Technical report

A-017/2021

Accident on 18 May 2021 involving a SPEED 2002 aircraft, registration EC-XIE, in Torremocha de Jiloca (Teruel, Spain)

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

MINISTRY OF TRANSPORT, MOBILITY AND URBAN AGENDA

DEPUTY SECRETARY

CIVIL AVIATION ACCIDENT AND INCIDENT INVESTIGATION COMMISSION

FOREWORD

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

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

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

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

CONTENTS

FOREWORD **2**

CONTENTS **3**

ABBREVIATIONS **6**

Synopsis **8**

1. FACTUAL INFORMATION **10**

1.1. Overview of the accident 10

1.2. Injuries to persons 11

1.3. Damage to the aircraft 11

1.4. Other damages 12

1.5. Information about the personnel 12

1.6. Information about the aircraft 12

1.6.1. General information 12

1.6.2. Dimensions and specifications 13

1.6.3. Airworthiness status 14

1.6.4. Maintenance information 14

1.6.5. Information about the brake system 15

1.6.6. Information about the parking brake valve 16

1.6.7. Weight calculation 17

1.7. Meteorological information 18

1.7.1. Information provided by AEMET 18

1.7.2. Data from the station at Torremocha de Jiloca 19

1.7.3. Information provided by the pilot 19

1.8. Aids to navigation 20

1.9. Communications 20

1.10. Information about the aerodrome 20

1.11. Flight recorders 21

1.12. Aircraft wreckage and impact information 23
1.13. Medical and pathological information 25
1.14. Fire 25
1.15. Survival aspects 25
1.16. Tests and research 25
1.16.1. Inspection of the brake system 25
1.17. Organisational and management information 27
1.18. Additional information 27
1.18.1. Information about the ELT 27
1.18.2. Information about the landing procedure 28
1.18.3. Information about the landing roll-out 30
1.18.4. Usage of the parking brake by the club members and the mechanic 30
1.18.5. Manufacturer's exploded view of the valve and installation diagram 31
1.19. Special investigation techniques 32
2. ANALYSIS 33
2.1. Analysis of the installation of the parking brake valve 33
2.2. Operational analysis 33
2.3. Analysis of the landing roll-out 34
2.4. Analysis of the documentation provided by the manufacturer of the parking brake valve 35
3. CONCLUSION 35
3.1. Findings 35
3.2. Causes/contributing factors 35
4. RECOMMENDATIONS 36
5. APPENDICES 37
5.1. Information provided by MATCO 37

ABBREVIATIONS

° ‘ “	Sexagesimal degree (s), minute (s) and second (s)
°C	Degrees Celsius (centigrade)
%	Per cent
AEMET	State Meteorological Agency
AESA	Spain’s National Aviation Safety Agency
AGL	Above ground level
CNIG	National Centre for Geographic Information
ELT	Emergency location transmitter
FAA	United States Federal Aviation Administration
FH	Flight hour (s)
ft	Feet (s)
GS	Ground speed
h	Hour (s)
hPa	Hectopascal (s)
IAS	Indicated airspeed
IGN	Spain’s National Geographic Institute
kg	Kilogram (s)
KIAS	Knots of indicated airspeed
km	Kilometre (s)
km/h	Kilometre (s) per hour
kt	Knot (s)
L	Litre (s)
LAPL	Light aircraft pilot license
LEMT	ICAO code for Casarrubios del Monte Aerodrome

m	Metre (s)
m/s	Metre (s) per second
m^2	Metre (s) squared
MHz	Megahertz (s)
N	North or northern latitude
O	West or western longitude
ICAO	International Civil Aviation Organisation
PPL (A)	Private pilot license (aircraft)
QNH	Altimeter subscale setting that indicates elevation while on the ground
RD	Royal Decree
RPM	Revolutions per minute
SEP	Single-engine piston rating
EU	European Union
UTC	Coordinated universal time
VFR	Visual flight rules

Technical report

A-017/2021

Owner:	Aeroclub Sierpe
Operator:	Private
Aircraft:	SPEED 2002, EC-XIE (Spain)
Date and time of accident:	18 May 2021, 11:31 h[1]
Site of the accident:	Torremocha de Jiloca Aerodrome (Teruel)
Persons on board:	1 (crew member), 1 (passenger)
Type of flight:	General Aviation - Private
Phase of flight:	Landing - Landing roll
Flight rules:	VFR
Date of approval:	**26 October 2022**

Synopsis

Summary:

On Tuesday, 18 May 2021, the amateur-built SPEED 2002 aircraft, registration EC-XIE, carried out a flight from Casarrubios del Monte Aerodrome (Toledo) to Torremocha de Jiloca Aerodrome (Teruel).

During the landing manoeuvre on runway 15, the aircraft veered off the left-hand side of the runway, its nose gear collapsed, and it flipped over.

The investigation has revealed that the accident was caused by the faulty installation of the parking brake valve, which prevented the pressure exerted on the pedals from reaching the brakes.

The aircraft's excessive speed on touchdown is also thought to be a contributing factor.

[1] Local time. UTC can be calculated by subtracting 2 h from the local time. Unless otherwise indicated, all times in this report are expressed in local time.

Three safety recommendations have been issued to the manufacturer of the parking brake valve: to include a permanent marking on the body of the valve to help prevent confusion during installation, to correct conflicting installation instructions and to develop a procedure for installing, bleeding and testing the parking valve.

In addition, a recommendation has been issued to the aeroclub, suggesting that it establish a parking brake usage procedure to be followed by all aeroclub members.

1. FACTUAL INFORMATION

1.1. Overview of the accident

The pilot of the EC-XIE aircraft planned the flight they intended to carry out on 18 May 2021 and contacted the destination aerodrome to confirm that they could depart.

On the day of the accident, the pilot and passenger arrived at Casarrubios del Monte Aerodrome (LEMT) at 9:40 h. The pilot conducted the pre-flight inspection, finding no anomalies.

According to the pilot, he checked the pads and discs during the inspection and found them to be in satisfactory condition. Furthermore, he started the engine with the parking brake in the "ON" position, holding the aircraft without any problems. Then, while they were taxiing, he carried out a functional brake test before entering the runway and an engine test before taking off, using the foot brakes. The pilot did not have any problems braking the aircraft. At approximately 10:10 h, the aircraft took off. Both the take-off run and the flight proceeded normally.

On arrival at Torremocha de Jiloca Aerodrome, the pilot selected runway heading 15 for landing and entered the aerodrome circuit at 4,100 ft, as planned. According to the pilot, he reported their position, selected flaps 1 on the base leg and approached at 120-130 km/h.

The pilot made adjustments to land at the start of the runway asphalt and recalls hearing the stall warning as he touched down on the landing gear wheels.

According to his account, he then increased flaps and lowered the throttle lever to idle[2]. He started braking on the first third of the runway, noticing that it seemed unusual and that he couldn't feel the aircraft braking. After pumping 3 times, the feel of the pedal made him think the parking valve might be activated, so he changed its position, although he can't remember which way he moved the lever. He stepped on the brake again, and when there was no change he changed the lever's position and stepped on the brake once more. At this point, the pilot recalls that they had already travelled halfway down the runway. He informed the passenger that they were going to overshoot the runway as they were still taxiing and he could not stop the aircraft. After covering two-thirds of the runway, the pilot ruled out a go-around, realising there wasn't enough runway left. Instead, he focused on finding a trajectory that would allow him to stop the aircraft. With this

[2]The pilot indicated that idle in this aircraft always stays high.

in mind, he steered to the left and exited the runway around 28 m before its end, heading for a slope with an upward gradient.

