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Report IN-015/2018

Incident involving a DIAMOND DA20-C1 aircraft, registration EC-MQT, at the La Axarquía aerodrome in Vélez-Málaga (Málaga) on 9 May 2018

GOBIERNO DE ESPAÑA

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COMISIÓN DE INVESTIGACIÓN DE ACCIDENTES E INCIDENTES DE AVIACIÓN CIVIL

Tel.: +34 91 597 89 63
Fax: +34 91 463 55 35
E-mail: ciaiac@mitma.es
http://www.ciaiac.es
C/ Fruela, 6
28011 Madrid (España)

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 object of the investigation, and its probable 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 5.5 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., 4. 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.

CONTENTS

ABBREVIATIONS

° ' "	Sexagesimal degrees, minutes and seconds
°C	Degrees centigrade
AEMET	National Weather Agency
AESA	National Aviation Safety Agency
AMM	Aircraft maintenance manual
ARO	Air traffic services reporting office
ATO	Approved training organization
AVGAS	Aviation fuel
CAMO	Continuing airworthiness management organization
COM	Communications
CPL	Commercial pilot license
dB	Decibels
dm3	Cubic decimeters
EASA	European Aviation Safety Agency
ELT	Emergency locator transmitter
EMA	Automated weather station
FI	Flight instructor rating
ft	Feet
GPS	Global positioning system
h	Hours
hp	Horsepower
IPC	Illustrated parts catalog
IR	Instrument rating
kg	Kilograms
KIAS	Indicated airspeed in knots
km	Kilometers
km/h	Kilometers/hour
kn	Knots
l , l/h	Liters, Liters/hour
LAPL	Light aircraft pilot license
LEAX	ICAO code for the La Axarquia-Leoni Benabu (Málaga) aerodrome
LEMG	ICAO code for the Málaga-Costa del Sol Airport
LPI	Liquid penetrant inspection
m	Meters
m^2	Meters squared
m/s	Meters/second
MEP	Multi-engine piston rating
METAR	Meteorological aerodrome report
Mhz	Megahertz
MTOW	Maximum takeoff weight
N	Newton (unit for measuring force)

N	North
Nm	Newton(s) per meter
P/N	Part number
PPL	Private pilot license
PTM	Position reporting point in Torre del Mar (Málaga)
PV	Position reporting point in the Viñuela reservoir (Málaga)
RPM	Revolutions per minute
SB	Service bulletin
SEP	Single-engine piston rating
SIL	Service information letter
S/N	Serial number
TCDS	Type certificate datasheet
TORA	Takeoff run available
TTSN	Total time since new
UTC	Coordinated universal time
VFR-VMC	Visual flight rules – Visual meteorological conditions
VA	Maneuvering speed
Vne	Never-exceed speed
Vno	Normal operating speed
Vs	Stall speed
W	West

Synopsis

Owner and operator:	Grupo One Air Aviación S.L.
Aircraft:	DIAMOND DA20-C1, registration: EC-MQT
Date and time of incident:	Wednesday, 9 May 2018 at 13:24 local time
Site of incident:	La Axarquía aerodrome, Vélez-Málaga (Málaga)
Persons on board:	1 crewmember – uninjured
Type of flight:	General Aviation – Training – Solo
Phase of flight:	Landing
Flight rules:	VFR
Date of approval:	29 May 2019

Summary of event

On Wednesday, 9 May 2018, a DIAMOND DA20-C1 aircraft, registration EC-MQT, was involved in an incident at the aerodrome of La Axarquía, located in Vélez-Málaga, province of Málaga, during a training flight.

During the landing maneuver, as the aircraft made contact with the runway, the bottom coupling of the nose landing gear detached. The flight was being supervised from the ground by the instructor pilot, who reported the situation to the student pilot, who decided to abort the landing maneuver. Later, after communicating with emergency services and with firefighters and an ambulance standing by, the aircraft made an emergency landing without further incident.

The student pilot was not injured.

The aircraft sustained minor damage.

The investigation into the event has determined that the incident was caused by the detachment of the nose gear fork coupling when contact was made with the runway during a hard landing as the student pilot was initiating the landing, forcing him to abort the maneuver.

The following may have contributed to the incident:

- The simultaneous contact by the main and nose landing gears with the runway at a speed higher than recommended, placing excessive stress on the nose gear.

The report contains one safety recommendation addressed to the aircraft manufacturer to have it consider the possibility of including an additional maintenance revision criterion based on the number of aircraft cycles.

1. FACTUAL INFORMATION

1.1. History of the flight

On 9 May 2018 at 13:24 local time, the student pilot of a DIAMOND DA20-C1 aircraft, registration EC-MQT, was involved in an incident during a VFR flight to and from the La Axarquía aerodrome (LEAX, Vélez-Málaga) that forced him to make an emergency landing on runway 12 at the aerodrome.

On the day of the incident, the instructor and student had been practicing takeoffs and landings at the La Axarquía aerodrome (LEAX) during a training flight before the student's first solo flight[1] They made eight takeoffs and landings and simulated various emergencies.

All the maneuvers were completed normally under the instructor's supervision, who deemed the student to be qualified to make the subsequent solo flight as a student pilot.

As a result, the instructor exited the aircraft and the student proceeded to start the engine. He continued with the applicable procedures and taxied to the holding point of the runway in use, 12, to start his solo flight.

The student entered the runway and made a normal takeoff, flying one circuit and then landing and stopping on the runway.

The instructor then informed the student by the radio that he had to fly additional circuits, so the student taxied once more to the runway 12 holding point.

Photograph 1. Incident aircraft after the emergency landing

[1] Solo flight: first flight that a student pilot flies by himself during the instruction period to obtain a pilot license for the various categories.

The student went through the procedures again and made a normal takeoff before flying a circuit with a low approach without landing.

He then flew another circuit and once established on final, with the aircraft apparently in good condition, he landed, at which point he heard a noise and felt something strange in the aircraft. He also heard the voice of the instructor, who had seen what had happened, telling him by radio to "go around".

When the nose gear contacted the runway, at a speed of 65 KIAS, the instructor, who was recording the student's solo flight as per school procedure, noticed that the nose wheel on the aircraft detached, along with other components, and told the student by radio to abort the landing.

From that moment on, the instructor provided constant guidance to the student by radio, telling him to fly several circuits before making a decision and to calm him down, since the airplane was able to fly normally.

At that point, the instructor and personnel from the school who were at the aerodrome reported the event to the School Training Manager.

They contacted emergency services at the aerodrome, both firefighters and medical personnel. While they were arriving to the runway, the instructor reviewed with the student pilot by radio, the applicable procedure, performing 21 circuits and approaches in total before landing.

When the firefighters arrived at the runway, they covered it with foam and the student, under the instructor's constant supervision, landed with no further incident on the runway centerline with almost no speed and without sustaining any injuries.

The aircraft sustained minor damage.

1.2. Injuries to persons

Injuries	Crew	Passengers	Total in the aircraft	Other
Fatal				
Serious				
Minor				
None	1		1	
TOTAL	1		1	

1.3. Damage to aircraft

The aircraft sustained minor damage due to the incident. This damage affected only the nose gear and occurred when the wheel fork coupling detached.

1.4. Other damage

There was no other damage.

1.5. Personnel information

1.5.1. Student Pilot

The student pilot, a 22-year-old Spanish national, was in training to obtain a private pilot license (PPL). By the date of the event, he had completed the theory phase and was finishing the practical phase, having logged 24 hours 25 minutes of flight time with dual controls and made a total of 56 landings.

