CIAIAC

COMISIÓN DE
INVESTIGACIÓN
DE **A**CCIDENTES
E **I**NCIDENTES DE
AVIACIÓN **C**IVIL

Report A-023/2005

Accident involving a PZL M18A aircraft, registration EC-FDN, operated by Martinez Ridao Tratamientos Aereos, in Beariz (Ourense), on 7 June 2005

MINISTERIO
DE FOMENTO

Report

A-023/2005

Accident involving a PZL M18A aircraft, registration EC-FDN, operated by Martinez Ridao Tratamientos Aereos, in Beariz (Ourense), on 7 June 2005

MINISTERIO DE FOMENTO

SECRETARÍA GENERAL DE TRANSPORTES

COMISIÓN DE INVESTIGACIÓN DE ACCIDENTES E INCIDENTES DE AVIACIÓN CIVIL

Edita: Centro de Publicaciones
Secretaría General Técnica
Ministerio de Fomento ©

NIPO: 161-07-074-6
Depósito legal: M. 23.129-2003
Imprime: Diseño Gráfico AM2000

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@fomento.es
http://www.ciaiac.es

C/ Fruela, 6
28011 Madrid (España)

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 of Law 21/2003 and pursuant to Annex 13 of the International Civil Aviation Convention, the investigation is of exclusively a technical nature, and its objective is not the assignment of blame or liability. The investigation was carried out without having necessarily used legal evidence procedures and with no other basic aim than preventing future accidents.

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.

Table of contents

Abbreviations

AFM	Aircraft Flight Manual
CIAIAC	Spain's Civil Aviation Accident and Incident Investigation Commission
DGAC	Spain's Civil Aviation Authority
E	East
EASA	European Aviation Safety Agency
FI	Flight instructor
GS	Groundspeed
h	Hours
HP	Horsepower
IAS	Indicated airspeed
IR	Instrument Rules
kg	Kilogram(s)
km	Kilometer(s)
kph	Kilometers per hour
kt	Knot(s)
m	Meter(s)
ME	Multi-engine
Mhz	Megahertz
MTOW	Maximum Takeoff Weight
N	North
S	South
SE	Single-engine
STC	Supplemental Type Certificate
TAS	True Airspeed
TSO	Time since overhaul
UTC	Universal coordinated time
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions
W	West

Synopsis

Owner and Operator:	Ángel Martínez Ridao Tratamientos Aéreos
Aircraft:	PZL M18A, Registration EC-FDN
Date and time of accident:	Tuesday, 7 June 2005; 13:00 UTC
Accident location:	The area surrounding the Beariz runway, Beariz city limits (Ourense)
Persons aboard and injuries:	1 (pilot), killed
Type of flight:	Aerial work. Commercial. Firefighting
Report approval date:	27 June 2007

Summary of the accident

Shortly before 15:00 local time, aircraft EC-FDN took off from the runway at the Beariz firefighting base (located in the town of the same name, belonging to the municipality of Beariz), to aid in fighting a fire that had been declared in the vicinity.

After takeoff, the aircraft started a 270°-turn to the right to proceed to the area of the fire. As it was completing the turn, the aircraft plunged to the ground a short distance away from the runway from which it had taken off.

The most likely cause of the accident was a stall during a climbing turn after takeoff, with a high bank angle and with an airspeed lower than that necessary to maintain the flight attitude.

Contributing factors to the accident are the supplemental type certification limitations covering the operation of the aircraft, which allowed turns with bank angles up to 30° above 5,000 kg of MTOW, and a possible excess takeoff weight.

Two safety recommendations are issued to the operator and the DGAC.

1. FACTUAL INFORMATION

1.1. History of the flight

On 7 June 2005, shortly before 15:00 local time, a PZL M18A aircraft, registration EC-FDN, took off from the firefighting base located at the Beariz Aerodrome (Beariz city limits, Ourense). The firefighting mission was being carried out by virtue of the contract the operator had signed with the local government of Galicia.

Three aircraft of the same type were performing the water drops. The accident aircraft took off third, in what was its first flight that day. The fire was centered some 30 km away to the W of the aerodrome, in the vicinity of Poio (Pontevedra), on the shore of an ocean inlet.

The operation was being conducted under VFR and prevailing weather conditions were good, with a moderate wind from the SE.

As was customary, the aircraft took off on the first flight of the day with the fuel tanks filled to capacity so as to avoid refueling delays on subsequent flights. After takeoff, and in accordance with the normal procedure at Beariz, the climbing aircraft had to turn 270° to the right, avoiding obstacles situated North and West of the field, before reaching a safe cruising altitude and proceeding directly to the site of the forest fire.