The aircraft lifted due to the gradient of the slope, and when it touched down again, the nose wheel collapsed, digging into the ground and causing the aircraft to overturn slowly. The engine stopped when the aircraft rolled over, and the propeller made contact with the ground, after which the pilot disconnected the magnetos and the electrical system.

The pilot has no recollection of moving the parking brake lever in flight, nor does he believe its position could have changed during the flight. He also doesn't think it likely that he could have moved it unintentionally.

When he applied the brakes, he could feel resistance underfoot. The pedal didn't sink; he felt like he was applying force but the aircraft didn't respond.

1.2. Injuries to persons

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

1.3. Damage to the aircraft

The aircraft sustained significant damage to its propeller, nose landing gear, transparent canopy, and the leading edge at the tip of its right wing. It also sustained minor damage to the vertical stabiliser.

1.4. Other damages

There were no additional damages.

1.5. Information about the personnel

The 59-year-old pilot had a private pilot license (PPL(A)) issued by Spain's National Aviation Safety Agency (AESA) on 2 December 2000, with a single-engine piston rating (SEP(land)), valid until 31 October 2021.

He also had a Class 2 medical certificate, valid until 10 March 2022, and a LAPL, valid until 10 March 2023.

His total flight experience was 503:05 h, of which 228:11 hours had been flown in the type of aircraft involved in the accident. The hours recorded in the pilot's logbook were:

Period	Hours (h)
Preceding 90 days	9:10
Preceding 30 days	3:15
Preceding 24 h	1:30

This was the only aircraft the pilot had flown in the last year.

According to the pilot, he had rested for 8 hours.

The 57-year-old passenger had a private pilot licence (PPL(A)) issued by AESA on 16 December 2019 with a single-engine piston rating (SEP(land)) valid until 30 November 2021.

He had a total flight experience of 74:25 h.

1.6. Information about the aircraft

1.6.1. General information

The aircraft with registration EC-XIE is a metal, two-seater, single-engine, low-wing aircraft with fixed tricycle landing gear and a two-bladed wooden propeller. Its specifications are provided below:

- Make: Amateur-built

• Model	Speed 2002
• Year of manufacture	2011
• Serial number	11001-2542
• Empty weight	337 kg
• Maximum take-off weight	600 kg
• Type of engine	Rotax 912 ULS
• Engine serial number	5,648,686
• Type of propeller	Hoffman HO-V352F1
• Information about the owner	Club Deportivo Elemental Aeroclub Sierpe.
• Information about the operator	Private

At the time of the accident, the aircraft had 1,335:20 h and 1,259 cycles, and the engine had 1,544:10 h. The engine came from another aircraft, which explains why it had more flight hours than the aircraft in which it was installed.

The aircraft was fitted with a GRS 5/560 SOFT ballistic parachute that had been installed on 2 July 2016.

1.6.2. Dimensions and specifications

• Wingspan	8.6 m
• Length	6.61 m
• Height	2.43 m
• Wing area	11.50 m^2
• Top speed	245 km/h
• Cruise speed	216 km/h
• Rate of climb	6 m/s

- Landing roll 120 m
- Stall speed 65 km/h
- Take-off speed 80 km/h
- Take-off run 120 m

This data comes from the ULM Technical Report, amateur construction. The club did not have a manual for the aircraft so used the manual for the Tecnam P2002 Sierra Deluxe and Tecnam P2002 JF aircraft as a reference. The dimensions of the SPEED 2002 aircraft are similar to those of the Tecnam P2002 Sierra Deluxe as it is an amateur-built aircraft of Tecnam design. In this report, reference is made to the flight manual of the Tecnam P2002 Sierra Deluxe[3] aircraft because of its similarity.

1.6.3. Airworthiness status

The aircraft was registered with AESA's record of active registrations on 05/10/2011 registration number 9025. On 18 July 2016, a registration certificate was issued to Club Deportivo Elemental Aeroclub Sierpe.

It had a restricted certificate of airworthiness, number A-1456, in the Private (3) Special category[4], which was issued by AESA on 18 June 2019 and was due to expire on 17 June 2021 or 200 FH. Since 18 June and until the time of the accident, the aircraft had flown 188:06 h.

The aircraft also had a GARMIN 695 navigator.

1.6.4. Maintenance information

The last brake-related maintenance tasks performed on the aircraft prior to the event were as follows:

[3] Version 6.0, 11 December 2021

[4] Categories: Private (type of flight performed by the aircraft); 3 (Aircraft suitable for visual flight only); Special (Only authorised to carry out flights within the limitations indicated in the documents attached to the Type Certificate)

Date	Hours	Action/overhaul
17 August 2018	936.35	1,200 h overhaul (brake hydraulics checked, no anomalies, brake fluid changed with Aeroshell Fluid 41, and circuit bled)
15 February 2019	1026	Brake pads on both wheels of the main landing gear changed, visible crack around one of the screw holes for the brake disc on left leg, glued with epoxy until replacement material arrives. Checked on 4/4/2019: the crack remains stable with no progression, and the glue is working.
02 May 2019	1029.3	100 h overhaul (right-hand main landing gear axle brake: changed brake disc, attachment bolts, brake pad and disc)
29 May 2020	1121.15	200 h overhaul
11 September 2020	1275	Re-tightening of a bolt on the right brake disc.
01 October 2020	1280.05	100 h overhaul

The next 200 h general maintenance overhaul was due when the airframe reached 1,380 h.

The brake fluid is changed every 800 h or three years, and this periodicity had not been exceeded at the time of the accident.

The aeroclub was responsible for maintenance; the members themselves managed and carried out minor maintenance tasks. An aircraft mechanic was charged with carrying out any major tasks.

1.6.5. Information about the brake system

The aircraft was equipped with a differential braking system equivalent to the one installed on the Tecnam P2002 Sierra Deluxe aircraft:

1.11.2 DIFFERENTIAL BRAKE SYSTEM (OPTIONAL).

The reservoir (4) is directly connected to the brake master cylinders (3), as shown in the figure. Two flexible hoses connect the master cylinders on the co-pilot's brake pedals to the master cylinders on the pilot's brake pedals. The parking brake valve (6) is mounted on the floor of the fuselage, below the seats and is activated by lever (2).