He had a solo flight authorization issued by the school on 9 May 2018 to conduct his first solo flight.

He had a class-1 medical certificate that was valid until 4 October 2018 and a class-2 and LAPL certificate that was valid until 4 October 2022.

On the flight prior to the event, carried out on 7 May 2018, the student pilot had practiced takeoffs and landings for 1 hour 20 minutes in the incident aircraft. On the day of the incident, 9 May 2018, he flew a 1-hour flight on the same aircraft, also practicing takeoffs and landings with different flap configurations. The instructor rated that flight as very good, and thus authorized the student to make his first solo flight, which is when the incident occurred.

1.5.2. Instructor

The instructor, a 39-year-old Spanish national, had the following license issued by the National Aviation Safety Agency (AESA):

- Commercial pilot license (CPL) since 3 July 2006, with the following ratings:
    - SEP (land), valid until 31 December 2019
    - MEP (land), valid until 31 December 2018
    - IR (A), valid until 31 December 2018
    - FI(A) for CPL, PPL, SEP IR NIGHT, valid until 31 May 2020

He had a class-1 medical certificate that was valid until 28 October 2018 and a class-2 and LAPL certificate that was valid until 28 October 2019.

According to information provided by the instructor, he had a total of 700 flight hours, of which 440 had been on the incident aircraft.

1.6. Aircraft information

1.6.1. General information

The DIAMOND DA20-C1 aircraft is a single-engine, two-seater aircraft with a cantilever low-wing configuration, a fixed tricycle landing gear and T-tail.

Photograph 2. Incident aircraft

Manufactured by DIAMOND AIRCRAFT INDUSTRIES, INC. (Canada), it is made of composite materials as per TCDS No. EASA. IM.A.223.

It is designed for VFR flights in VMC.

Instrument cockpit:

Photograph 3. Cockpit after the incident

Landing gear:

The aircraft has a fixed tricycle landing gear consisting of a nose gear and the main gear. Both have just one wheel per leg and low-pressure tires, and feature hydraulically actuated disc brakes.

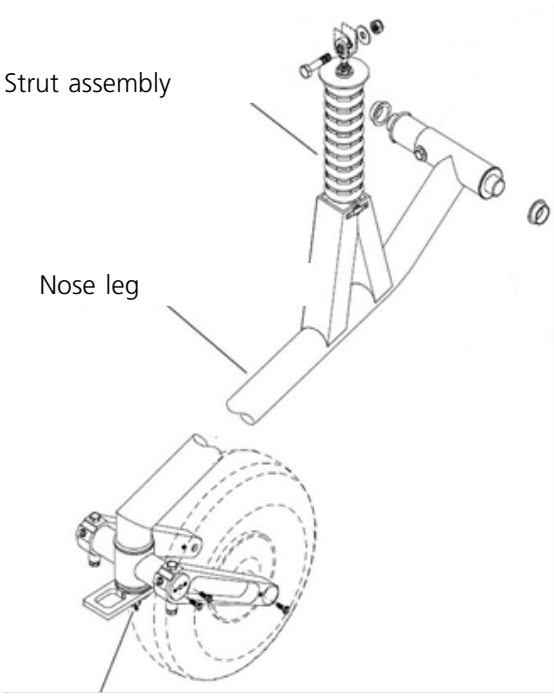


Figure 2: nose landing gear

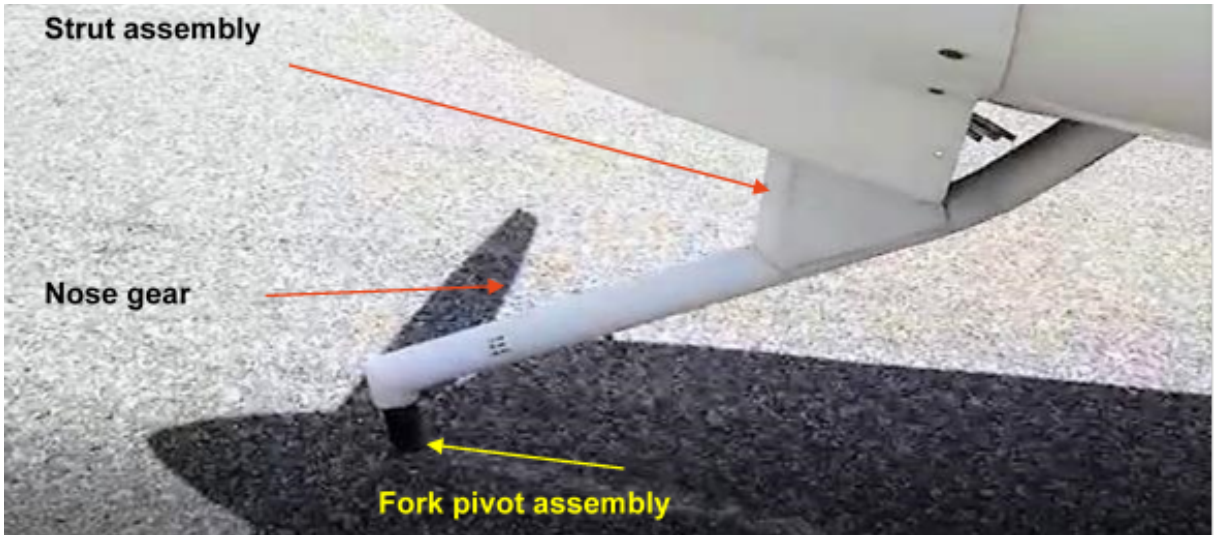
In particular, the nose gear has a single welded tubular steel bar that is fixed to the engine mount by a stud, and a rotating wheel. The attachment of this bar consists of an elastomer spring that provides damping (Figure 2).

At the front end of the bar is another, practically vertical, pivot that attaches the fork where the nose wheel is mounted. The pivot allows the wheel to turn ± 64º. The friction adjustment on this pivot is what allows the wheel to turn without shimmying.

The wheel fairing on this aircraft type is optional, and the incident aircraft did not have one.

The aircraft is turned on the ground by actuating the pedals.

Photograph 4 shows the main components of the nose gear on the aircraft after the incident.



Photograph 4: Nose landing gear on the aircraft after the incident

Fuel:

- Type of fuel authorized and used: AVGAS 100
- The aircraft has one aluminum tank in the fuselage with a total capacity of 93 liters, of which 2 liters are unusable.

Lubricant:

- Type of lubricant: aviation oil, TCM MHS24 specification.
- Tank: wet sump.

1.6.2. Maintenance records

This aircraft was manufactured in 2004 with S/N C0300. The maintenance was performed by an organization approved by AESA as a Part-145 organization, with Rev. 6 of the certificate issued on 16 May 2017, and as a Continuing Airworthiness Management Organization, with Rev. 6 of the certificate issued on 25 April 2016. The "DIAMOND DA20 Series" of aircraft were within the scope of the certificates.

The aircraft maintenance program in effect at the time of the incident, and authorized by AESA, was PM-DA20MQT, Ed. 1, Rev. 0A, dated 7 December 2017.

This program required the following inspections of the aircraft:

- Basic check every 50 hours
- Periodic check every 100 hours
- Overhaul every 200 hours or annually
- Overhaul every 1000 hours
- Overhaul every 6000 hours
- Special inspections (engine, fuel filter, magnetos and other components not affecting the airframe).