The aircraft preceding the accident aircraft completed these maneuvers and was able to observe as the last aircraft took off and started its turn. The pilot of that first aircraft later stated that EC-FDN made a tighter turn than usual.

During the turn, once the aircraft was perpendicular to the runway from which it had taken off, it crashed to the ground on a hill situated on the right side of the runway.

1.2. Injuries to persons

Injuries	Crew	Passengers	Total in the aircraft	Other
Fatal	1		1	
Serious				
Minor				Not applicable
None				Not applicable
TOTAL	**1**		**1**	

1.3. Damage to aircraft

The aircraft was destroyed by the impact with the terrain.

1.4. Other damage

No other significant damage was produced.

1.5. Personnel information

1.5.1. *Pilot*

Age:	42
Nationality:	Spanish
License:	Commercial aircraft pilot
Initial issue date:	17 December 1997
Expiration date:	08 April 2008
Ratings:	— Single engine piston land until 02 December 2006 — Agricultural and Forest (only Spanish aircraft) until 28 November 2005
Total experience:	1,493 h
Experience on the type:	377 h
Firefighting experience:	377 h
Medical certificate:	Class I until 05 June 2005 [1]

On 28 April 2005, he had carried out the training specified by the company's Operations Manual on operating PZL M18 Dromader-type aircraft, in keeping with DGAC requirements, and had passed the proficiency tests.

His flight activity on the previous days had consisted of 11:05 hours between 03 June 2005, when he reported to the base at Beariz, and 07 June 2005. His previous activity had taken place on 04 May 2005.

[1] The operator assured that he had renewed this certificate, but could provide no supporting documentation.

1.6. Aircraft information

The Dromader PZL M18A is a single-engine aircraft used in aerial work involving spraying and firefighting. This aircraft is only suited for VFR flights.

Its aircraft flight manual (AFM) authorizes operations up to a MTOW of 4,200 kg. A supplement to the AFM (Supplement 1) allows for the general use of the aircraft with a MTOW of up to 4,700 kg, with a slight load factor limitation and modifications to the allowed airspeeds, but without changes to either approved operations or restricted maneuvers.

Supplement 16 to the AFM, published on 31-01-94, allows, under certain new limitations and operating conditions, firefighting operations with a MTOW of up to 5,300 kg. The maximum jettisonable weight of water or fire-fighting agent is 2,200 kg, the available hopper volume being limited by air bladders which prevent undesired shifts in the airplane's center of gravity.

Prior to the publication of Supplement 16 to the AFM, a supplementary airworthiness certificate, STC-83S, issued by the Spanish DGAC on 16-03-92, authorized the use of the aircraft with a MTOW of up to 5,300 kg for firefighting missions, with certain conditions and restrictions.

Section 1.18 below makes an exhaustive comparison of the operating limits and conditions imposed by Supplement 16 to the AFM and by STC-83S.

1.6.1. *Airframe*

Manufacturer:	PZL Mielec
Model:	PZL-M18A
Serial number:	1Z022-18
Registration:	EC-FDN
MTOW:	5,300 kg (following incorporation of DGAC STC-83S)
Owner:	Servicios Aéreos Europeo y Tratamientos Agrícolas, S. L. (Martínez Ridao)
Operator:	Same as above

1.6.2. *Airworthiness certificate*

Number:	3214
Type:	Special restricted

Renewal date:	04 June 2004
Expiration date:	04 June 2005 (it had a one-month extension)

The airworthiness certificate's period of validity had been extended one month in accordance with DGAC Circular Instruction 11-19B, Section 2.a.

1.6.3. *Maintenance records*

Total flying hours:	997 h
Last annual inspection (100-hour):	10 August 2004
Hours on last annual inspection:	943 h

According to the information provided, the aircraft had been maintained in compliance with the maintenance program prescribed for it.

1.6.4. *Power plant*

The engine is of the reciprocating supercharged type, with nine radial cylinders.

Total hours:	975 h
Manufacturer:	PZL Kalisz
Model:	ASz-62IR-M-18
Power:	980 HP (Takeoff)
Serial number:	KAA 810095
Last inspection:	— 31 March 2005 (50-hour) — 10 August 2004 (100-hour) with 922 h

The four-blade, constant-speed, variable-pitch propeller is driven by the engine via speed-reducing planetary gears.

1.6.5. *Estimate of the operating weight*

The Aircraft Specification Sheet attached to the Airworthiness Certificate lists a basic weight for aircraft EC-FDN in its firefighting variant of 2,809 kg.