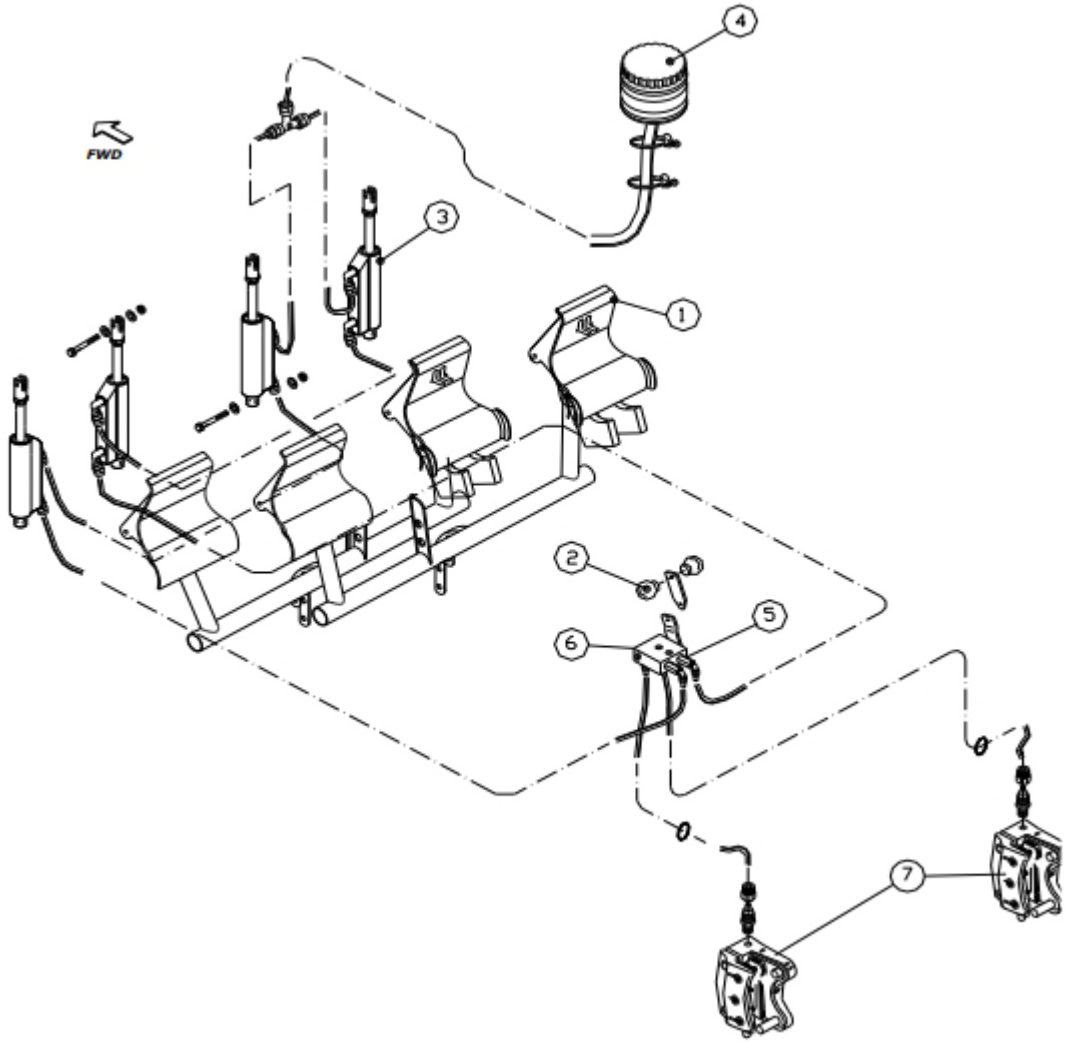


FIG. 1 IMAGE EXTRACTED FROM THE FLIGHT MANUAL OF THE TECNAM P2002 SIERRA DELUXE AIRCRAFT

The EC-XIE aircraft only had brake pedals in the pilot's seat.

Since the aeroclub acquired the aircraft, the brake system has always been the same, has not been modified and has undergone the necessary maintenance for wear and tear.

1.6.6. Information about the parking brake valve

The aircraft's brake system was equipped with a MATCO PVPV-D parking brake valve.

An exploded view of the valve and the manufacturer's installation drawings can be found in the appendix and downloaded from the manufacturer's website[5].

The MATCO PVPV-D valve functions as a non-return valve. When the valve is closed, it does not allow fluid to flow back from the brakes to the cylinders. The parking valve always allows pressure to be sent to the brakes even when the circuit is accidentally closed.

It should be noted that, in the installation guide provided by the manufacturer, which can be seen in figure 11 in the appendix, the adapters with item number 6 in the exploded view (fitting, adapter) in figure 10, are attached to the fluid lines leading to the brake callipers on each wheel.

In addition to the information in the appendix, the manufacturer provides information on fitting the valve[6]. The manufacturer was asked if it had any further information in regard to the installation, bleeding or testing procedure to add to that published on the website. No response was received.

In terms of maintenance, the manufacturer recommends an annual inspection to check its functionality and that the necessary maintenance be carried out, depending on its condition.

Since acquiring the aircraft, the aeroclub had not carried out any maintenance on the valve that required its disassembly or dismantling. However, on 28 April 2019, maintenance was carried out on the radio system and having removed the central plastic cover between the seats, a visual inspection of the parking brake valve was also conducted, during which no leaks or damage were identified. No instructions for the valve were available during the inspection.

In addition to the aircraft logbook, the aeroclub maintained a flight and defect log for the aircraft. The aircraft's users had not reported any malfunctions in either of these logs.

1.6.7. Weight calculation

According to the information provided by the pilot, at the time of take-off, the aircraft was carrying approximately 100 litres of 95-octane unleaded automotive petrol in its tanks.

[5] http://www.matcomfg.com/PARKINGBRAKEVALVEDUAL-idv-3579-8.html

[6] https://static.veracart.com/matco/item_pdfs/3806/document1.pdf

	Weight [kg]
Aircraft's empty weight	337.0
Fuel[7]	72.0
Pilot	70.0
Passenger	79.0
Additional load	3.0
Total	**561.0**

According to this calculation, the aircraft's weight on take-off was lower than its maximum take-off weight.

When it landed, the aircraft was carrying 60 L of fuel and weighed 532.2 kg.

1.7. Meteorological information

1.7.1. Information provided by AEMET

The following figure shows the low altitude map predicted for 18 May 2021 at 12 UTC (valid for the 3 hours before and after 12 UTC). No significant phenomena are visible in the area of the accident.

[7] Calculated based on a 95-octane petrol density of 0.72 kg/L.

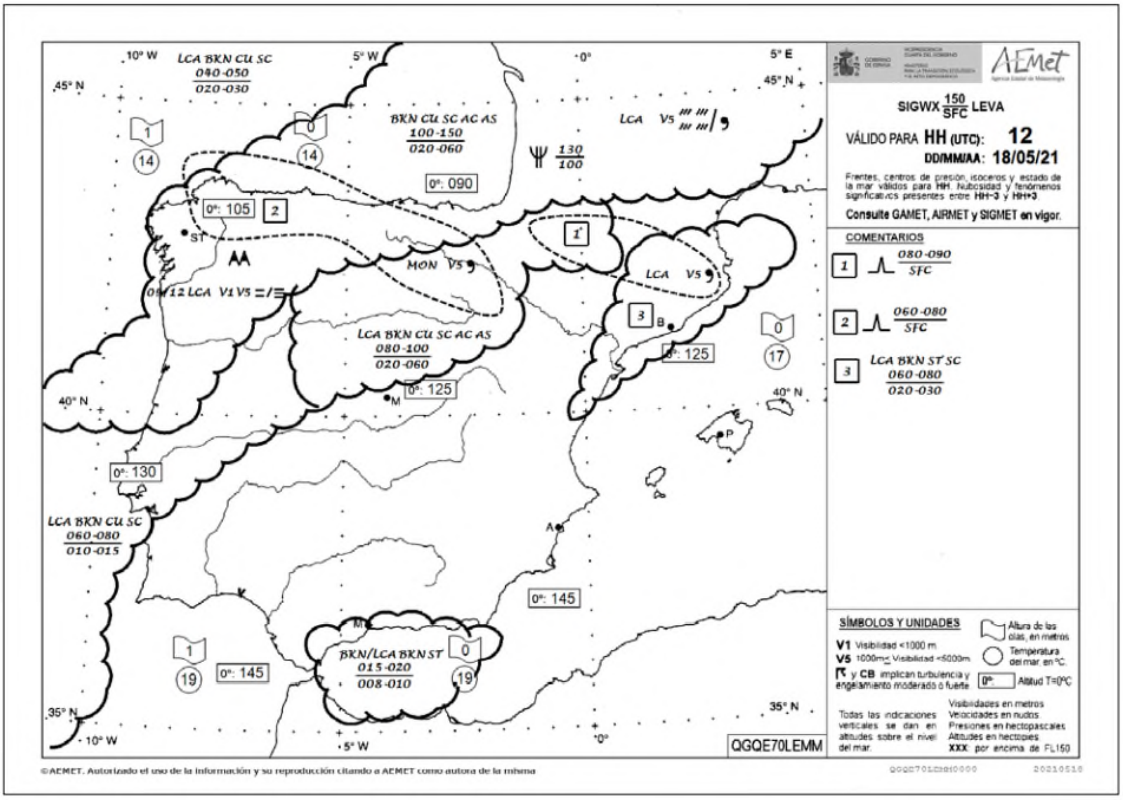


FIG. 2 LOW ALTITUDE MAP FOR 18 MAY 2021 AT 12 UTC (VALID FOR THE THREE HOURS BEFORE AND AFTER 12 UTC)

At the time of the accident (09:30 h UTC), the Santa Eulalia del Campo station[8] recorded winds of 7.9 km/h from 176° with a gust at 15.1 km/h from 195°. The temperature recorded was 18.5°C, and there was no precipitation.

