Technical report
A-021/2022

Accident on 09 April 2022 involving a Diamond DA-40 aircraft with registration EC-IQD, operated by Aerotec Escuela de Pilotos, at Cuatro Vientos Airport (Madrid)

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GOBIERNO DE ESPAÑA
MINISTERIO DE TRANSPORTES, MOVILIDAD Y AGENDA URBANA
UNDERSECRETARIAT
CIVIL AVIATION ACCIDENT AND INCIDENT INVESTIGATION COMMISSION

Notice

This report is a technical document that reflects the point of view of the Civil Aviation Accident and Incident Investigation Commission regarding the circumstances of the accident that is the object of the investigation, its probable causes, and its consequences.

In accordance with the provisions in Article 5.4.1 of Annexe 13 of the International Civil Aviation Convention; and with Articles 5.6 of Regulation (EU) No 996/2010 of the European Parliament and of the Council of 20 October 2010; Article 15 of Law 21/2003 on Air Safety; and Articles 1 and 21.2 of RD 389/1998, this investigation is exclusively of a technical nature, and its objective is the prevention of future aviation accidents and incidents by issuing, if necessary, safety recommendations to prevent their recurrence. The investigation is not intended to attribute any blame or liability, nor to prejudge any decisions that may be taken by the judicial authorities. Therefore, and according to the laws specified above, the investigation was carried out using procedures not necessarily subject to the guarantees and rights by which evidence should be governed in a judicial process.

As a result, the use of this report for any purpose other than the prevention of future accidents may lead to erroneous conclusions or interpretations.

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CONTENTS

ABBREVIATIONS

° ‘ “	Sexagesimal degrees, minutes and seconds
A/C	Aircraft
AD	Airworthiness directive
AEMET	State Meteorological Agency
AESA	Spain’s National Aviation Safety Agency
ASTM	American Society for Testing and Materials
ATPL	Airline transport pilot licence
CAMO	Continuing Airworthiness Management Organisation
CAR	Civil Aviation Regulations
CPL	Commercial pilot license
CRS	Certificate of release to service
DOA	Design organisation approval
EASA	European Aviation Safety Agency
FI	Flight instructor
ft	Feet
h	Hours
IR	Instrument rating
kg	Kilograms
km	Kilometres
kt	Knots
lb	Pounds
LECU	ICAO code for Cuatro Vientos Airport (civilian)
LEVS	ICAO code for Cuatro Vientos Airport (military)
m	Metres
MEP	Multi-engine piston rating
METAR	Aviation routine weather report (in aeronautical meteorological code)
mm	Millimetres
MSB	Mandatory Service Bulletin
N	Newton(s)
NDT	Non-destructive testing
ICAO	International Civil Aviation Organisation
OSB	Optional Service Bulletin
p/n	Part number
PPL	Private pilot license
SEP	Single-engine piston rating
SB	Service Bulletin
SI	Service information
STC	Supplementary type certificate
TAF	Terminal aerodrome forecast
TC	Type certificate

TCCA	Canadian Civil Aviation Authority
UTC	Coordinated universal time
VFR	Visual flight rules

Technical report

A-021/2022

Owner	Aerotec Escuela de Pilotos
Operator:	Aerotec Escuela de Pilotos
Aircraft:	Diamond DA-40, registration EC-IQD (Spain)
Date and time of accident:	9 April 2022, 9:45 h[1]
Site of the accident:	Cuatro Vientos Airport
Persons on board:	2 (crew)
Type of flight:	General aviation - Training flight - Dual command
Phase of flight:	Taxi – Taxi from the runway
Type of operation:	VFR
Date of approval:	30 November 2022

Synopsis

Summary:

On Saturday, 9 April 2022, the crew of the Diamond DA-40 aircraft, registration EC-IQD, took off from Cuatro Vientos Airport (LECU) for a local training flight; specifically, an advanced phase VFR flight. On board were an instructor pilot and a student pilot.

After take-off, they proceeded to reporting point N. While flying over this reporting point, they heard on the radio that several traffics were returning to the field due to bad weather, which was causing a loss of visual contact with the ground. They made the decision to return to the aerodrome, and the tower controller cleared them to join the first third of the downwind leg of the traffic circuit to land on runway 27.

After approaching and landing without incident, they left the runway at exit J3, being instructed to taxi onto the general apron via gate E. They noted that parking stand no. 2 was clear. Due to the aircraft's wingspan and to avoid a sharp turn, the instructor pilot steered the aircraft to the parking stand by turning it. At that instant, the front landing gear leg collapsed, causing the aircraft to fall and hit the ground, damaging the propeller blades.

The instructor pilot and student pilot were unharmed.

After securing the aircraft, they climbed down and observed that the nose wheel was displaced several centimetres forward.

[1] All times referenced in this report are local time. The UTC is 2 hours less.

The investigation has determined that the cause of the accident was an in-service failure of the pivot axle on the nose wheel fork, due to material fatigue.

Two safety recommendations have been issued to Diamond, the aircraft manufacturer, suggesting that it update its Maintenance Manual and Service Bulletins in order to ensure consistency between them.

1. THE FACTS OF THE INCIDENT

1.1. Overview of the accident

The aircraft's last 200 h overhaul was carried out at the ASPA maintenance centre on 5 February 2022. As part of this overhaul, in compliance with Diamond's mandatory service bulletin MSB[2] 40-046 covered by EASA airworthiness directive AD 2009-0016, the condition of the pivoting axle on the nose leg fork was examined using dye penetrants (Type II penetrants). No signs of material fatigue were detected.