The aircraft logbook was issued on 19 May 2017, and at the time of the incident it showed a total logged flight time of 2612 hours 45 minutes.

The last flight logged before the incident was a flight from and to the La Axarquía aerodrome on the day of the event, leaving at 08:15 and arriving at 08:55, during which eight landings were made. On the previous flight, also made that same day, leaving at 05:30 and arriving at 07:35, one landing was made.

The most significant maintenance inspection performed to the aircraft was a 2000-hour check, during which no findings of relevance to the investigation into this incident were documented.

The most recent maintenance inspections carried out by the authorized organization were as follows:

- On 13 April 2018, a 200-h airframe inspection with 2531 hours 15 minutes on the aircraft. This inspection involved specific tasks of interest to the investigation, such as the removal of the nose wheel fork, a check of the threaded end of the pivot on the nose wheel and the lubrication of both components. The steering friction adjustment was also checked. This directly affects the castellated nut and its pin, which attaches the nose gear leg to the fork.
- On 3 May 2018: a 50-h check of the airframe with 2582 hours 30 minutes on the aircraft. This check did not include any tasks involving the nose gear.

None of these checks contained any notes or remarks involving the nose landing gear.

Between the last maintenance check of the aircraft, done on 3 May 2018, six days before the incident, and the date of the incident, the aircraft made a total of 127 landings, including nine landings, one go-around and one emergency landing on the day of the incident.

The table below shows the number of flight hours and landings made per day between the date of the final maintenance inspection and the flight prior to the incident:

Date	Flight hours	Landings
03/05/18	5:10	2
04/05/18	4:00	12
05/05/18	3:20	20
06/05/18	4:50	18
07/05/18	5:05	31
08/05/18	7:50	35
09/05/18	2:45	9
TOTAL	**35:00**	**127**

As for the engine, according to the engine logbook, it was installed new from the factory on 19 May 2017. It had a total of 679 flight hours through the day before the incident. The last maintenance inspections of the engine were:

- on 13 April 2017, a 100-hr check, and
- on 3 May 2018, a 50-hr check.

Neither of these inspections revealed any significant problems.

1.6.3. Airworthiness status

The aircraft with S/N C0300 and registration EC-MQT was, according to the registry of active registrations of the National Aviation Safety Agency, registered on 14 September 2017 under registry number 9930. The aircraft is owned and operated by a private pilot school based in Málaga that is approved by AESA as an EASA-ATO (authorized training organization). The incident aircraft is included in its operations manual.

The aircraft had certificate of airworthiness number 7920 issued by AESA on 23 May 2017 in the "Semi-acrobatic Airplane Category – Utility Category".

It also had an airworthiness review certificate, number ES.ARC-MQT-001, issued by an approved continuing airworthiness management organization on 13 March 2018 and valid until 12 March 2019. At the time when this certificate was issued, the airframe had 2526 flight hours.

The aircraft also had the following authorizations:

1. Aircraft station license, issued by AESA on 22 July 2017, which included the following units: COM1 (Garmin SL40), COM2 (ICOM IC-A200), NAV1 (Garmin GNS-430), TRANSPONDER (Garmin GTX 330), ELT (KANNAD ELT 403 AF COMPACT) and GPS1 (Garmin GNS-430).
2. Noise level certificate issued by AESA on 22 May 2017, with a takeoff noise level of 75.3 dB(A)[2]
3. A certificate issued by the CAMO confirming that the incident aircraft satisfied all the requirements and had all the equipment necessary to operate in special conditions (800-kg MTOW, VFR-Nighttime flights with deliberate tailspins).

The organization had a valid insurance policy whose coverage included the incident aircraft.

1.7. Meteorological information

1.7.1. General situation

At low levels, the relative pressure over the Iberian Peninsula was low, except in Cantabria, with a weak overall pressure gradient. By the time of the incident, convective clouds had started to form over the southeast of the peninsula, joining the already existing clouds in Catalonia and the Balearic Islands. In the area of Gibraltar, the relative pressure was high in the Gulf of Cádiz, with lower relative pressures in the Alborán Sea, which created winds from the west, gusting to as much as 29 kt in Marbella.

[2] dBA: A-weighted decibels, a unit of noise that removes part of the low and very high frequencies.

1.7.2. Situation at incident location

The weather situation in the vicinity of the La Axarquía aerodrome at 11:24 was as follows, according to information provided by AEMET:

- At the rainfall and temperature station of Vélez-Málaga: temperature of 25º C, 55% humidity and no precipitation.
- Just over 5 km away (to the southeast), at the automatic station of Algarrobo: temperature of 23º C, 70% humidity and wind from the south (190º) at 10 km/h, with a maximum windspeed in the previous 10 minutes of 20 km/h.
- In Nerja, just over 25 km away (to the east), the temperature was 24º C, 65% humidity and wind from the south (190º) at 9 km/h, with a maximum windspeed in the previous 10 minutes of 16 km/h.
- At the Málaga Airport, just over 30 km away, the 11:30 UTC METAR was as follows:
  METAR LEMG 091130Z 29010KT 250V320 9999 FEW040 26/15 Q1012 NOSIG=

The weather conditions were thus not limiting for visual flight.

1.8. Aids to navigation

The flight took place under VFR.

1.9. Communications

No communication logs are available.

1.10. Aerodrome information

The aerodrome of La Axarquía – Leoni Benabu (LEAX) is a private, restricted aerodrome with no control service located in the town of Vélez-Málaga (province of Málaga). The aerodrome is owned and run by the Real Aeroclub de Málaga. It is for sports use only and it only operates under VFR. Its geographic coordinates are N 36° 48' 08" W 4° 08'13".

It has one asphalt runway in a 12/30 orientation with a TORA length of 959 m and 637 m, respectively. It is 20 m wide and is at an elevation of 120 meters above sea level. Its assigned air-to-air communications frequency is 123.500 MHz.

The assigned air traffic services reporting office (ARO) is Málaga (LEMG) and the position reporting points are Torre del Mar (PTM) and the reservoir of Viñuela (PV). All aircraft not based at the aerodrome have to request clearance to land at the aerodrome from the owner, the Real Aeroclub de Málaga.

Photograph 5: Aerodrome of La Axarquía

The following instructions are contained in its operating procedures:

1. Flying without a radio is prohibited.
2. Aircraft in the traffic circuit have priority.
3. Report entering the aerodrome traffic circuit and the tailwind, base and final legs.
4. Do not cross the runway or any of its extended centerlines without first reporting on the air-to-air frequency (123.500 MHz).
5. Aircraft flying over the aerodrome must report their overflight intentions and the altitudes they will use on the air-to-air frequency (123.500 MHz).

If an aircraft is going to remain in the circuit over La Axarquía or inside the Seville control area, that is, at altitudes below 3500 ft, it is the responsibility of the pilot to ensure their own separation with other aircraft when operating in the circuit.

1.11. Flight recorders

The aircraft was not equipped with a flight data or cockpit voice recorder, as neither is required by the applicable regulation for this type of aircraft.

1.12. Wreckage and impact information

The statements from the student pilot, the instructor and the proof documented through photographs and video recordings of the incident show that during the emergency landing, the fork that attaches the nose gear wheel to the gear leg detached, along with the wheel itself, as shown in photographs 6 and 7.

The aircraft landed on runway 12 at the La Axarquía aerodrome, where the mark left on the asphalt by friction with the nose gear leg, following the detachment of the fork assembly from the nose leg, was identified (photographs 6 and 8).