1.7.2. Data from the station at Torremocha de Jiloca

The municipality of Torremocha de Jiloca has a weather station[9]. At 11:30 h, it recorded winds at 4.9 km/h from the west, a temperature of 24°C and a QNH of 1,019 hPa.

1.7.3. Information provided by the pilot

[8] The Santa Eulalia del Campo station is 6 km from the accident site (40°34'1.20 "N, 1°19'15.60 "W, altitude 1,000 m).

[9] The information can be found on the Meteoclimatic website (https://www.meteoclimatic.net/perfil/ESARA4400000044381A?screen_width=414). The Torremocha de Jiloca station is 3 km from the accident site (40° 35' 40" N, 1° 17' 43" W, altitude 994 m).

According to the pilot, "on arrival at Torremocha de Jiloca Aerodrome, there was very little wind".

1.8. Aids to navigation

Not applicable. The flight was operating under visual flight rules.

1.9. Communications

Not applicable

1.10. Information about the aerodrome

Torremocha de Jiloca Aerodrome is located 3 km northeast of the municipality of the same name and approximately 32 km northwest of Teruel. The aerodrome's coordinates are 40° 36' 16'' N and 1° 15' 53'' W, its altitude is 3,227 ft, and it has an asphalt runway designated 15 - 33, which is 525 m long and 25 m wide.

FIG. 3 TORREMOCHA DE JILOCA AERODROME[10]

Air-to-air communications at Torremocha de Jiloca Aerodrome use 130.125 MHz.

1.11. Flight recorders

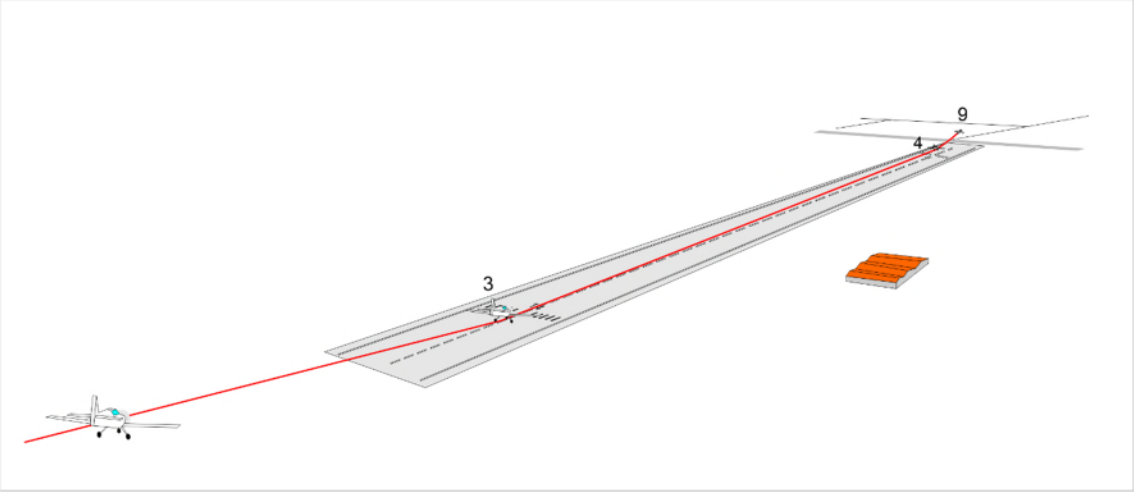
The aircraft was not equipped with a flight data or cockpit voice recorder because they are not a regulatory requirement for this type of aircraft.

The investigation was unable to retrieve the navigation data from the GARMIN 695 installed in the aircraft because the data was not being recorded. However, the passenger connected to the IGN maps of Spain application on his mobile phone at 11:12 h when they were on the 073 heading. This data provided the following relevant information about the aircraft's final trajectory:

[10] Image obtained from IBERPIX, a cartographic viewer published by Spain's National Centre for Geographic Information (CNIG) and National Geographic Institute (IGN) (https://www.ign.es/iberpix2/visor/)

Point	Local time	Altitude (m)	GS[11] (km/h)	Heading (°)	Coordinates	IAS[12] (km/h)	Observations
1	11:28:42	1249	182	059	40.59702° N 1.28993° W		Start of aerodrome circuit at 4,100 ft
2	11:30:04	1122	118	150	40.61539° N 1.27323° W		Start of final approach
3	11:30:42	1020	104	154	40.60505° N 1.26629° W	92	Touchdown at the start of the runway
4	11:30:59	1019	69	146	40.60179° N 1.26398° W	60	Deviation from runway heading
5	11:31:01	1018	67	145	40.60150° N 1.26373° W	58	Runway excursion occurs between this point and the next.
6	11:31:03	1017	64	148	40.60123° N 1.26348° W	55	
7	11:31:05	1017	52	148	40.60096° N 1.26325° W	44	
8	11:31:07	1016	1.2	009	40.60074° N 1.26307° W		
9	11:32:11	996	0.0	279	40.60094° N 1.26303° W		Aircraft at a standstill

The points in the table have been plotted in the images below to show the trajectory of the aircraft.



[11] Ground speed

[12] Indicated airspeed estimated on the basis of the conditions on the day of the accident.

FIG. 4 PERSPECTIVE VIEW OF THE TRAJECTORY

FIG. 5 VIEW OF THE TRAJECTORY FROM ABOVE

The final approach was flown at between 118 and 129 km/h, and on touchdown, the aircraft was travelling at approximately 104 km/h. taking into account the prevailing conditions at the time, the table estimates that the aircraft's indicated airspeed at touchdown was approximately 92 km/h.

The roll-over occurred at approximately 52 km/h, a speed similar to that recalled by the pilot after the event.

According to the data recorded, the landing roll-out lasted an estimated 30 seconds before the aircraft flipped over. Therefore, the aircraft's average speed would have been 63 km/h.

1.12. Aircraft wreckage and impact information

The aircraft came to rest in an adjacent field at the end of the runway. The field's coordinates are 40° 36' 3.0" N, 1° 15' 47' 3" W and its altitude is 1,016 m.

The aircraft's approximate distance from the end of the runway was 50 m in a direction parallel to the runway centreline. The distance from the aircraft to the extension of the runway centreline was 21 m.

About 30 m from the end of the runway, a slight slope rises to a dirt road about 7 m wide. On the other side of the road, another slight slope bridges the upward gradient to the farmed field.

FIG. 6 TRACKS AND FINAL POSITION OF THE AIRCRAFT

Given that there were no signs of wheel wear or marks on the runway, there was no evidence of heavy braking.

During the inspection carried out by the Civil Guard on the day of the accident, two tracks were observed on the unpaved ground to the left of the runway and about 28 m before its end, which is where the aircraft likely veered off the asphalt.

They observed tracks in the terrain on the slope between the road and the field.

In addition, between the edge of the field and the point where the aircraft came to rest, there was an area of disturbed and sunken earth that could have been created when the aircraft's nose hit the ground before the roll-over.

The aircraft was found in an inverted position, resting on its cockpit and right wing with its nose facing the runway.