On 9 April 2022, after 110:06 h of flight time since the last 200 h overhaul, the aircraft experienced an in-service material fatigue failure while taxiing on the parking apron at Cuatro Vientos Aerodrome.

When the nose gear leg broke, the aircraft slid along the ground on its nose, causing damage to the propeller and engine.

The instructor pilot and student pilot were unharmed.

1.2. Injuries to persons

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

1.3. Damage to the aircraft

The aircraft suffered damage to its forward landing gear, propeller and engine.

1.4. Other damage

There was no further damage.

[2] In the Maintenance Manual, Diamond states that an MSB includes a description of a problem and its solution. It warns that, if an MSB is not implemented, failures or malfunctions may occur during subsequent operation. It concludes that an MSB should always be implemented.

1.5. Information about the personnel

1.5.1. Information about the instructor pilot

The 22-year-old instructor pilot had a commercial pilot license (CPL) for aircraft, first issued on 18 March 2020, with the following ratings: MEP(land), SEP(land) and IR, all valid until 31 March 2024, and flight instructor (FI) for PPL, CPL and SEP, valid until 31 October 2023.

His Class 1 medical certificate was valid until 21 October 2022.

The instructor pilot had a cumulative experience of 772:30 h. As an instructor, he had 524:12 h of experience. His experience in the accident aircraft was 14:48 h.

1.5.2. Information about the student pilot

The 33-year-old student pilot had a Class 2 medical certificate valid until 6 March 2027.

The student pilot had a cumulative experience of 91:30 h.

He was taking the integrated ATPL course. On the day of the accident, he was to make his first flight in the aircraft type, which was to be his second advanced VFR flight.

1.6. Information about the aircraft

- Make: Diamond
- Model: DA-40
- Year of manufacture: 2002
- Serial number: 40229
- Registration number: EC-IQD
- Maximum take-off weight: 1150 Kg
- Number of engines: 1
- Type of engines: Lycoming IO-360-M1A, with serial number L2719851E.
- Information about the owner and operator: The aircraft has been registered to Aerotec Escuela de Pilotos in the Spanish Aircraft Registry since 22 September 2003.

The aircraft has an Airworthiness Certificate issued on 23 May 2014 and its Airworthiness Review Certificate was valid until 25 August 2022.

At the time of the event, the aircraft had a total of 4,855:06 h of operation.

The photograph below shows the aircraft's instrument panel:

Image 1: Instrument panel on board the aircraft

The nose leg installed on the aircraft was part number D41-3223-10-00.

1.6.1. Description of the aircraft's forward landing gear leg

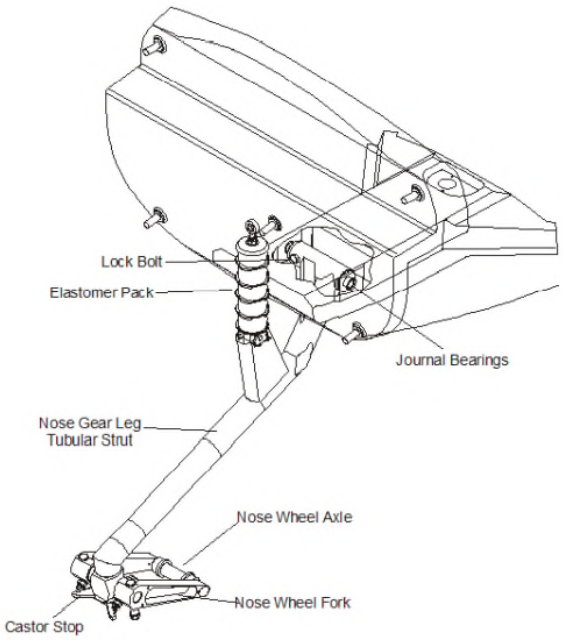
The DA-40 aircraft has a fixed tricycle landing gear. The main legs attach to the fuselage centre-section. The nose leg attaches to the forward fuselage. Each main wheel has a disc brake. Hydraulic pressure operates each disc brake. The wheel on the nose gear leg can be rotated.

The figure on the right shows the nose gear assembly.

The nose gear strut is a welded steel tube. Its upper end terminates in a cross tube containing the main attachment bearings, which allow the strut to move up and down only.

The strut has a welded bracket that holds an elastomer pack, the upper end of which is attached to the engine mount.

At the lower end of the strut is a near-vertical pivot for the fork, which allows the wheel to move. The stoppers limit this rotation to within ±30°. A lateral load on the wheel rotates it on the axle. The fork pivot's rigidity (steering friction) can be adjusted with its lower mounting screw.