The weight of the gasoline with the tanks full is 508 kg and the weight of the pilot can be estimated at 75 kg. The weight of the water load was around 2,000 kg.

The sum of all these quantities yields an approximate actual operating weight of 5,392 kg.

1.6.6. *Overload flight characteristics of the Dromader PZL M18A aircraft*

Supplement 16 to the manufacturer's AFM in Section 4.10, LEVEL FLIGHT, states that «The aircraft displays longitudinal instability with free control stick. After some 20 seconds and two vibration cycles, the aircraft has a tendency to reach stall speed or to exceed the maximum airspeed».

Also, in Section 4.19, FIREFIGHTING, recommends flying at an airspeed of 170 kph, without exceeding a 15° + 5 bank angle. «Below that speed, some changes to the forces acting on the elevator may occur. Piloting at speeds below 170 kph is safe but demands increased attention from the pilot.»

Concerning low-speed flying, it should be pointed out that the aircraft had an audible and visual Stall-warning system. In the AFM normal takeoff checklists, paragraph 4.6 requires the Stall-warning is switched ON before takeoff.

1.7. Meteorological information

According to available information, people on the runway on the day of the accident estimated a wind speed of 10 kt, with gusts. The wind was from 150°, the temperature at approximately 28° Celsius and visibility of greater than 10 km.

Data automatically recorded at weather stations situated in nearby mountaintops, where the wind turbines of a wind park were sited, indicate that the wind reached speeds of 17 kt and was coming from the SE.

1.8. Aids to navigation

Not applicable.

1.9. Communications

The frequency in use was VHF 122.6 Mhz. Other aircraft that took off to fight the same fire communicated with the accident aircraft without any problems while they were on the apron. There were no other communications.

1.10. Aerodrome information

The runway at Beariz, at coordinates 42° 27′ 45″ N, 8° 20′ 33″ W, is in the municipality of Beariz (Ourense), next to the border with the province of Pontevedra. It is some 30 km away from the Pontevedran coast. It is on property owned by the government of Galicia and is used to station firefighting aircraft.

The runway strip is situated atop a large hill in an approximate N-S orientation. The area is mountainous, the higher elevations being to the S, W and N of its location. A wide valley opens up to the E of the aerodrome, with a narrower one to its SW.

The runway's physical characteristics are as follows:

— Runway orientation: 17-35
— Runway length: 858 m
— Maximum elevation: 806 m
— Elevation threshold 35: 806 m
— Elevation threshold 17: 781 m
— Type of surface: Asphalt

The runway features a downward gradient of 1.0% in the first quarter of its length in the northerly direction. In the other three quarters the negative gradient increases to 3.4%.

The extension for runway 35, beyond the runway 17 threshold, is at a lower altitude than the runway by a distance in excess of 500 m. An obstacle-free area of that length is thus available (in reality, only half the length of the runway, 429 m in this case, may be considered to be obstacle-free), such that the available takeoff distances available for runway 35 are:

— Takeoff Distance Available (TODA): 1,287 m
— Takeoff Run Available (TORA): 858 m

For a landing on runway 17, the Landing Distance Available (LDA) is 858 m.

On a heading of 360° at distances of 1.2 km, 1.6 km and 2.5 km there are mountains 815 m, 832 m and 851 m in altitude, respectively.

The mountains to the W are at an elevation of over 990 m. Those to the S reach 877 m with high mountain range grades.

Other faraway obstacles, situated at a distance of over 3 km on a NE heading, rise to 901 m.

In the valley to the East, which is over 5-km wide, there are no elevations above that of the runway.

This geography conditions the use of the available runway such that takeoffs are only performed on runway 35 and landings on runway 17.

At the time of the accident the meteorological facilities at the base consisted of a wind cone situated halfway down the runway and a hand anemometer. It did not have equipment for precisely measuring wind speed and direction, pressure, precipitation, temperature or dew point.

The base infrastructure and its use are not subject to compliance with aviation requirements.

1.11. Flight recorders

Not applicable.

1.12. Wreckage and impact information

The impact took place on a hillside with a slope gradient of some 20 degrees. Marks on the ground show a final course parallel to the direction of the hill, S-N, at a 60º angle with the horizontal.

After sliding barely 7 m over stones and shrubs, and turning slightly downhill to the right, the aircraft stopped at coordinates 42° 27.968' N, 8° 20.148' W, at an altitude of some 724 m. The fuselage ended up on a heading of 50º.

The aircraft partially maintained its structural integrity and the wreckage was confined to a small area; all of the detached remains were found within 13 m of the main wreckage.