Several propeller fragments and other pieces of debris were found between the runway and the aircraft. Both propeller blades had come off.

Fuel was leaking from the left wing due to the damage sustained.

The nose landing gear had buckled. There was damage to the transparent canopy, the right wing, the vertical stabiliser and the left-hand landing gear wheel fairing.

1.13. Medical and pathological information

No evidence was found to suggest the pilot's performance was affected by physiological or disabling factors.

1.14. Fire

No fire broke out.

1.15. Survival aspects

The cabin maintained its structural integrity, and the four-point safety harnesses functioned correctly. The pilot stopped the engine and cut the fuel and the power supply. The two occupants managed to get out of the aircraft without assistance.

However, as the aircraft was resting on the transparent cockpit canopy, they were unable to open it backwards in the normal way, so the passenger used his arm and leg to break it.

According to the pilot, when he secured the aircraft, he saw that the ELT had been activated. The pilot called 112 (emergency services) and the Civil Guard was dispatched to the crash site. The pilot secured the ballistic parachute before the aircraft was recovered.

1.16. Tests and research

1.16.1. Inspection of the brake system

The photos taken by the pilot after the accident and provided to this Commission show the parking valve lever in the ON position.

The aircraft's brake system was inspected and tested a few days after the accident.

The wheel brake packs moved, and the pedal pumps picked up pressure.

The condition of the brake packs was good; wear was not excessive, no contamination was found, and there were no signs of high-temperature discolouration due to brake pad pressure on the discs.

The temperature-sensitive plastic hoses were found to be in perfect condition.

The hydraulic reservoir was approximately one-third full of fluid, and no leaks were detected in any part of the system.

An indentation was found in the bulkhead, apparently caused by the movement of the pedal. However, the pedal didn't reach the bulkhead during the system test.

The fact that the brakes failed on both sides of the landing gear pointed towards the involvement of the brake valve, which is common to both sides. As a result, it was disassembled, and its interior was inspected. The seal assemblies were in good condition and no leaks were found.

The following pictures show the valve installed in the EC-XIE aircraft. The photograph on the left shows that the lever has to be pushed forward to put the valve in the OFF position. To put it in the ON position, the lever has to be pulled back.

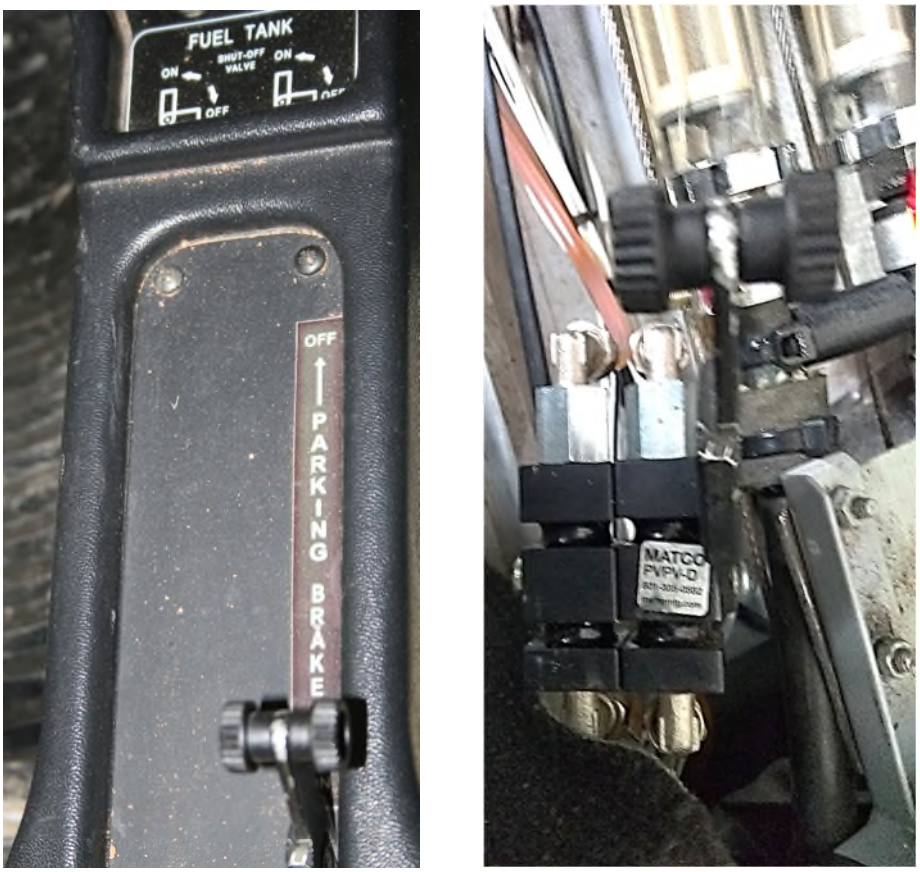


FIG. 7 PARKING BRAKE VALVE

The photograph on the right shows the valve installed on the aircraft once the parts covering it had been removed. The valve's connections are shown in the next image:

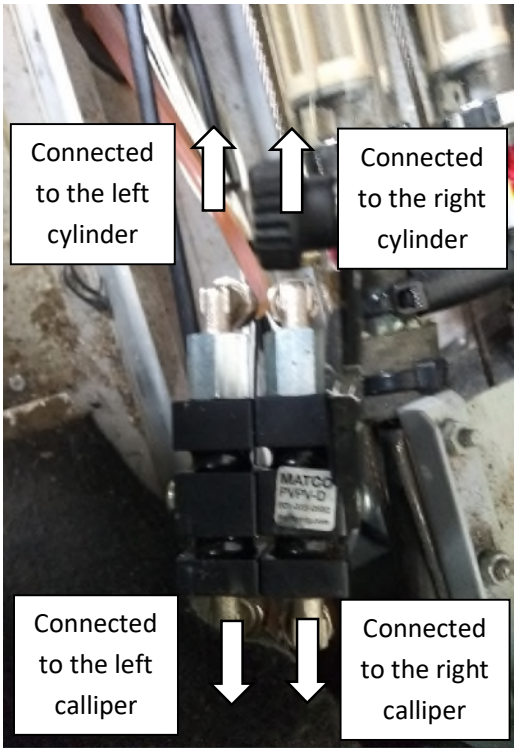


FIG. 8 OVERVIEW OF THE PARKING BRAKE VALVE INSTALLATION

In this photograph, you can see that the adapters with item number 6 in the manufacturer's exploded view (fitting, adapter) are attached to the lines coming from the cylinders.

1.17. Organisational and management information

The Club Deportivo Elemental Aeroclub Sierpe had 5 members. The EC-XIE aircraft was the only aircraft owned by the club.

1.18. Additional information

1.18.1. Information about the ELT

The EC-XIE aircraft was fitted with an ELT, model AK-450. This type of aircraft is not legally required to have an ELT.

1.18.2. Information about the landing procedure

The pilot had his own checklists, which he had configured from the Tecnam P2002 JF and Tecnam P2002 Sierra Deluxe manuals, extending them to incorporate the equipment available on the EC-XIE aircraft:

APPROACHING THE RUNWAY	
Parking brake	OFF
Landing light	ON
Transponder	ON
Governor control	SET TO MAX RPM
PRE-LANDING	
Seats and belts	FASTENED
Fuel tanks	BOTH ON
Fuel pump	ON
Landing light	ON
Cowl flaps	INSIDE
Governor	INSIDE
Flaps 0°	130 km/h
Flaps 15°	120 km/h
Full flaps	100 km/h
AFTER LANDING	
Flaps	Up 0°
Transponder	STANDBY
Fuel pump	OFF
Landing light	OFF

According to the pilot, he adjusted the landing speed to the aircraft's stall speed.