1.6.2. Maintenance of the aircraft's landing gear nose leg, as specified by the aircraft manufacturer

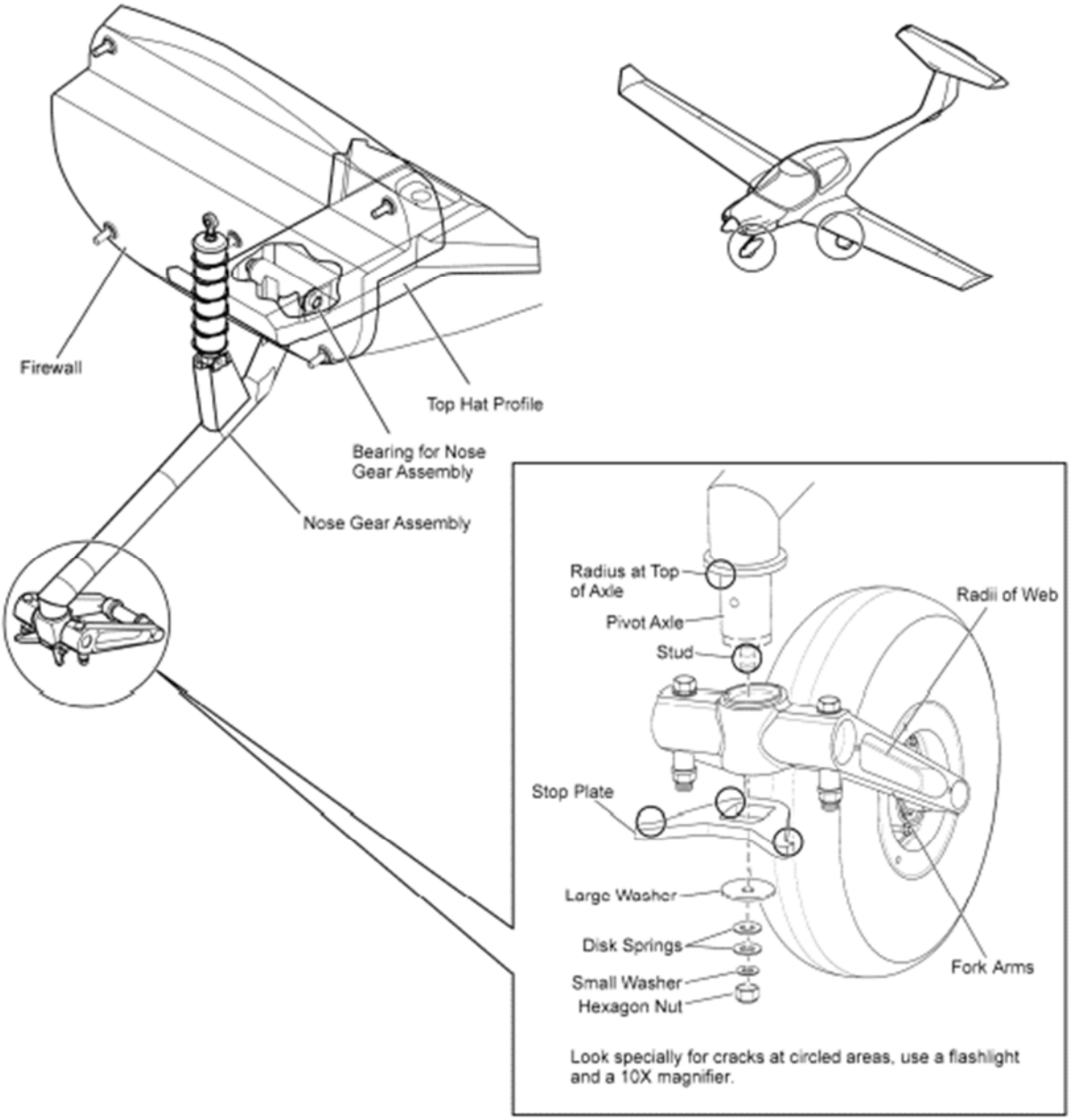
Diamond, the aircraft's manufacturer, specifies in section 05-28-50 of its Maintenance Manual[3], on maintaining the aircraft's structure, the tasks to be carried out on the landing gear nose leg. These are:

1. Inspect the nose landing gear leg for cracks, corrosion, paint condition and deformation.
2. Examine the nose-wheel assembly. Look specially for incorrect attachment, cracks and deformation.
3. Examine the nose-gear journal-bearings in the bottom of the fuselage. Look specially for play.
4. Examine the elastomer pack: the journals in the elastomeric spring, the spherical bearing at the top of the elastomeric spring and the elastomeric spring and the centre tube.
5. Remove the NLG fork. Inspect the fork for cracks, corrosion, and deformation. Look specially on the legs and filleted areas.
6. Inspect the nose landing gear fork collar bushings.
7. Inspect the NLG leg for cracks, corrosion and damage. Use a flashlight and a 10X magnifier. Pay special attention to the pivot axle (especially the radius at the top) filleted areas, and the threads at the bottom of the fork pivot axel. If cracks are suspected, perform a fluorescent dye penetrant inspection in accordance with ASTM 1417 or equivalent method.
8. Inspect the stop plate for cracks and damage.
9. Install the nose wheel fork. Do a test for play and caster friction. The friction force should be 30 - 50 N (6.75 - 11.25 lb) at the axle.

All tasks are to be carried out in the periodic overhauls after 100, 200, 1,000 and 2,000 h of flight, except for the elastomer centre tube, which must be inspected every 1,000 h.

The next figure shows a description of the nose leg components together with an enlarged diagram of its fork:

[3] *DA 40 Series Airplane Maintenance Manual*, document 6.02.01, Rev 8 of 18/10/2019

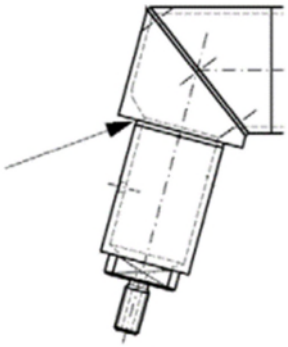


Diamond publications applicable to the DA-40 180 aircraft:

The tasks specified in the Maintenance Manual are complemented by those set out by Diamond in its service bulletins.