This mark consists of a friction mark on the asphalt with hardly any wear or depth on it.

The damage to the aircraft was minor, and affected only the nose landing gear. The bottom coupling with the detached nose wheel was recovered from the runway where the airplane landed.

The rest of the aircraft sustained no damage during the incident.

Top photograph 6: Nose gear leg
Bottom left photograph 7: Fork and nose wheel
Bottom right photograph 8: Mark along the runway

1.13. Medical and pathological information

The student pilot was not injured and exited the aircraft under his own power.

1.14. Fire

Not applicable.

1.15. Survival aspects

The student pilot made an emergency landing that was supervised from the ground. By the time the landing was made, emergency services (firefighters and ambulance) were already at the aerodrome and the situation was under control. The runway had been covered in foam and the landing was carried out at low speed, with the pilot in full control of the aircraft.

The safety harness worked properly. The anchor points were in good condition.

The student pilot exited the aircraft under his own power and sustained no injuries.

1.16. Tests and research

1.16.1. Statements

School Director's Statement

An account of the events of the incident was provided during the investigation by the director of the flight school. This statement was corroborated and signed by the student pilot and the instructor. It was also verified to match the video footage of the incident.

According to the manager, on the flight before the incident, the instructor and the student had practiced takeoffs and landings with the Diamond DA20 aircraft, registration EC-MQT, at the La Axarquía aerodrome (LEAX), during a training flight prior to the student's first solo flight. During this flight, they made a total of eight takeoffs and landings and simulated emergencies. Everything progressed normally under the supervision of the instructor, who deemed the student to be qualified to make the subsequent solo flight.

The instructor exited the aircraft and the student started the engine, continued with the procedures and taxied to the runway 12 holding point. He entered the runway and took off normally. He then flew a circuit and landed and stopped on the runway. The instructor then radioed the student to tell him he had to fly another circuit, so the student again taxied to the runway 12 holding point, went through the procedures and took off normally to fly another circuit.

According to the manager's statement, the student, with the aircraft seemingly in good condition for landing on the runway, heard a strange noise and felt something unusual in the aircraft and decided to go around. It was then that the nose wheel detached, along with another component, as declared by the instructor, who also urged the student to go around. This type of flight, an initial solo flight, is recorded as part of a specific requirement at the school. As a result, the instructor was recording the flight. The instructor then notified the student on the radio to continue flying circuits while they decided what to do, since he had lost the nose wheel. He told him to calm down since the airplane was able to fly normally.

At that point, the instructor and school personnel who were at the aerodrome called the director (who was also the school's Training Manager) to report what had happened, informing him that the student was in the air flying without a nose wheel.

After evaluating the situation, and since the student's previous flight had been uneventful and took place at the same aerodrome, meaning the student was familiar with it, the manager instructed them to have him continue flying circuits.

After considering the situation, they notified the firefighters and emergency services. They radioed the student to explain and review the procedure he was to carry out, which consisted of:

- checking and fastening the harness, no loose objects in the aircraft;
- normal approach: use a point before the threshold as the reference;
- making contact with the main gear, holding the nose up while decelerating and shutting off the fuel, electrical system and all the items specified in the checklist;
- finally, bringing the nose of the airplane down gently.

By the time the firefighters arrived, the student had been briefed and they proceeded to cover the runway with foam.

He flew a total of 21 circuits/approaches before the landing, simulating the maneuver each time to ensure the safety of the operation. Finally, the student flew the last circuit, holding the specified altitude and guided by radio at all times, carrying out the procedure previously explained to him without any kind of deviation and under the supervision of emergency personnel.

The airplane landed safely at a very low speed. At no time did the propeller touch the ground. The airplane, with the nose leg without a wheel acting as the landing gear, came to a stop on the runway centerline.

The student exited the aircraft unaided and uninjured. After taking several photographs and collecting the relevant data for the authorities, they called the accident reporting hotline. Finally, the aircraft was removed from the runway.

Photographs of the landing

The incident flight was the student's first solo flight as part of the training program to obtain his private pilot license.

School personnel, in keeping with the school's procedures, were recording the flight from the ground at the time of the incident. Included below is a sequence of frames taken from the video recording that show what happened during the incident. Also included is another series taken from a recording that was made from the tower at the aerodrome at the time of the emergency landing. This sequence shows the safety measures that were employed by emergency units, firefighters, police and ambulance personnel.

First is the series of photographs from when the student, after completing his first solo flight, attempts to land. This landing was aborted when the student heard a strange noise and felt an unusual vibration in the aircraft, at which time he decided to go around. At the same time, the instructor, who was on the ground, radioed him to tell him that part of the nose gear had detached.

Series of photographs 9: Aborted landing sequence

Lastly, photographs of the emergency landing taken from the tower at the aerodrome and the runway are provided below.

Series of photographs 10: Emergency landing sequence

1.16.2. Information on nose landing gear

This section provides information of interest on the nose landing gear that was obtained during the investigation and that will be referred to in the subsequent analysis of the causes and contributing factors of the incident.

This information was taken from the aircraft flight manual, the illustrated parts catalog (IPC), the maintenance manual and the applicable service bulletins and service letters.

Pre-flight inspection

According to the aircraft flight manual, the nose gear must be checked and the tow bar removed during the pre-flight inspection.

This bar is part of the aircraft's equipment and must be used for both manual towing and vehicle towing, as well as when moving the aircraft on the runway.

The tow bar is attached to the nose wheel fork with two bolts. When the tow bar is removed, the pilot would be able to identify excessive play or shimmy of the nose wheel, if any.