Section 6 of the Tecnam P2002 Sierra Deluxe aircraft manual contains the take-off and climb checklist followed by the before-landing and after-landing checklist:

6.1.3.8 Take-off and climb

Parking brake:……OFF

Carburettor heat:……OFF

Taxi to line-up:

Magnetic compass and DG:……..CHECK, SET

Throttle:……FULL POWER

Note: Static RPM is approximately 5100 ± 250 RPM

Engine instruments:……..CHECK

Vr (Rotation speed):……..~48 KIAS

Note: Rotate to take-off attitude and accelerate to a climb speed of 60 knots with 15° flaps.

Above 300 ft AGL:

Flaps:……RETRACT

Establish Vy clean:……68 KIAS [64 KCAS]

Trim:……ADJUST

Cruise climb:……..75-80 kt

Electric Fuel Pump:…OFF

6.1.3.10 Before landing

Electric fuel pump:…ON

Landing light (if installed)…… ON

On downwind leg: Speed and flaps at your discretion based on traffic, etc.

Traffic:……CHECK

Flaps:…… AS DESIRED

Optimal touchdown speed (full flaps):…….. 40 kt

6.1.3.12 After landing

Taxi at an appropriate speed for conditions

Flaps:…… UP

Transponder:……..STANDBY

It should be noted that the optimum touchdown speed indicated in the manual is 40 kt or 74 km/h with full flaps.

1.18.3. Information about the landing roll.

Section 4 of the Tecnam P2002 Sierra Deluxe aircraft manual contains information about the landing roll.

The graph shows that with adequate aircraft and engine conditions, intermediate piloting skills, ISA conditions at mean sea level, zero wind, flaps at 38°, engine at idle and on a dry, compact grass runway with no slope, the landing roll[13] for an aircraft weighing 532.2 kg would be approximately 141 m. With conditions as they were on the day of the accident, this distance would increase[14] to 307 m.

1.18.4. Usage of the parking brake by the club members and the mechanic

The five club members and the aircraft mechanic were consulted to gain an understanding of how they used the parking brake.

According to the pilot involved in the accident, when the parking brake lever was pulled back (in the ON position), it blocked the flow of hydraulic pressure to the brakes. He usually tested the magnetos and governor with the parking valve in the OFF position (not blocking the pressure flow to the callipers) in order to be able to hold the aircraft with the required pressure on the brake pedals. Then, after completing the test, he entered the runway and did not engage the valve again until the aircraft was parked.

The first member consulted said they didn't normally use it because it only held well if the engine was idle.

[13] Although the Tecnam P2002 Sierra Deluxe aircraft manual does not expressly state it, we can assume that this is for a touchdown speed of 40 kt or 74 km/h with the brakes applied.

[14] With flaps at 15° and a speed of 85 km/h, the landing roll would be estimated at 171 m (a 21% increase). In addition, this scenario contemplates calm winds, a temperature of 24°C (4.5% increase), a QNH of 1,019 hPa, a density altitude of 4,877 ft (24% increase), a paved runway (10% reduction), a speed of 92 km/h (17% increase) and the safety factor (43% increase). The landing roll has not been corrected to account for runway gradient.

The second aeroclub member consulted said, like the pilot involved in the accident, that they used the parking brake during pre-take-off tests but not for engine tests because when it was ON, pressing the brake pedals didn't hold the aircraft.

The third member consulted indicated that if they had not pumped sufficient pressure, the aircraft moved during the engine test, and they had to reapply the brakes and put the lever in the ON position.

The last member said that during the engine test, they pressed the brake pedals, put the parking brake ON and then kept the pressure on the pedals as the parking brake alone could not hold the aircraft in the engine test.

The aircraft mechanic said that, for engine tests, he used the parking brake and kept pressure on the brake pedals as the aircraft would move after passing 4,000-4,200 rpm.

The aircraft's regular parking stand is not sloped, and they usually leave it chocked and with the parking brake OFF, except for one of the members who puts the parking brake ON.

1.18.5. Manufacturer’s exploded view of the valve and installation diagram

In the manufacturer's exploded view of the parking brake valve, which can be found in the appendix, the hexagonal adapters with item number 6 in the manufacturer's exploded view (fitting, adapter) are connected to the wide part of the valve body; however, in the installation diagram provided by the manufacturer (figure 11), they are connected to the narrow part. This is shown in the diagrams below:

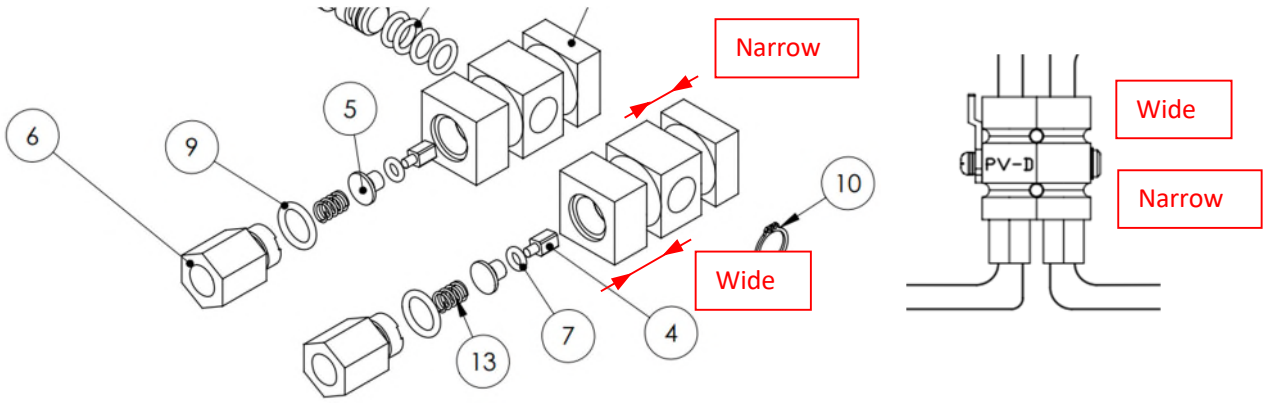


FIG. 9 EXPLODED VIEW AND INSTALLATION OF THE VALVE

1.19. Special investigation techniques

None required.

2. ANALYSIS

The analysis of the accident will focus on the influence of the installation of the parking brake valve, the operation, the landing roll, and the documentation provided by the manufacturer of the parking brake valve.

2.1. Analysis of the installation of the parking brake valve

Having reviewed the manufacturer's information on installing the parking brake valve (sections 1.6.6 and 5.1) and the information gathered from the inspection of the brake system on the EC-XIE aircraft (section 1.16.1), the investigation has found that the valve was installed in the opposite direction to that indicated by the manufacturer in figure 11.

With the valve installed in this position and the lever in the ON position, the fluid pressure could not reach the brake callipers when the pedals were pressed.

The way in which most of the pilots habitually used the parking brake confirms that its installation was faulty, as had it been installed correctly, the hydraulic flow would have been allowed to reach the brakes, even with the valve closed. The aircraft's users and the mechanic either understood the operation of the valve as a stopcock or simply doubted its effectiveness; therefore, its malfunction went undetected during both use and inspections.

As the users were aware of the functional limitations of the aircraft's parking brake, as installed, it didn't usually affect them because they left it in the OFF position.

2.2. Operational analysis

The meteorological information gathered indicates that the flight was not affected by any limiting conditions.

In terms of speed, based on the data recorded by the IGN maps of Spain application on the passenger's mobile phone, it is estimated that the aircraft was travelling at 92 km/h on landing. However, given that with flaps at 15°, the appropriate landing speed is 80-85 km/h, this was approximately 7 km/h too fast.