In 2005, Diamond's SI 40-027 reported airworthiness directive reference A-2005-005 issued by the Austrian civil aviation authority, Austro Control, requiring the inspection of the nose leg due to the appearance of fatigue cracks in the fork's pivot axle. For aircraft operating on paved runways, as was the case for the accident aircraft, this inspection had to be carried out within the next 100 h of operation and every 200 h of operation thereafter.

Subsequently, in 2008, Diamond issued mandatory service bulletin MSB 40-046, which specified that the pivot axle on the nose gear fork (see the area marked by the arrow in the figure on the right) should be inspected for fatigue cracks:



- It also specified that only the dye penetration method could be used.
- For aircraft operating on paved runways, as was the case for the accident aircraft, this inspection had to be carried out within the next 100 h of operation and every 200 h of operation thereafter.

Diamond stated in this service bulletin that if a crack is found, the leg should be replaced. If the installed leg was P/N D41-3223-10-00_1 or higher, no further action was required by Diamond.

Later, EASA published airworthiness directive AD 2009-2016 to enforce Diamond's MSB 40-046.

During the investigation, we asked Diamond why MSB 40-046 states that the dye penetration (Type II penetration) method must be used to detect potential cracks, while the Maintenance Manual states that the check should be performed using a fluorescent dye penetrant (Type I penetrant) inspection or an equivalent method. Diamond explained that when MSB 40-046 was drafted, using a red dye penetrant was the recommended practice in aviation. However, it was later discovered that the red dye could remain on the inspected parts after testing and affect subsequent inspections. Residue from colour contrast materials, introduced by inspections carried out previously, may create contamination of the fluorescent penetrant process, causing poor inspection results. To ensure optimum inspection results are achieved it is essential to thoroughly remove visible dye inspection residue by pre-cleaning the part using approved cleaning methods. ASTM E1417 prohibits the use of Type II penetrant examination for final acceptance examination of aerospace products. Additionally, ASTM E1417 notes Type II penetrant examination shall not be used prior to a Type I examination of the same surface. As a result, the recommended penetrants today are Type I. Therefore, Diamond used the term "fluorescent" in the Maintenance Manual to encourage the use of Type I penetrants.

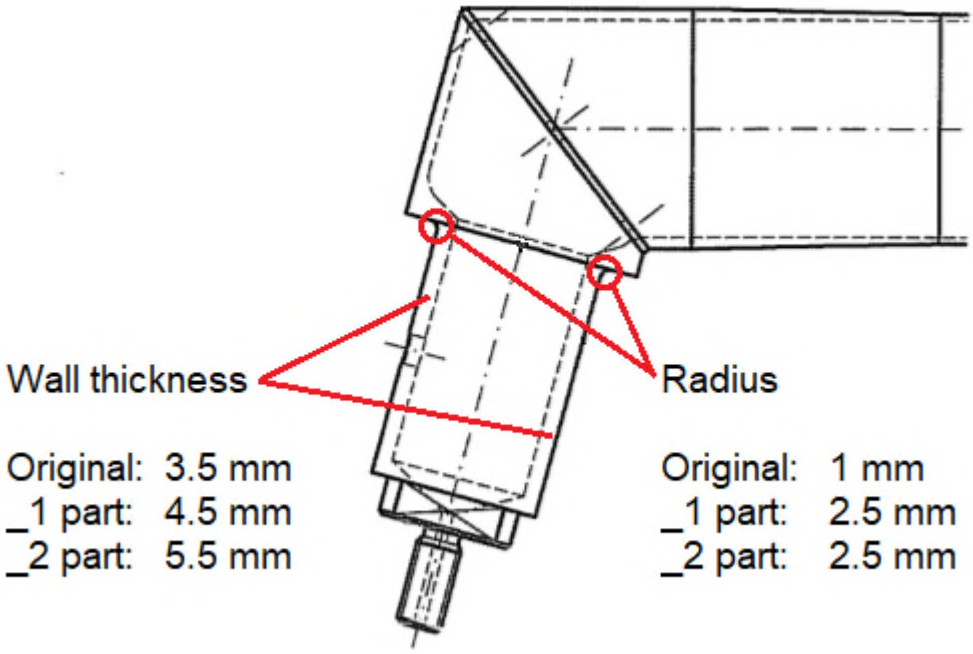
More recently, in 2021, Diamond issued a new mandatory service bulletin, MSB 40-091, applicable to aircraft with P/N D41-3223-10-00 and D41-3223-10-00_1 nose gear legs. This service bulletin requires a dye penetrant (Type II penetrant) inspection to be performed every 100 hours of operation, regardless of the type of surface on which the aircraft operates.

Diamond states that the terminating action for the service bulletin is to replace the nose leg with the redesigned part number D41-3223-10-00_2 or higher.

To date, EASA has yet to issue the corresponding airworthiness directive to enforce this latest MSB published by Diamond[4]. During the investigation, this issue was discussed with EASA, who, after consulting with the TCCA, reported that the TCCA is working with Diamond Canada on a new AD, which will replace the current EASA AD 2009-2016.. The use of dye penetrant (Type II Visible dye) recommended in MSB 40-091 published 18 January, 2021 applicable to DA 40 P/N D41-3223-10-00 and P/N D41-3223-10-00_01 does not align with TCCA regulatory requirements. The new AD will address the need to avoid the use of dye penetrant (Type II Visible dye) for the final acceptance examination of aerospace products as outlined in the American Society for Testing and Materials – ASTM – E1417 and in accordance with the Civil Aviation Regulations – CAR – Standard 571.10.