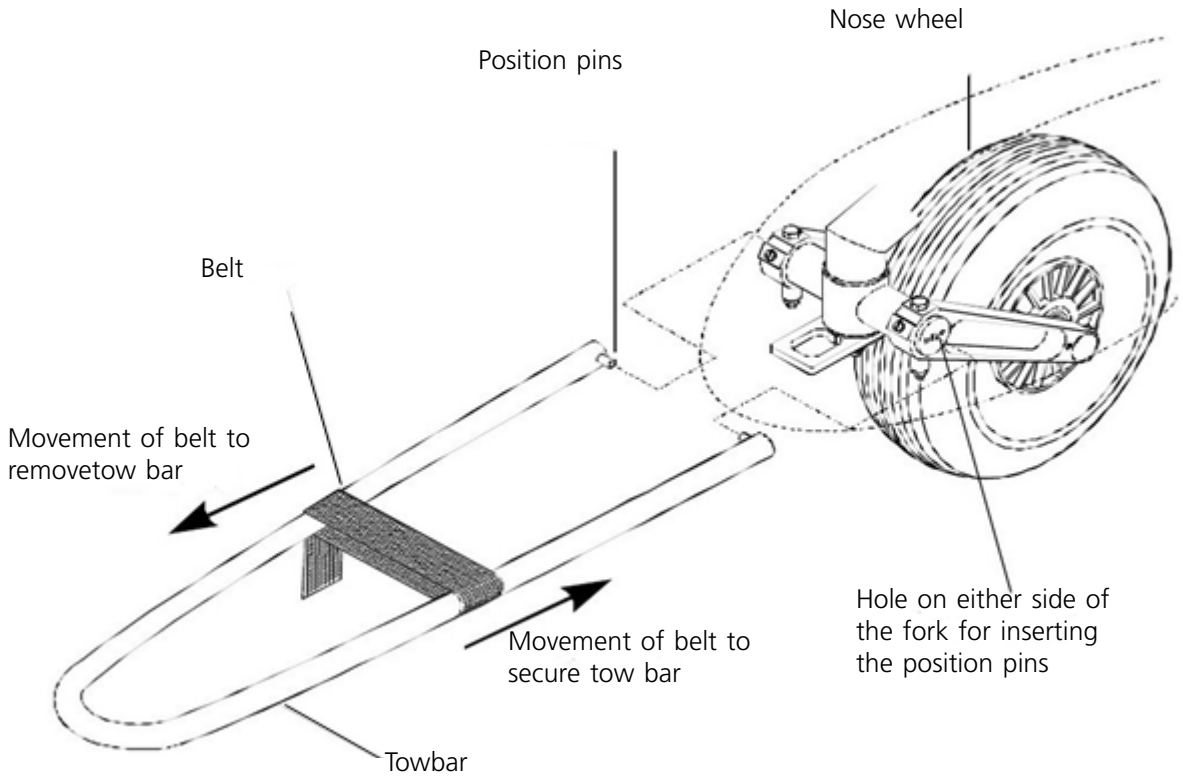


Figure 3: Aircraft tow bar

Maintenance inspections

According to the aircraft maintenance manual and the maintenance program approved by the authority, the flight hour intervals at which the scheduled inspections must be performed are 50, 100, 200, 1000 and 6000 hours.

Specifically, the maintenance inspection on the nose wheel is done as part of the inspection that the maintenance manual refers to as "front fuselage" (Section B of the AMM), which also includes the external components of the main gear and the canopy.

In addition to the general tasks applicable to the main gear as well, such as verifying the tire pressure, checking for the presence of wear or cracks on the tire tread, the condition of the brakes, and so on, the following tasks specifically apply to the nose gear:

1. Examine the nose gear assembly, specifically its attachment to the fuselage.
2. Check the nose wheel assembly. Look especially for correct attachment, cracks and deformation.
3. Examine the shock absorber assembly.
4. Remove nose wheel fork.
5. Inspect the nose gear fork for cracks, corrosion and deformation. Look especially for cracks in radius areas.
6. Visually examine the fork pivot. Look especially for cracks in the radius where the fork makes contact. Check for corrosion and wear. Any corrosion needs to be assessed, treated and/or the component replaced if required. Inspect the pivot stud threads of the lower end of the strut for cracks/damage.
7. Lubricate the nose gear fork pivot and install.
8. Visually examine nose gear strut condition. Look especially for distortion, corrosion and condition of the paint. Ensure that there is no excessive play in the nose gear stud pivot. Allowable radial play is 0.05 mm. If play is excessive, remove strut and inspect condition of flanged bushings.
9. Do a test for play and caster friction. The friction should be 3 to 5 N.
10. Lubricate the spherical bearing at the top of the shock absorber assembly.

All the tasks have to be done every 100, 200 and 1000 flight hours, except for 8 and 10, which are only done every 1000 hours, and 9, every 200 and 1000 hours.

In addition to lubricating the fork pivot every 100, 200 and 1000 hours, as task 7 above specifies, it must also be lubricated whenever the part is removed or installed for any reason.

The 6000-hour inspection also includes a check of the nose landing gear that is primarily intended to inspect its attachment to the underside of the fuselage. The incident aircraft in this case did not have that many hours.

Among the main problems normally found in the nose gear, the maintenance manual distinguishes between those caused by a hard landing and those identified through vibrations or shimmying of the nose wheel. In the event of a hard landing, an additional, unscheduled inspection of the nose gear is required. When the nose wheel vibrates or shimmies, one possible cause is low friction in the steering system, which can be solved by simply adjusting the fork mounting screw.

The most recent maintenance manual published by the aircraft manufacturer is Rev. 22, issued on 30 May 2014, which is affected by temporary revision DA201-C1 TR 32-01, from 11 September 2018, after the date of this event. This temporary revision is mentioned because the aircraft manufacturer evaluated the need to conduct an additional inspection of the nose gear, and specifically of the pivot that connects the gear to the nose wheel fork, since there have been cases where cracks have appeared in these components that can affect operational safety. Of particular concern is the area labeled A in Figure 4, pivot radius. This component has P/N 20-3220-02-00, and is an assembly that is welded to the threaded end of the nose gear leg. Said component was also replaced by P/N 20-3220-02-00_1, which improves its structural design. In the incident investigated in this report, area B, pivot stud, in Figure 4, is the area that was severed after the emergency landing.

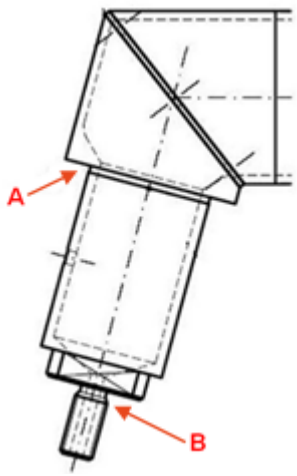


Figure 4: Pivot at end of nose landing gear

This temporary revision includes a new task to be performed in the 2000 flight hour inspection consisting of checking the pivot on the nose landing gear using liquid penetrants (LPI[3]), as per the testing procedure that is contained in the revision itself.

The investigation also evaluated the publication and implementation of service bulletins and service information letters issued by the aircraft manufacturer that affect the nose gear, as detailed below:

Service Information Letter (SIL) No. SIL20C1-005, dated 7 October 2010: this letter, which affects various aircraft S/N, including the incident aircraft, describes the design change to the nose wheel fork assembly, resulting in a change in its part number. The reason for the change was cracks that were found in the fork assembly during some routine inspections. The main cause was identified to be the high number of aircraft flight hours, although in some cases with

[3] LPI: Liquid Penetrant Inspection.

fewer hours, cracking still occurred as a result of hard landings and landings on rough fields.

- Service Bulletin (SB) No. DAC1-32-03 Rev. 0, dated 15 July 2011: this bulletin provides information on an upgrade to the fork and instructions for installing the nose wheel assembly to reduce wear and set the proper steering friction. This change resulted from the identification of nose wheel shimmy in some incidents caused by steering friction adjustments. Compliance with this SB is, as per the manufacturer, "highly recommended", noting that it should be completed at the next 200-hour or annual inspection, since it is approved as part of the type design and must be entered in the aircraft logbook.
- Service Information Letter No. SIL20C1-011, dated 19 September 2018: affects various aircraft S/N, including the incident aircraft, with a TTSN[4] of 2000 hours or more for the nose landing gear. For the old design of this component, P/N 20-3220-02-00, it states that in some cases, fatigue cracks have been found that could cause the loss of the nose wheel. Because of this, the manufacturer included an additional inspection in the AMM by way of temporary inspection DA201-C1 TR 32-01, dated 11 September 2018, referenced earlier. The component is replaced by a new one with P/N 20-3220-02-00_01. If this new part were already installed on the aircraft for any other reason, this additional inspection would not be required.

The center responsible for maintaining the aircraft confirmed to investigators that SIL20C1-005 and SB DAC1-32-03 were implemented and considered during all the inspections performed after mid-2012. They were then added to the AMM and the IPC, and since this organization started to work on the incident aircraft in 2017, it confirmed that every task carried out involving the nose gear was performed in accordance with said documents.