Furthermore, the following sequence of events are considered relevant:

1. The pilot recalls having performed the engine test before initiating the take-off with the parking brake OFF.

2. The feel of the brake pedal described by the pilot suggests that the parking brake was ON when he started the landing roll, which led him to change the position of the parking brake lever, possibly to OFF.
3. The pilot then changed the position of the parking brake lever again, possibly back to ON (coherent with the position of the lever after the roll-over).

In the absence of any brake system malfunctions, it's possible the position of the brake lever was inadvertently changed either before take-off or during the flight. On realising that the parking brake was ON, the pilot moved the lever to OFF; however, despite pumping the brake pedal, he felt the aircraft was not decelerating sufficiently and rushed to move the parking lever again, placing it back in the ON position until the aircraft flipped over. In this position, the pressure exerted on the cylinders may not have reached them due to the valve's faulty installation.

The excessive landing speed further compounded the situation by increasing the distance required to stop the aircraft and decreasing the time available during the landing roll to take the correct action.

On realising that the aircraft was going to overshoot the runway, the pilot could have cut the engine, closed the fuel tank and shut down the electrical systems. If he had done so, the damage to the aircraft might have been reduced.

The incorrect installation of the parking brake valve is considered a latent failure which became apparent when the possible inadvertent activation of the parking brake lever in flight and an excessive landing speed combined to precipitate the accident.

2.3. Analysis of the landing roll

In relation to the estimated length of the landing roll in the accident conditions (aircraft weight, runway type, etc.) and normal circumstances, the runway length was sufficient for the landing. As the aircraft touched down at the start of the runway, it had the full extent of it to decelerate.

According to the information gathered during the investigation, the landing took place on a dry, uncontaminated runway. Given that the wind was light, its influence on the landing roll was minimal.

The decision to steer towards the slope may have facilitated the deceleration of the aircraft.

2.4. Analysis of the documentation provided by the manufacturer of the parking brake valve

As detailed in 1.18.5, the investigation detected a contradiction between the exploded view of the parking brake valve and the installation diagram provided by the manufacturer (figures 10 and 11 in the appendix). This conflicting information could lead to confusion during the installation process; therefore, a safety recommendation is issued in this respect.

Furthermore, the investigation has not been able to identify any manufacturer-provided installation, bleeding or testing procedure for the parking brake valve, which means maintenance personnel lack this information and, therefore, a further safety recommendation is issued in this regard.

3. CONCLUSION

3.1. Findings

- The brake system functioned correctly when the parking brake valve was in the OFF position.
- The parking brake valve was incorrectly installed in such a way that, when in the ON position, it did not allow hydraulic pressure to reach the brake calliper.

3.2. Causes/contributing factors

The investigation has revealed that the accident was caused by the faulty installation of the parking brake valve, which prevented the pressure exerted on the pedals from reaching the brakes.

The aircraft's excessive speed on touchdown is also thought to be a contributing factor.

4. RECOMMENDATIONS

Given the faulty installation of the valve, the conflicting information in the exploded view of the valve and the lack of procedures, the following recommendations have been deemed necessary:

REC 32/22. It is recommended that MATCO mfg, as the manufacturer of the parking brake valve, add a permanent marking to the body of the valve to help prevent confusion during installation.

REC 33/22. It is recommended that MATCO mfg, as the manufacturer of the parking brake valve, correct any contradictory installation instructions to prevent confusion during installation.

REC 34/22. It is recommended that MATCO mfg, as the manufacturer of the parking brake valve, draw up a procedure for installing, bleeding and testing the parking valve.

Since the investigation found that the aeroclub's members all used the parking brake in different ways, the following recommendation has been deemed necessary:

REC 35/22. It is recommended that Sierpe Aeroclub establish a parking brake usage procedure to be followed by all its members.

