20005-24, as recommended, and on the other is p/n: NAS6605-23, which measures 4.84 cm long without the head.

Number 2 is a new bolt provided and commonly used by the maintenance workshop, which is not one of the bolts recommended by the aircraft manufacturer.

The following photographs show the deformation of the lateral bolts and the material wear caused by intermittent excess traction and friction stress between the nut and the bolt.



Photograph 16. Left leaf spring lateral bolt 1 attached to the incident aircraft



Photograph 17. Left leaf spring lateral bolt 2 after its removal from the incident aircraft



Photograph 18. Left leaf spring lateral bolt 1 after its removal from the incident aircraft



Photograph 19. Top half of severed lateral leaf spring bolt 2 after the incident

1.17. Organisational and management information

The school that owns and operates the aircraft involved in the incident, Ignagua Center, S.L., has been authorised by AESA since 11/10/2016 as a ULM flight school for the multi-axis fixed-wing ultralight aircraft rating (MAF). Its base of operations is at Casarrubios del Monte Aerodrome - LEMT (Toledo), and it is subject to the limitations derived from the applicable regulations.

The organisation is permitted to run courses for those looking to obtain the pilot license for multi-axis, fixed-wing ultralight aircraft (MAF), instructor courses and seminars (FI) and radio operator courses (RTC).

Neither the flight school's operating manual, nor its activity permit, nor the relevant regulations² establish any requirement for continuous or refresher training to be provided

to its instructors after periods of inactivity, nor do they contemplate the 'experience' flight affected by the incident as one of the flight types that can be carried out in the school's aircraft within the scope of its training permit.

1.18. Additional information

We have reviewed similar accidents, investigated by various authorities, involving the main landing gear attachment system of Tecnam P-92 Echo aircraft.

In all the cases identified, the main landing gear leaf spring attachment bolts (sometimes lateral and sometimes central) were severed due to material fatigue, with cracks or corrosion sometimes found around the breakage zone. However, we were unable to find another incident involving the loosening of the self-locking nuts, as occurred in the event that is the subject of this investigation.

1.19. Useful or effective investigation techniques

Not applicable.

2. ANALYSIS

2.1. Analysis of the meteorological conditions

The meteorological conditions in the area and around the time of the event were suitable for the flight and, therefore, adverse conditions are not deemed to have been a factor in the accident.

The only assessable meteorological parameter at the time of landing was that when the aircraft veered towards the left side strip and turned about 90°, a 10 to 12 kt headwind on the runway helped to stop the aircraft without the need to reapply the brakes, as the pilot confirmed in his statement.

2.2. Operational analysis

According to his statement, the pilot carried out pre-flight inspections for each and every one of the five flights he made on the day of the event, with satisfactory results in all.

² Regulations applicable to ULM Flight Schools:

- Royal Decree 1070/2015, of 27 November, which sets out the technical standards for the operational safety of restricted-use aerodromes and modifies Royal Decree 1189/2011, and the Directive of 24 April 1986, which regulates ultralight flights.
- Royal Decree 123/2015 of 27 February, which regulates the license and ratings for ultralight pilots.
- Directive of 24 April 1986, which regulates ultralight flights.

Furthermore, according to the pilot's statement, after he touched down for the last time on the first third of runway 08, with all three wheels on the ground, he applied the brakes, intending to leave the runway via the central asphalt exit taxiway (located roughly halfway along). It was then that he noticed a vibration he couldn't identify, and, just as he released the brake, the aircraft sank onto its left side and began to veer to the left, heading towards the side strip and coming to a halt on a level with the windsock.

The pilot's statement is consistent with the aerodrome's video recordings, which show, presumably when the pilot applied the brake, the aircraft veering gradually to the left at the same time as its left side sinks, causing the failure and bending of the left main gear leg.

Consequently, it was the application of the brake that put pressure on the left leaf spring attachment, and it must have been at that moment that the central bolt's nut detached, which, in turn, resulted in the lateral bolts buckling under the pressure and throwing their corresponding nuts, allowing the left leaf spring to bend under the fuselage. Until this point, the aircraft had been moving toward the edge of the runway.

It then pivoted on the collapsed left leg and turned more than 90° to the left before coming to a stop off the runway on the left-hand side strip. The video recordings show that the pilot shut down the engine a few seconds later.

According to the video recordings, the aircraft stopped almost in front of the windsock, which showed the wind was blowing head-on to the aircraft at a speed of approximately 12 kt. This wind helped to stop the aircraft without any additional braking, as confirmed by the pilot.

According to the pilot, he shut off the engine before the aircraft's left wing hit the ground and before it came to a stop after exiting the runway. However, the video recordings show that pilot shut the engine down after the aircraft came to a stop and the left wing had already hit and been dragged along the ground several times. The landing took place in a short period of time in which the pilot was not aware of the actual sequence of events. Of particular note is the fact that the pilot's assessment of the speed at which the aircraft landed was incorrect. In fact, the video recordings show the aircraft landed at considerable speed, which would have required forceful braking.