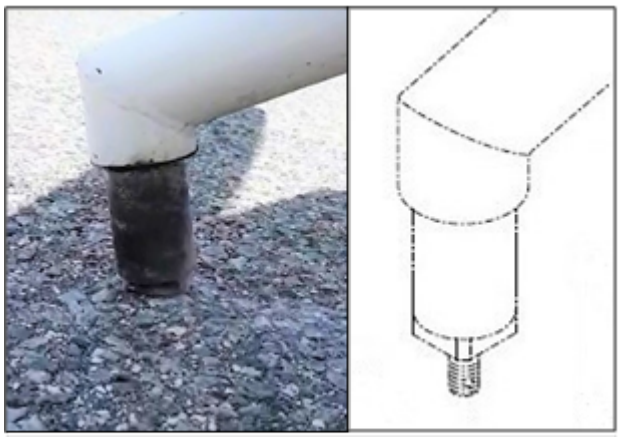
As for SIL20C1-011, it was implemented in 2018 as a Temporary Revision to the AMM, though given its publication date, 19 September 2018, this was done after the incident. This SIL is based on the need to do an additional inspection of the nose landing gear strut with liquid penetrant every 2000 hours, and thus could be related to the loss of the nose wheel. The incident aircraft had 2612 flight hours at the time of the incident, and the 2000-hr maintenance inspection was done before the temporary revision was published, meaning the changes in the SIL were not implemented.

The aircraft maintenance manual includes the details for tasks to be performed during maintenance practices when removing and installing the front fork assembly, as well as for adjusting the steering friction on the nose wheel to keep it from shimmying.

[4] TTSN: Total Time Since New

1.16.3. Information on fragments recovered from nose gear

As noted above, the only damage to the aircraft as a result of the incident was to the nose landing gear.



Left photograph 11: Close-up of pivot where the Wheel fork attaches to the nose landing gear.
Right figure 6: Close up of pivot in the IPC.

Photograph 11 shows the pivot that attaches the nose gear to the wheel fork. As the video footage shows, the stud supported part of the aircraft's weight at the end of the landing run after the fork assembly broke off, causing the stud to come into direct contact with the runway surface. The aircraft was also supported by this end of the nose gear after coming to a stop.

As Figure 6 shows, the threaded end of the pivot in the incident aircraft, which attaches the nose wheel fork, was missing. The rest of the surface on the pivot exhibited signs of corrosion.

Series of photographs 12: Nose landing gear fork from the incident aircraft

The nose wheel fork assembly that detached during the aborted landing was recovered, but the nuts, washers and other components used to secure it to the nose gear were not.

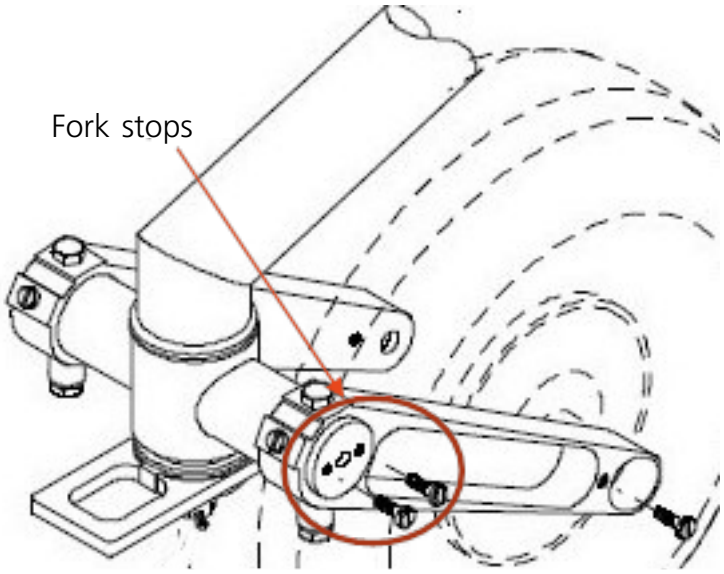


Figure 7: Nose wheel fork attachment

The fork was in acceptable condition, as were the wheel and tire, as series of photographs 12 shows.

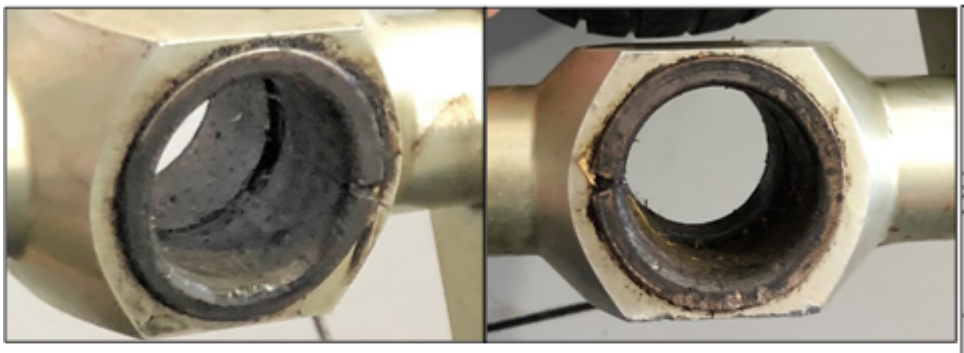
The stops on the sides of the fork, which are attached with screws, as shown in the IPC in Figure 7, were also not found.

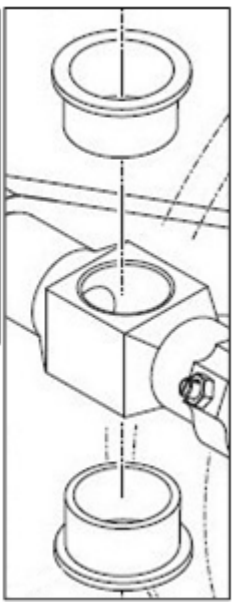
The housing for the end section of the nose gear has two adjustment bushings, as shown in Figure 8.

In the incident aircraft, as series of photographs 13 shows, the bushings remained inside the housing after the nose wheel fork detached.

These bushings exhibited wear and corrosion.

The play between the pivot and flanged bushings could not be measured due to the poor condition of the parts.





Left series of Photographs 13: Close up of pivot housing and bushings
Right figure 8: Close up of pivot housing and pivot bushings as per IPC.

1.17. Organizational and management information

Since the incident occurred during the first solo flight of a student flight as part of his training for his private pilot license, the procedures followed during the emergency situation by school personnel, the Training Manager (who was also the director of the ATO) and the instructor were reviewed.

The student was being monitored at all times from the ground via radio. He was instructed on the procedures to follow and reassured and calmed down so he could carry out the emergency landing maneuver as safely as possible.

Emergency services and firefighters were also coordinated, resulting in a safe and controlled operation.

1.18. Additional information

Not applicable.

1.19. Useful or effective investigation techniques

Not applicable.

2. ANALYSIS

2.1. Analysis of the weather situation

The weather conditions present in the area of the La Axarquía aerodrome at around the time of the event (13:24 local time) were not limiting for visual flight, and no adverse weather conditions had any effect on the incident.

2.2. Analysis of the flight

The accounts of the instructor, the student-pilot, the director of the ATO and the video footage of the incident all show that until the attempted landing, the flight was normal and executed according to procedure, and thus could not have contributed to the event.

During the final approach, the aircraft reached a speed of 65 KIAS, in excess of the maximum recommended speed in the flight manual, which is 55 KIAS for a normal landing operation with the flaps fully extended.

Since the recommended speed is so determined in order to achieve a smooth transition during the flare, that is, to start to decelerate in a way that lowers speed while maintaining minimum lift in order to make a smooth landing that does not overload the gear, it may seem at first that the high speed of the maneuver contributed to the incident.