Evolution of the design of the nose leg fork pivot

During the investigation, Diamond provided information on how the pivot design has evolved in the different versions of the nose leg:



After conducting a stress analysis on the NLG fork, Diamond concluded that the version_2 gear is less susceptible to fatigue than the version_1 gear. The results from the analysis show that the version_2 gear may last 6 to 10 times the number of cycles the version_1 gear is expected to last depending on the limit load used during the calculation.

[4] Through the DOA (Design Organisation Approval) oversight process, EASA encourages TC/STC holders to only designate a Service Bulletin (SB) as mandatory if they know it will be covered by an AD. In all other cases, the TC/STC holder should use the term "highly recommended" (or equivalent). For SBs designated as "mandatory" by the TC/STC holder but for which no AD has been issued and which are not included in the manufacturer's maintenance programme, as in this case, the final decision to apply the SB rests with the owner/operator or contracted CAMO.

1.6.3. Aircraft Operator Maintenance Programme. Landing gear maintenance carried out by the aircraft operator

The aircraft operator has established in its Maintenance Programme, that takes into account Diamond Maintenance Manual and the applicable airworthiness, the landing gear maintenance tasks..

In particular, the most recent maintenance tasks performed by the aircraft operator on the landing gear as a whole and the nose leg in particular, are detailed in the following table:

ITEM	DESCRIPTION OF THE WORK	CRS #	A/C H	DATE	MAINTENANCE CENTRE
1	EASA AD 2009-0016	21/081	4494:54	05/06/2021	ASPA, S.L. (ES.145.099)
2	200 h overhaul	21/160	4544:00	24/09/2021	ASPA, S.L. (ES.145.099)
3	100 h overhaul	21/192	4645:00	02/12/2021	ASPA, S.L. (ES.145.099)
4	EASA AD 2009-0016	21/203	4692:06	29/12/2021	ASPA, S.L. (ES.145.099)
5	200 h overhaul	22/020	4745:00	05/02/2022	ASPA, S.L. (ES.145.099)
6	100 h overhaul	22/049	4840:06	30/03/2022	AEROTEC, S.L. (ES.CAO.021)

The table shows that the last maintenance check performed was the 100 h overhaul on 30 March 2022. As required by the Diamond Maintenance Manual, the nose leg was inspected for cracks, corrosion and damage using a flashlight and a 10X magnifying glass. At that time, the aircraft had 4,840:06 hours of flight time. When the aircraft was involved in the accident on 9 April, it had 4,855:06 h of flight time; therefore, 15:06 h had passed since the last 100 h overhaul.

The last 200 h overhaul was performed on 5 February 2022 at the ASPA maintenance centre. As part of this inspection, in compliance with Diamond's mandatory service bulletin MSB 40-046 covered by EASA airworthiness directive AD 2009-0016, the condition of the nose leg fork pivot was examined with dye penetrant testing[5], and no signs of material fatigue were detected. At that time, the aircraft had 4,745:00 h of flight time. When the aircraft was involved in the accident on 9 April, 110:06 h had elapsed since the last 200 h overhaul.

[5] The operator performed a colour contrast dye penetrant inspection, for which it has the necessary equipment. With regard to fluorescent dye penetrant inspections (using ultraviolet light), the operator indicated during the investigation that it does not have the means to do this in-house (and if it were to be necessary, they would have to use an approved organisation to perform this type of test).

1.7. Meteorological information

The State Meteorological Agency (AEMET) provides half-hourly METAR and TAF predictions for Cuatro Vientos Airport.

The METAR issued before and after 7:45 UTC were as follows:

METAR LEVS 090730Z 24006KT 9999 SCT050 BKN060 BKN070 10/09 Q1018=
METAR LEVS 090800Z 23009KT 9999 FEW006 BKN060 BKN070 11/10 Q1018=

The TAF provided for that hour was as follows:

TAF LEVS 090500Z 0906/1006 25008KT 9999 SCT045 TX18/0914Z TN09/0906Z PROB30 TEMPO 1003/1006 OVC005=

Therefore, there were no significant meteorological conditions at Cuatro Vientos Airport at the time of the event, the cloud ceilings had bases between 5,000 and 6,000 ft, and the wind was light from the west-southwest.

1.8. Aids to navigation

N/A

1.9. Communications

N/A

1.10. Information about the aerodrome

Cuatro Vientos Airport (ICAO code LECU) is located 8.5 km southwest of the city of Madrid. Its elevation is 692 m. It has one runway: 09/27, which measures 1,500 m long by 30 m wide.

At the time of the accident, the aircraft, having landed via the head of runway 27, had exited the runway through gate E and was taxiing towards the parking apron to park at stand 02. The aircraft's movement is shown on the aerodrome plan (in orange):