According to the operating procedures, the optimal speed for touchdown with full flaps is 39 kt (about 62 km/h); therefore, with the flaps set at 15°, it would be around 67 km/h. Based on the aerodrome video recordings, the aircraft landed at an approximate speed of 75 km/h, which was faster than that recommended and perceived by the pilot, and probably necessitated more forceful action on the brakes, especially since the intention was to leave the runway via its intermediate exit.

In view of the preceding, it can be concluded that the pilot followed the operating procedures adequately and, therefore, his actions are not considered to have contributed to the accident.

2.3. Analysis of the aircraft wreckage

The damage to the aircraft is consistent with the pilot's statement and the aerodrome's video recordings. As the aircraft slowed down, the left wing lowered until it hit the ground and continued to drag along it. As a result, it sustained damage to its underside and the left horizontal stabiliser.

The failure of the left main landing gear leaf spring was caused by the detachment of the self-locking nut from the central bolt due to the axial pulling force exerted on the nut as the pilot braked the aircraft. If the nut had been properly tightened to the correct torque, the assembly would have absorbed the stress without the nut coming off. Therefore, it can be deduced that the nut was not properly tightened.

The fact that the bolt was not deformed confirms that the nut must have worked its way loose gradually without forcing the attachment system, probably, due to the assembly vibrating during the successive taxiing and landing cycles carried out on the day of the incident and perhaps even before then. Eventually, the nut came off completely when the pilot braked with somewhat more force than normal, causing the accident.

If the nut *had* been properly tightened, when the assembly was placed under excessive braking force, the central bolt would have bent or snapped before its nut came off, as happened with the lateral bolts. This confirms that the nut on the central bolt was inadequately tightened.

In turn, the detachment of the central nut allowed the leaf spring to rotate towards the fuselage, opening the bracket, moving and buckling the lateral attachment bolts as a result, which, subjected to this strong traction force with their nuts correctly tightened, became deformed and sustained material wear before finally separating completely from their nuts.

Considering the geometry of the leaf spring and its anchoring, it's unlikely the central bolt's nut would have separated or detached during previous flights because it would have caused the main landing gear to vibrate, knock, or even collapse before the brakes were applied during the incident flight.

2.4. Analysis of the aircraft's maintenance

The aircraft inspection found that the overhaul records were in order and compliant with the approved maintenance programme. In fact, the main gear leaf spring attachment bolts were replaced earlier than recommended by the manufacturer.

This was corroborated by the fact that the attachment bolts and their nuts looked new, with no rust or other signs of deterioration. Therefore, the failure or poor condition of any of the components or materials used is not considered to have contributed to the accident. However, given that the aircraft had only flown 74 hours since the last maintenance intervention involving work on the parts in question, the investigation has concluded that maintenance malpractice was a factor in the incident.

The separation of the nut from the central bolt that allowed the leaf spring to come loose and vibrate on braking, resulting in the rotation of the leg and other damage to the aircraft, was caused by a failure to tighten the self-locking nut correctly.

Although the pilot must have braked with considerable force because, as indicated above, he intended to take the central runway exit, if the central bolt and its nut had been adequately tightened, the central nut would not have come off, the lateral bolts would not have been deformed to the extent that their nuts also came off, causing the leaf spring to bend under the fuselage, and the accident wouldn't have occurred.

The landing gear should have been able to absorb the force of the braking without compromising its structure and attachment to the fuselage, even if the brakes had locked the wheels, which didn't happen because there was no evidence of deformities or unusual wear to the tyres or brake system, nor any transfer of tyre material to the runway.

Although we cannot determine whether the nut loosened and ultimately came off completely due to over or under-tightening with respect to the requirements, what can be determined is that the tightening torque applied was incorrect. This has been deduced from the state of the central bolt, which was in perfect condition and undamaged by its nut, suggesting that it became loose without difficulty, which would be consistent with a failure to use the appropriate tool to apply torque.

In regard to the type of bolts used, the inspection found that they did not correspond to the aircraft manufacturer's specifications. This may have led to play between the parts causing vibrations and further contributing to the loosening and eventual detachment of the nut.

The lateral bolts buckled under the strain produced when the bracket was released, the leather spacers that act as shock absorbers were lost, and the vibration of the entire assembly, which caused the spring to move and rotate.

Consequently, we have determined that the inadequate tightening of the nut on the central bolt was the result of maintenance malpractice.

2.5. Analysis of the organisation

The pilot had not flown any ultralight aircraft in the last year and, as the training organisation has not established it as a requirement for its instructors, had not carried out any type of refresher flight prior to the day of the incident.

Furthermore, according to the pilot's statement, the type of flight involved in the incident was an ultralight experience flight. However, AESA establishes that ULM flight schools are only authorised to provide instruction for obtaining or maintaining a ULM license and are not permitted to carry out activities other than training.

The organisation's training plan for obtaining the ULM pilot license includes an initial 45-minute flight where the student is taught to carry out a pre-flight inspection and given a first

introduction to the aircraft, for which they are required to have knowledge of the school's manuals. The flight affected by the accident lasted for 45' but does not meet the other criteria set by the school to be considered as the initial flight of a training course. Thus, the flight in question is not considered to have been a training flight, and, consequently, the pilot-in-command was not acting as an instructor. However, it was carried out in an aircraft belonging to the ULM pilot school.