Also, as the footage of the flight shows, when the aircraft made contact with the runway, it did so simultaneously with the main and nose gears. The images show all three wheels hitting the runway hard at a high speed.

In addition to the simultaneous contact with the nose and main gears, the higher-than-recommended speed also contributed to the lack of suitable conditions for the smooth transition that would be expected when landing.

The three gear wheels simultaneously supported the vertical load of the aircraft's weight, which bounced on the runway after making contact. It was also at this time that the nose fork and wheel assembly detached.

That was when the student pilot decided to go around. This was confirmed by the instructor from the ground. The decision to go around after part of the nose landing gear detached was correct and made at the appropriate time. This fast reaction prevented greater damage to the student and/or the aircraft.

After flying several circuits, monitored from the ground by the instructor, the student pilot executed a careful emergency landing in keeping with the applicable procedures

and in coordination with the aerodrome's emergency services, who had the situation and the runway under control.

2.3. Analysis of the detachment of part of the nose gear

As noted earlier, the aircraft sustained minor damage that was confined exclusively to the nose landing gear; specifically, the nose wheel fork detached just as the gear contacted the runway during the aborted landing, as seen in the footage of the flight.

The analysis of the debris from the gear showed that:

1– the threaded end of the nose landing gear had been severed, and there was wear and corrosion on the stud.

2– the coupling bushings where the pivot is inserted into the leg also showed a lack of lubrication, as well as corrosion and wear on the contact surfaces.

3– the castellated nut and its pin were not found; thus, it was not possible to determine their condition or if they broke. The other components in the attachment assembly were also not found[5].

4– the stops on the fork and its two mounting screws were also not in their positions. The housings for these stops are used to attach the tow bar to the aircraft, as indicated in the section on the pre-flight inspection. Before the first flight of the day, this bar would have been used, and at that time it would have been possible to see if there was any play or shimmy in the assembly. There are no indications that any problems were identified. Since the sole purpose of these stops is to protect the housings and make sure they are not subjected to any forces, it is safe to assume that they were simply not attached, since it is unlikely that the mounting screws came off.

The nose wheel fork and the wheel itself were in good condition, so it is unlikely that they could have influenced the incident. Not even the wear or lack of lubrication on the flanged bushings are deemed to have had any effect on the detachment of the fork.

The evidence shows that the nose gear was not properly maintained, at least in terms of preventing corrosion at the bottom end of the leg and the flanged bushings.

The nose leg remained attached to the aircraft, suffering no apparent damage after the emergency landing. This was aided by the fact that its contact with the runway was delayed as much as possible, until the aircraft had barely any speed. This also helped prevent additional damage to the aircraft.

[5] Attachment assembly: consists of the thrust washer, stop flange, spaces, spring washers, flat washers and the castellated nut with pin (see Figure 5).

Eventually, after making contact with the runway, the nose gear leg, along with the main gear, supported the entire weight of the aircraft. The stud at the bottom of the leg was in direct contact with the asphalt, as evidenced by the marks left on the runway.

The threaded end where the nose leg attaches to the fork was missing after the incident. Since it is this component that holds the fork in place, investigators deduced that it must have broken off either during the initial contact on the aborted landing, or when the aircraft contacted the runway the second time during the emergency landing.

On the day of the event, the aircraft made nine takeoffs and landings before the incident. All of them were normal, with no incidents or problems reported.

Because of this, it can be assumed that until the tenth takeoff of the day, the nose gear was operational. The takeoff was normal, as was the flight, meaning that it was not until the attempted landing that the problem with the nose gear became apparent; specifically, when contact was made with the runway, when the aircraft bounced off the runway after both landing gears touched down at the same time and the nose gear fork and wheel detached. This impact was thus a determining factor in the incident. The subsequent rapid rotation, aborting the landing, prevented further damage.

In addition to the abrupt contact made with the runway, the fact that the approach was made at a speed higher than recommended, as indicated by the eyewitness accounts, is also crucial. As the footage shows, the operation seems rushed and improper, as evidenced by the simultaneous contact with the main and nose landing gears, instead of adhering to the normal procedure and contacting first with the main gear, and then with the nose gear.

However, if the nose gear had been in good condition, given the circumstances of the approach, it would presumably have supported the additional loads resulting from the simultaneous contact by both gears with the runway. The landing would have been hard and required a subsequent and specific inspection, but it would not have necessitated a go-around. The abruptness of the landing is deemed to have contributed to the detachment of the fork on the nose gear, but it was not the root cause of the incident.

Given the good overall condition of the fork, it stands to reason that it detached easily. This means that it must have been the fastening components that did not work properly.

The fastening components were the threaded end of the pivot that attaches the wheel fork to the nose leg, and the fastening assembly, namely the castellated nut and its pin. Therefore, the components involved in the detachment were:

1. the threaded end of the pivot on the nose gear, and
2. the castellated nut and its pin.

In light of the above, the following are identified as the potential causes of the detachment of the nose gear fork:

1– the breakage of the threaded end of the nose leg pivot, which, by way of a castellated nut and a pin, holds together the wheel fork assembly to the nose landing gear.

An analysis of the fragments shows that it severed. Even in the case the failure was not a fracture of the pivot radius, since this component was the subject of a temporary revision to the AMM after the date of the event due to the presence of cracks due to material fatigue in landing gears with over 2000 flight hours (as in the incident aircraft), it is safe to assume that this component was not inspected and checked if it was in good condition. This was not identified in the scheduled maintenance inspection, however, and thus the stiffness of the gear itself, added to a hard landing at a speed higher than recommended, could have propitiated its fracture when the gear touched down on the runway, with the ensuing instantaneous detachment of the fork.

The subsequent wear on the severed pivot caused by traveling on the runway during the emergency landing made it impossible to identify how the threaded end fractured. There were signs of corrosion throughout its surface, however.

2– the breakage or detachment of the castellated nut and its pin:

a) due to breakage: it is not likely that the stainless-steel nut broke, as it is not an impact point. If the lockpin broke, came loose or was not installed, considering the brief nature of the flight, if the nut had been tightened to the appropriate torque, it is unlikely that it would have come loose, even if some other component such as a washer or another part in the fastening assembly had broken, and additional vibrations occurred to shake it loose.

b) due to loosening and detachment of the nut: if this had happened, the fork assembly would have detached from the gear leg, and the threaded end on the leg would have been severed by the impact with the runway during the emergency landing.

Since the contact between the nose gear and the runway was delayed as much as possible, until the aircraft had barely any speed, which resulted in the nose gear leg touching down with barely any friction between it and the foam-covered

asphalt, it is safe to assume that for the threaded end to sever under these conditions, its material would have to have been weakened.

If the nut detached, it would have been caused by the fracture or non-presence of the lockpin, since it is this pin that prevents the nut from loosening by blocking its rotation. It would also have necessitated an incorrect torque since if it had been properly tightened, it is unlikely to have come loose during the brief flight made.

However, the successive number of operations, a total of 127 landings since the last maintenance check in just 7 days, could have caused additional vibrations that helped loosen the nut, causing it to detach at the moment of impact.

As a consequence of the above, it is reasonable to conclude that one of the following hypotheses, neither of which can be proven, explains the incident:

Hypothesis 1: the detachment of the nose wheel fork, along with the fastening components on the nose gear leg, must have occurred due to the breakage or severing of the threaded end of the pivot when the leg impacted the runway during the aborted landing.