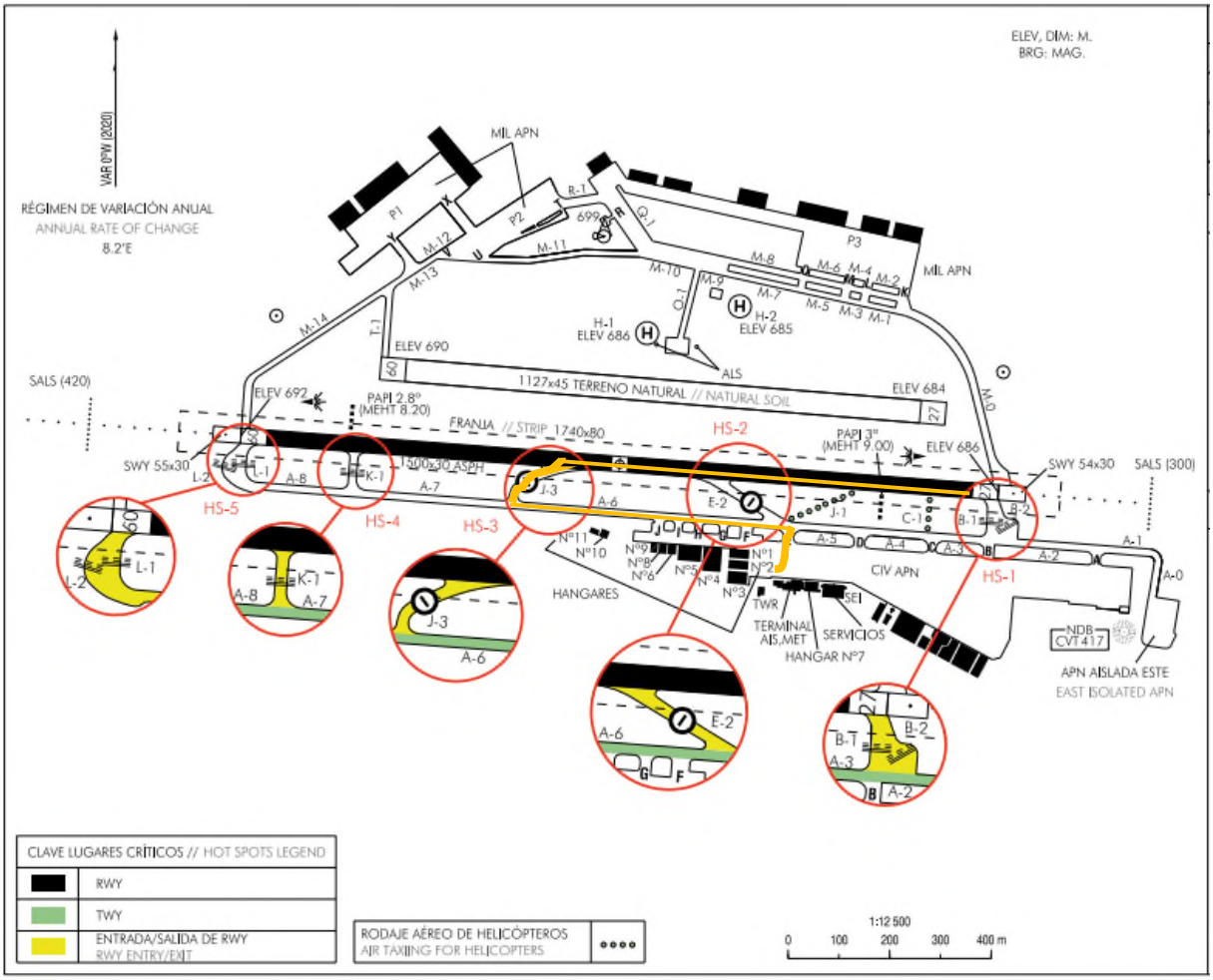


Image 2: Aerodrome plan

1.11. Flight recorders

N/A

1.12. Aircraft wreckage and impact information

The following image shows the aircraft's condition after the front landing gear leg broke. The damage to its propeller blades, caused by the aircraft moving along the runway without its front leg, can also be seen:

Image 3: Condition of the aircraft after the event

1.13. Medical and pathological information

There was no evidence to suggest the flight crew's performance was affected by any physiological or disabling factors.

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

The damage to the landing gear nose leg was studied in detail. In the diagram below-left, the area of the breakage is marked with a red arrow. The two photographs on the right show the breakages on the tubular strut and the pivot axle, which attaches to the nose wheel support:

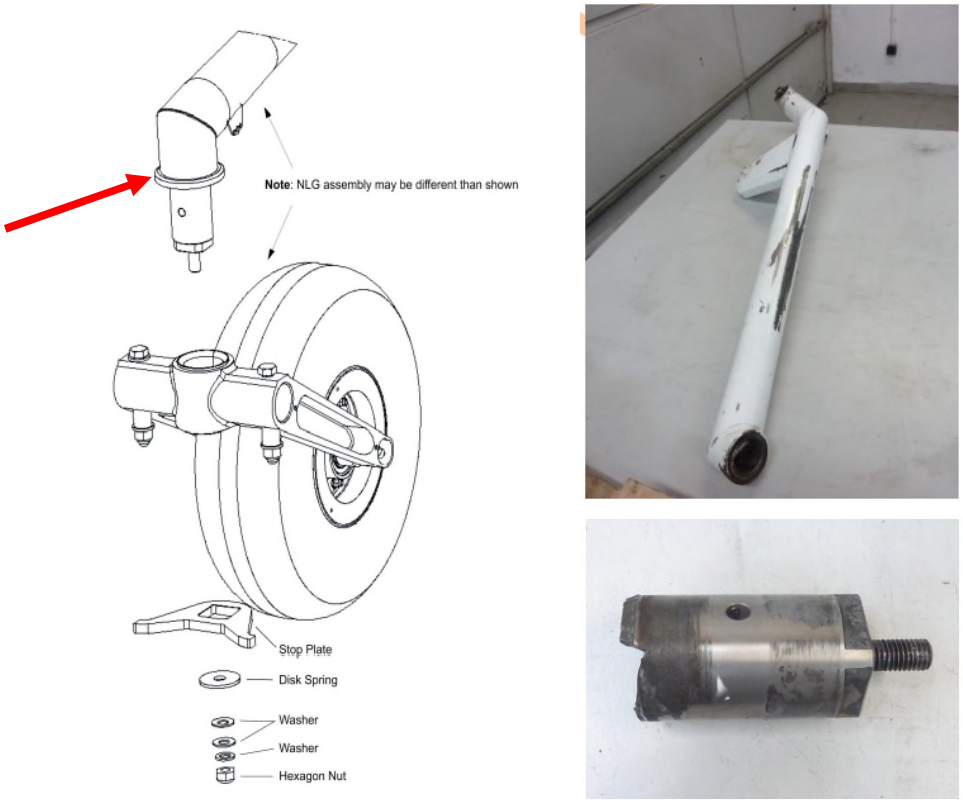


Image 4: Breakage of the nose landing gear leg parts

On visually examining the fracture surface and fractographic features left by the failure process that led to the complete breakage, the SGS laboratory found 3 clearly distinct areas, distinguishable from one another in terms of their topography, on the fracture surface of both parts:

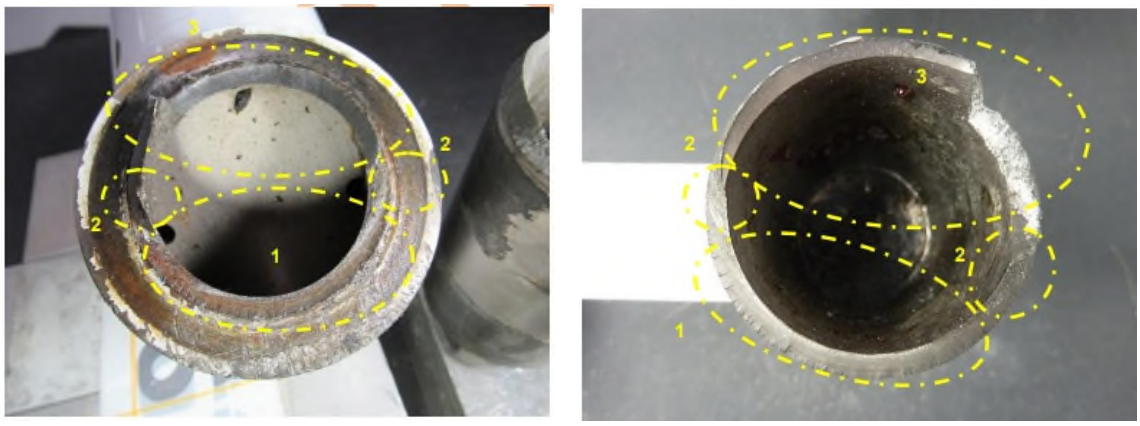


Image 5: The photograph on the left shows the breakage on the tubular strut, and the photograph on the right shows the pivot axle

Zone 1 has a smooth, matt texture, with the main feature being the presence of radial marks throughout, covering approximately one-third of the section. Behind these radial marks are circumferential marks with a highly open curvature that practically follow the circumferential perimeter of the tube. These features are typical of a fatigue fracture.

The presence of numerous radial marks suggests numerous origins of the fatigue fracture via the outer surface and generally associated with elevated stress on the perimeter of the surface where they occur. Given the high level of stress present, the breakage progressed rapidly.

When the applied load exceeds the material's resistance to tearing, the fracture mechanism changes (zone 2) to a semi-fragile tear, where the surface texture is rough and with a change in the plane of the fracture progression.

Lastly, in zone 3, plastic deformation occurred due to the excess stresses on the remaining section of the part.

The fatigue fracture occurred in the upper part of the axle, at a non-smooth transition between sections that constitutes a geometric notch; in other words, a point of stress accumulation around the entire perimeter, generating the onset of the fatigue fracture and favouring its rapid progression.

1.17. Organisational and management information

The operator of the accident aircraft is Aerotec Escuela de Pilotos, an EASA-approved training organisation (E-ATO-185). It has bases at Madrid-Cuatro Vientos Airport and San Pablo-Sevilla Airport.

1.18. Additional information

1.18.1. Internal report by the aircraft operator

After an internal analysis of the incident, the aircraft operator decided to replace the nose leg with a redesigned P/N D41-3223-10-00_2 version as per the aircraft manufacturer's mandatory service bulletin MSB 40-091, which states that this is the definitive action to be taken in order to avoid this type of service failure in the future.

1.19. Special investigation techniques

N/A

2. ANALYSIS

Given that failure of the nose leg pivot axle was studied and determined to have failed in service due to material fatigue, this report analyses: the design of the aircraft nose leg, the maintenance specified by the manufacturer and the maintenance carried out by the operator.

2.1. Analysis of the aircraft's nose leg design

The SGS laboratory determined that the pivot axle of the nose leg fork suffered an in-service failure due to fatigue. It concluded that the design of the pivot axle was inadequate because the change in section, with an abrupt transition due to the small radius, constituted a point of stress accumulation around the entire perimeter. In addition, it was noted that the chrome plating on the pivot axle was severely worn, suggesting the existence of considerable friction between the pivot axle and the fork, which would also have contributed to stresses in the area.