Up to now, AESA has not disclosed the need to initiate a regulation of the requirements or demands regarding the refresher flights of the instructor pilots of the ULM flight schools, however, in relation to the type of flight of the event, of which there is currently no national or international regulation that contemplates it, in the course of the investigation, AESA has reported that it is currently in the process of regulating the regulatory framework for this type of flight, since the Draft Royal Decree on ultralight motorized aircraft (ULMs), which has just completed the public audience process, thus contemplates it in article 9 "Introduction Flights".

3. CONCLUSION

3.1. Findings

- The aircraft wreckage is consistent with the pilot's statement and the aerodrome's video recordings.
- When the pilot applied the brakes on landing, the retaining nut on the central attachment bolt of the left leaf spring came off.
- The investigation has shown that the nut detached because of a failure to apply the correct torque during a maintenance intervention.
- The attachment bolts of the left leaf spring were in good condition but were not the ones specified by the aircraft manufacture. By contrast, the self-locking nuts did correspond to the part number specified by the manufacturer.
- The aircraft's maintenance was generally adequate, although the failure to use the appropriate tool when tightening the main landing gear attachment assembly is considered maintenance malpractice.

3.2. Causes/contributing factors

The probable cause of the accident was the collapse of the main landing gear's left leaf spring after the pilot applied the brakes on landing due to the detachment of the self-locking nut that secures its central bolt.

The self-locking nut probably became loose as a result of the incorrect torque being applied due to maintenance malpractice.

4. RECOMMENDATIONS

REC 49/21: It is recommended that Ignagua Center, S.L. ensure the appropriate tools are used for maintenance tasks involving a torque specified by the aircraft manufacturer, as well as that guarantees that the technical specifications of the components involved are those required by the aircraft manufacturer.

As a result of this investigation, the CIAIAC considered relevant to recommend to AESA that it regulates the type of ULMs flight of this event in order to guarantee the safety conditions of this practice for its pilots and passengers. During the writing process of this document, AESA reported that it is currently in the process of regulating the regulatory framework for this type of flight, since the Draft Royal Decree on ultralight motorized aircraft (ULMs), which has just finalized the public audience procedure, as contemplated in article 9 "Introduction Flights". Consequently, it is considered that this safety action carried out by AESA has been satisfactorily implemented and therefore it is not considered necessary to issue said safety recommendation.

5. ANNEXES

5.1. Applicable TECNAM Service Bulletins

The service bulletins emitted by TECNAM and analysed during the investigation are detailed below.

- Service Bulletin No. 07-UL of 06/12/2007: in order to improve the connection between the main landing gear leaf springs and the fuselage, it is recommended that the installed UNI bolts be replaced with new ones at standard MS. It is recommended they be replaced within the next 100 flight hours. The required attachment components will now be as follows:
 - Lateral bolts p/n: MS20005-24 (2 per leg).
 - Central bolts p/n: MS20006-64 (1 per leg).
 - Self-locking nuts p/n: MS21042-5 (1 per bolt, the same p/n for both the lateral and central bolts).
- Service Bulletin No.17-LSA and No. 22-UL ed.1 of 11/08/2011, regarding the recommendation to check the torque values of the main landing gear attachment bolts. In order to ensure a better connection between the leaf-spring-type landing gear leg and the fuselage. It is recommended that the torque values be checked within the first 10 flight hours when the total number of flight hours is less than 100, and after that, every 100 hours.
 - For the 4 self-locking nuts p/n: MS21042-5 for the lateral bolts p/n: MS20005-24, a tightening torque of 15 +/- 1 Nm should be applied.
 - For the 2 self-locking nuts p/n: MS21042-6 for the central bolts p/n: MS20006-64, a tightening torque of 25 +/- 2 Nm should be applied.
- Service Bulletins No.18-LSA rev. 2, of 13/09/2011 and No. 23-UL ed. 1 rev. 3 of 29/12/2011 relative to the recommendation to replace the bolts connecting the main landing gear legs to the fuselage, to improve the connection by installing the new kit of self-locking nuts reference No. SB018LSA that includes the following nuts:
 - 4 Self-locking nuts p/n: AN365-524A for the lateral bolts with p/n: MS20005-24, whose tightening torque should be 15 +/- 1 Nm.
 - 2 units Self-locking nuts p/n: AN365-624A for the central bolts with p/n: MS20006-64, whose tightening torque should be 25 +/- 2 Nm.
 - Should the aircraft has metric nuts, the recommendation is to inspect rather than replace them.
- Service Bulletin No. 066 ed.2 rev.1, of 09/07/2012, this is a mandatory Service Bulletin regarding the replacement of the main landing gear nuts. The measure must be implemented within the next 25 flight hours. The reference No. of the new nut kit is SB066CS and includes the following nuts:
 - 4 Self-locking nuts for the lateral bolts p/n: AN365-524A, whose tightening torque must be between 14 and 16 Nm.
 - 2 units Self-locking nuts for the central bolts p/n: AN365-624A, whose tightening torque must be between 23 and 28 Nm.