5. APPENDICES

5.1. Information provided by MATCO

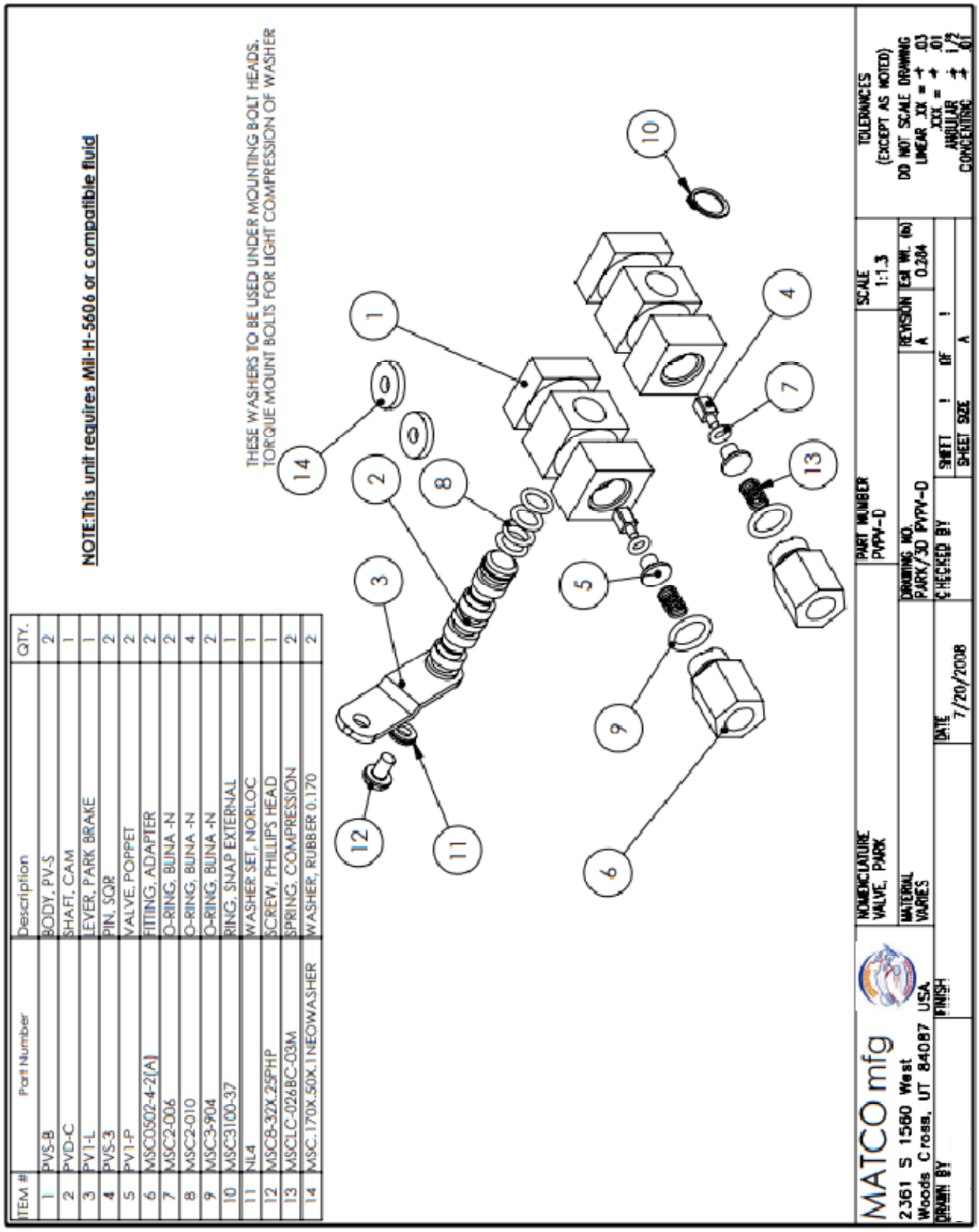


FIG. 10 EXPLODED VIEW OF THE VALVE MATCO PVPV-D

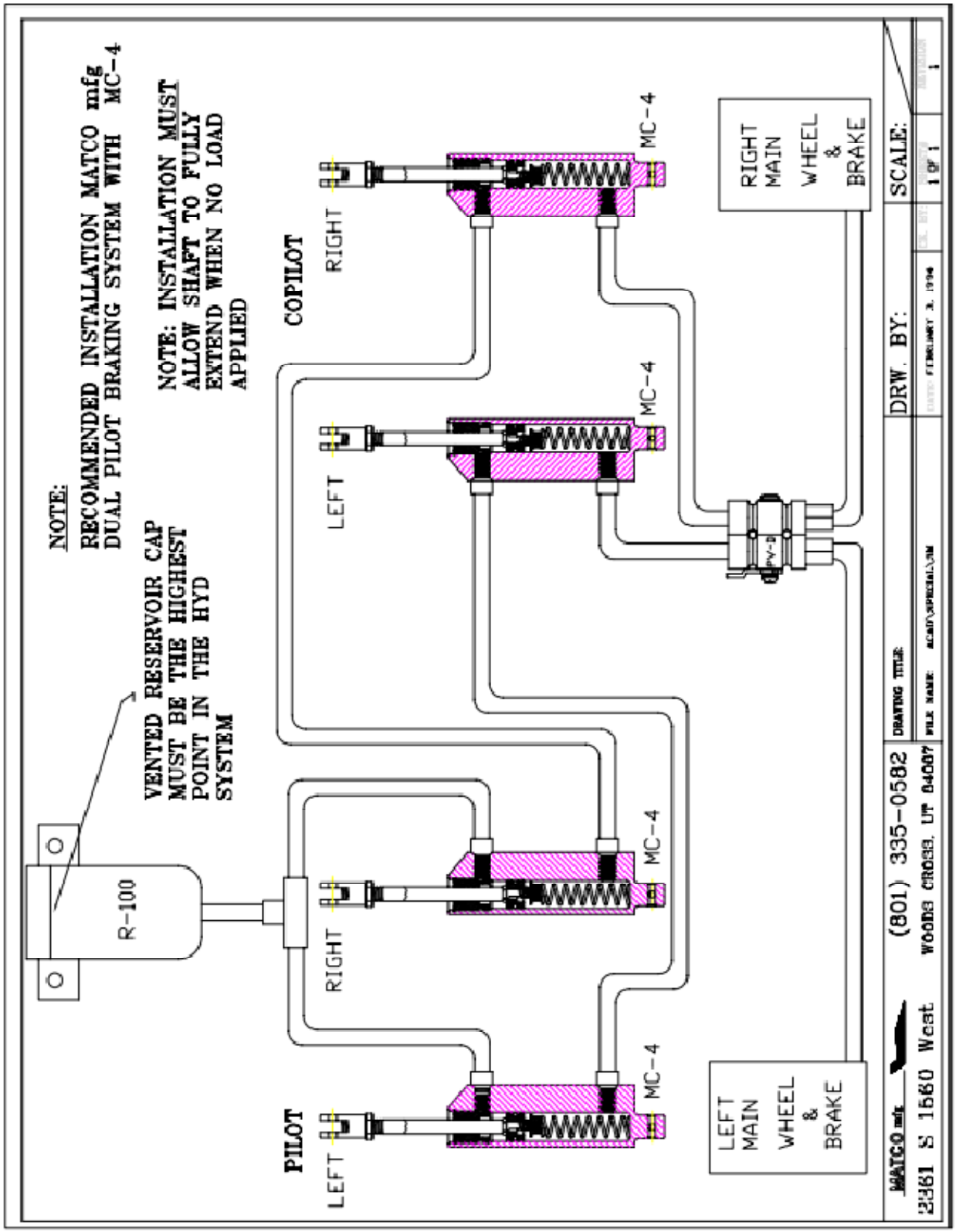


FIG. 11 INSTALLATION OF THE VALVE **MATCO PVPV-D(1)**

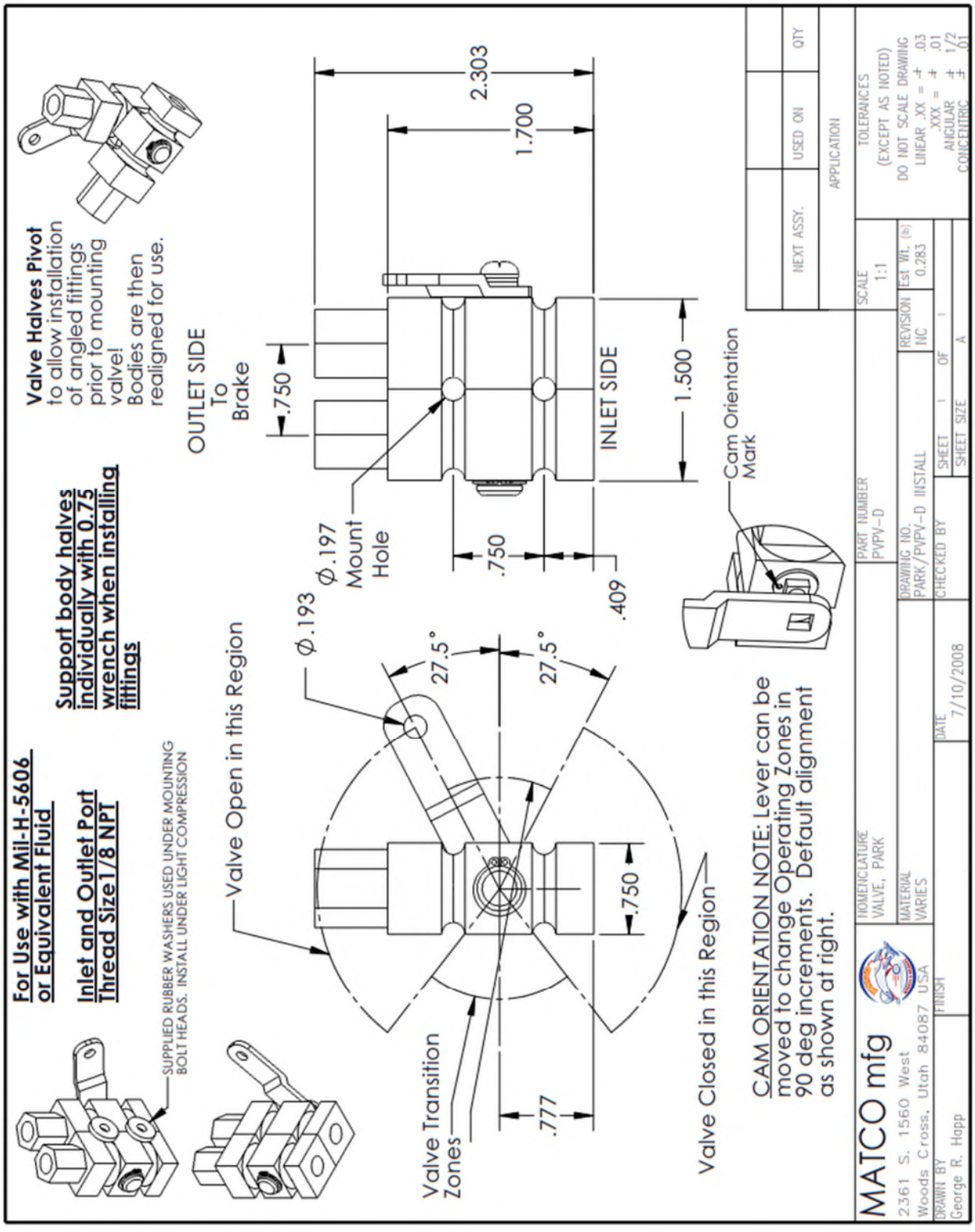


FIG. 12 INSTALLATION OF THE VALVE MATCO PVPV-D(2)