During the investigation, Diamond detailed how the design of the pivot axle on the nose leg fork had evolved to prevent it from failing in service due to material fatigue. The company indicated that the wall thickness of the pivot axle had been increased: 3.5 mm in the original version, 4.5 mm in version_1 and 5.5 mm in version_2, as had the radius that joined it to the rest of the leg: 1 mm in the original version, 2.5 mm in version_1 and 2.5 mm in version_2.

As Diamond has determined that the useful life of version_2 is approximately 6 to 10 times longer than that of version_1, CIAIAC have concluded that Diamond is already taking action to extend the useful life of the nose legs and, therefore, no safety recommendation is issued in this regard.

2.2. Analysis of the aircraft’s nose leg maintenance, as specified by the manufacturer

In section 05-28-50 of its Maintenance Manual[6], on maintaining the aircraft's structure, Diamond lists the tasks to be performed on the nose leg, regardless of its version (original, _1 or _2). Specifically, it establishes that the nose leg must be inspected for cracks, corrosion and damage in the periodic overhauls performed after 100, 200, 1,000 and 2,000 h of flight, paying particular attention to the fork’s pivot axle. If cracks are suspected, a fluorescent dye penetrant (Type I penetrant) inspection in accordance with ASTM 1417 or equivalent method should be performed.

By contrast, the EASA airworthiness directive AD 2009-2016, which makes Diamond MSB 40-046 applicable, establishes that penetrant dyes (Type II penetrant) must be used for inspecting the pivot axle of the nose leg fork and that, for aircraft operating from paved runways, as in the case of the accident aircraft, this check must be carried out every 200 hours of operation.

[6] *DA 40 Series Airplane Maintenance Manual*, version 6.02.01

Given the incoherence between the Maintenance Manual, which specifies the use of penetrant with fluorescent (Type I penetrant), and MSB 40-046, which stipulates the use of penetrant dyes (Type II penetrant), the issue of a safety recommendation to Diamond, recommending it update MSB 40-046 to bring it into line with the content of the Maintenance Manual, is deemed necessary.

More recently, in 2021, Diamond published MSB 40-091, which has yet to be backed by an airworthiness directive. In this service bulletin, Diamond requires that a dye penetrant (Type II penetrant) inspection be performed every 100 h of operation, regardless of the type of surface on which the aircraft operates.

Again, the issue of a safety recommendation to Diamond is considered necessary to recommend that if the manufacturer judges that compliance with the new MSB should be mandatory, it should update its Maintenance Manual accordingly, as the publication of an airworthiness directive to support it is not foreseen.

2.3. Analysis of the operator's maintenance of the aircraft nose leg

According to its approved maintenance programme, the operator of the accident aircraft complied with the specifications detailed in the Diamond Maintenance Manual and the EASA AD 2009-2016 airworthiness directive that enforces Diamond's MSB 40-046; therefore:

- Every 100 flight hours, it inspected the nose leg for cracks, corrosion, and damage using a flashlight and 10X magnifying glass. The last 100 h overhaul, carried out on 30 March 2022, did not detect any anomalies.

- Every 200 h of operation, it examined the condition of the pivot axle on the nose leg fork using a dye penetrant (Type II penetrant). This check was most recently performed on 5 February 2022, and no signs of material fatigue were found.

When the aircraft was involved in the accident on 9 April, 15:06 h had elapsed since the last 100 h overhaul, and 110:06 h had elapsed since the previous 200 h overhaul.

Given the results of the study into how and why the part fractured, we believe carrying out a detailed inspection of the axle during maintenance overhauls is necessary to anticipate possible in-service failures. Since the issue of two safety recommendations to Diamond has been deemed necessary, recommending it update its Maintenance Manual and Service Bulletins MSB 40-091 and MSB 40-046, we have concluded that no further recommendations are required.

3. CONCLUSIONS

3.1. Findings

- At the time the aircraft was involved in the accident, 15:06 hours had passed since its last 100 h overhaul, in which the nose leg was inspected for cracks, corrosion

and damage using a flashlight and a 10X magnifying glass. No anomalies were detected during this inspection.

- Since the last 200 h overhaul, during which the condition of the pivot axle on the nose leg fork is examined using dye penetrant, 110:06 h had passed. No signs of material fatigue were detected during the inspection.
- The nose leg fork pivot axle suffered an in-service failure due to material fatigue.
- The aircraft operator maintained the aircraft in accordance with the Diamond Maintenance Manual and EASA airworthiness directive AD 2009-2016, which enforces Diamond MSB 40-046.
- Diamond's MSB 40-046 provides for the inspection of the nose leg fork pivot axle with penetrant dye every 200 h of operation for aircraft operating from paved runways, as was the case of the accident aircraft.
- In its MSB 40-091, Diamond stipulated that the nose leg fork pivot axle should be inspected with penetrant dye every 100 h instead of every 200 h.
- MSB 40-091 is not supported by any airworthiness directive, nor have its provisions been incorporated into the Diamond Maintenance Manual.

3.2. Causes/contributing factors

The investigation has determined that the cause of the accident was an in-service failure of the pivot axle on the nose wheel fork, due to material fatigue.

4. OPERATIONAL SAFETY RECOMMENDATIONS

As some inconsistency between the Maintenance Manual and Diamond's service bulletins has been identified during the accident investigation, two safety recommendations are issued:

REC 42/22: It is recommended that Diamond update MSB 40-046 to bring it into line with the content of the Maintenance Manual.

REC 43/22: It is recommended that if Diamond judges that compliance with MSB 40-091 should be mandatory, it should update its Maintenance Manual accordingly, as the publication of an airworthiness directive to support it is not foreseen.