This hypothesis is deemed likely, given the changes made to the AMM by the aircraft manufacturer after finding signs of fatigue at the bottom of the nose gear leg, especially in aircraft with more than 2000 flight hours, which the incident aircraft had, or in aircraft with fewer hours but with hard landings or landings in rough fields.

Although the changes implemented in the AMM are specifically related to the pivot radius and not to the pivot stud, the part as a whole is susceptible of fatigue.

Therefore, the findings in this event – that the threaded end on the gear leg could have been affected by material fatigue or been in poor condition, and the large number of cycles in a few flight hours, as well as a hard landing at a speed higher than recommended – are consistent with the severing of the threaded end, and therefore with the detachment of the nose wheel fork.

Hypothesis 2: the detachment of the fork assembly on the nose wheel, as well as of the fastening components on the gear leg, must have occurred due to the breakage or loosening of the castellated nut and its pin, which was in turn caused by using an improper torque when tightening it, along with a broken, loose or simply uninstalled lockpin. In this case, the threaded end would have broken off when it contacted the runway during the emergency landing.

This second hypothesis is deemed less likely, since it assumes that the tightening torque on the nut was incorrect and that the lockpin did not serve its purpose. It would also have required vibrations to loosen the nut on successive flights between the final maintenance inspection and the hard landing during the incident flight that caused it to

detach. In either case, it was not possible to verify any of this, nor are there precedents that justify the probability of its occurrence.

2.4. Analysis of the maintenance of the nose gear

According to information contained in the maintenance records provided by the Part-145 organization, the scheduled inspections were conducted in keeping with the approved maintenance program. Because of this, all the tasks involving the nose gear were analyzed in detail, since the improper performance of any of them could have contributed to or caused the incident.

The presence of corrosion in the flanged bushings where the fork attaches to the nose gear, as well as on the threaded end of the attachment pivot on the leg, should have been detected in the maintenance inspections that were conducted. Specifically, in the last maintenance activity, done on 13 April 2018, less than a month before the incident, the corrosion and wear should have been evident. During this check, which was part of a 200-hour inspection, the fork was removed from the nose gear leg, meaning all the attachment fittings should have been checked, along with the condition of the threaded end of the gear, which was severed during the incident. Based on the analysis in the previous section, it is evident that the maintenance must not have detected the presence of corrosion, or if it did, it was not logged in the maintenance orders. There was also insufficient lubrication, something that the maintenance tasks should have corrected.

However, even if there had been signs of fatigue on the threaded end of the nose gear leg (of which there is no evidence), no task in the maintenance program requires a deep inspection and not just a visual one, meaning it was not identified preventively. It is reasonable to assume that at least as concerns the documentation, the maintenance inspections were done correctly and in keeping with the approved maintenance program and the AMM in effect at the time of the event.

The caster friction on the nose gear should also have been adjusted. This operation specifically entails checking the pivot adjustment by using the castellated nut and the pin that attaches the nut: therefore, if any of the components was in poor condition, this should have been detected during the inspection. If their condition was acceptable, these components may still have been improperly adjusted by virtue of having been inspected and handled by maintenance personnel.

As a result of the above, the investigation revealed that the components identified as having caused or contributed to the incident were precisely those that were inspected during the most recent maintenance inspections.

During the 50-h check done on 3 May 2018, just six days before the incident, the nose gear was not inspected, as this was not required in the AMM. It is worth noting, however, that the aircraft, due to belonging to a flight school, had flown 35 hours and made

127 landings in only seven days, including the day of the incident. This information indicates that training aircraft are more likely to have their landing gear subjected to higher forces than aircraft not used for training. It would be advisable, therefore, to consider doing an additional maintenance inspection based on the number of effective aircraft cycles in order to ensure that the landing gear is in good condition at all times.

3. CONCLUSIONS

3.1. Findings

- The student piloting the aircraft was completing the practical phase of training for his private pilot license (PPL), having completed the theory phase.
- He had an authorization issued by the training school to fly solo, dated 9 May 2018, to make his first solo flight.
- The student pilot had valid class-1, class-2 and LAPL medical certificates.
- The student pilot had a total of 24 hours 25 minutes of flight time, on the incident aircraft.
- The instructor had a commercial pilot license (CPL) with SEP (land) and ME (land) ratings, as well as FI(A), CPL, PPL and SEP IR NIGHT ratings, all of them valid.
- The flight instructor had valid class-1, class-2 and LAPL medical certificates.
- The instructor had a total of 700 flight hours, of which 440 had been on the incident aircraft.
- Weather conditions were not limiting for visual flight.
- The pilot was uninjured and exited the aircraft unaided.
- The damage to the aircraft was limited to the nose landing gear.
- The aircraft was manufactured in 2004, registered on 14 September 2017 and had a total of 2612 hours 45 minutes of flight time logged.
- The aircraft was maintained by an approved EASA-Part 145 organization that was also certified as a Continuing Airworthiness Management Organization.
- The aircraft was owned and operated by a private flight school approved by AESA as a certified EASA-ATO.
- The aircraft had a valid certificate of airworthiness for the operation. This certificate was last renewed on 13 March 2018 and was valid until 12 March 2019.
- The pilot attempted to make a landing at 65 KIAS during the final approach, with 55 KIAS being the speed specified by the manufacturer in its flight manual.
- At the time of the incident, the airplane touched down simultaneously with the main and nose landing gear, resulting in what might be termed a "hard landing".
- During the incident, the fork holding the nose wheel detached from the rest of the leg.
- A go-around was executed after the nose wheel fork detached, which occurred after both landing gears touched down simultaneously with the runway at a speed higher than recommended.
- The subsequent emergency landing was carried out without a nose wheel.

- The emergency landing was executed correctly and did not injure the pilot or damage the airplane.
- The last two scheduled maintenance checks were conducted on 13 April 2018 (200-hr inspection) and 3 May 2018 (50-hr inspection). Components directly involved in the incident were checked in the first inspection, and none in the second.
- The center responsible for maintaining the aircraft had records that documented the completion of the inspections required by the maintenance program and confirmed the implementation of all applicable SBs, SILs, etc.
- The aircraft manufacturer made a revision to the AMM after the incident date to include an additional LPI of the nose leg pin, after the nose wheel fork detached due to the pin material breaking from fatigue in landing gears with more than 2000 flight hours or "hard landings".
- The investigation revealed that the components identified as causing or contributing to the incident had been checked during the most recent maintenance inspections.
- The flanged bushings for the nose leg pivot showed signs of corrosion and a lack of lubrication.
- The threaded end on the nose leg pivot was severed after the incident.
- The components that attach the fork to the nose gear leg were not found.
- The aircraft made 127 landings in 7 days, including the day of the incident, over the course of 35 flight hours.

3.2. Causes/Contributing factors

The investigation into the event has determined that the incident was caused by the detachment of the nose gear fork coupling when contact was made with the runway during a hard landing as the student pilot was initiating the landing, forcing him to abort the maneuver.

The following may have contributed to the incident:

- The simultaneous contact by the main and nose landing gears with the runway at a speed higher than recommended, placing excessive stress on the nose gear.

4. SAFETY RECOMMENDATIONS

REC 26/19: It is recommended that the manufacturer, DIAMOND AIRCRAFT INDUSTRIES, INC., include as a determining criterion for conducting scheduled maintenance inspections of the DA-20-C1 aircraft, the number of takeoff/landing cycles made by the aircraft, in addition to those specified based on the number of flight hours or elapsed time.