The landing gear had collapsed and the wings were resting on the ground along the entirety of their span, with major damage to the left wing, which was on the uphill side. The right wing was detached from the fuselage.

Power plant

The entire power plant was detached from the engine mounts and shifted half a meter ahead.

Two of the four propeller blades were buried beneath the remains of the engine, and the other two blades were slightly damaged, showing signs of buckling toward the rear, evidence of limited rotation at the time of impact.

One engine cylinder had detached axially from the crankcase, symmetrically fracturing its fourteen mounting bolts, and was just a few centimeters away from the engine block, the spark plug cables still intact. The fracture of the fourteen bolts was produced by uniform tensile forces, with noticeable necking of the fractured section.

The carburetor butterfly was open with its actuating cable attached. The governor's control cable was attached to said component.

Flight controls

Continuity was established for the elevator, rudder and trim controls. The trim control could be moved freely. The rudder's continuity was confirmed and its trim tab was essentially in a neutral position. The aileron controls were deformed and fractured in parts, but showed no signs of failure prior to impact.

No indications could be found concerning the position of the flaps prior to impact.

The pedals were bent, their inward sides forward of their usual position.

Cockpit controls and indicators

— Water drop lever not actuated.
— Throttle lever at minimum.
— Propeller pitch lever at maximum.
— Alternate air closed (cold air to the carburetor).
— Cowl flaps closed.
— Elevator trim full down.
— Tail skid locking lever locked (normal position).
— MASTER switch ON.
— Generator switch ON.
— Instrument switch ON.
— Fuel gauge switch ON.
— Communications switch OFF.
— Switch for overhead and instrument lights ON.
— Switch for taxi and main lights OFF.
— Fuel pump switch ON.
— Stall-warning switch OFF.

— Control for the fuel shut-off valve in the valve open position.
— Magneto control in BOTH.

1.13. Medical and pathological information

The autopsy established the cause of death as cranial trauma with a loss of brain mass.

A toxicological analysis did not reveal any signs of alcohol, drugs of abuse or commonly prescribed medications.

1.14. Fire

The aircraft wreckage did not burn.

1.15. Survival aspects

The pilot's safety harness did not withstand the impact. Although it was fastened, the webbing on the right side of the belt (lower part of the harness) had torn. A visual inspection of the remaining elements revealed their apparently poor condition.

Given the characteristics of the accident, it can be safely stated that the occupant had practically no chance of surviving the impact with the ground, regardless of the performance of the safety harness.

1.16. Tests and research

1.16.1. *Dismantling and inspection of the engine in the workshop*

The engine was blocked internally. It was gradually dismantled in the shop. No anomalies were found with the propeller reduction gear or the accessories. Upon reaching the crankcase, it was discovered that the crankshaft had shifted laterally and backward. The lack of clearance between the crankcase counterweights, the master connecting rod and the aft wall was determined to have caused the engine to become blocked. Once the crankcase was moved to its normal position, the engine shaft moved without difficulty.

The cylinders were dismantled. The coloration of the deposits on the valve heads, cylinder heads and pistons was consistent with normal operations.

There were no signs of any defects existing prior to the impact or of any abnormal engine operation in prior periods.

1.16.2. *Performance and control characteristics of the aircraft*

In a coordinated turn with 15° bank, at a TAS of around 180 kph, the turn radius for this aircraft, given its weight condition, has been estimated at approximately 850 m. With 30° and 45° banks, the turn radii would be approximately 400 m and 225 m, respectively.

1.16.3. *Eyewitness statements*

Pilot who was flying the aircraft that preceded the accident aircraft

According to the statements of the pilot who took off immediately before the accident aircraft, they used runway 35. All were using the same radio frequency. No distress calls were made by the accident aircraft. The maneuver to be completed after takeoff consisted of a 270° turn to the right while climbing, the intention being to fly over the runway at an altitude of 600 feet and then proceeding to the fire.

They left with a load of 2,000 liters of water and full fuel tanks. Under those conditions, he estimated that the maximum climb rate on the day of the accident would have been around 500 feet per minute.

According to the pilot, this aircraft's behavior is fairly reliable and warns of an impending stall. In case of a stall, 300-400 feet are needed to recover. A stall may result in a spin.

The accident aircraft started its takeoff run as soon as he cleared the runway. He saw how it tightened the turn and was surprised by this fact. He did not see the aircraft fall since it was already behind him at the time of the accident.

1.16.4. *Flight path determination*

This pilot's statement, the location of the impact point, the positions of the obstacles to be avoided and the usual maneuver performed were used to determine the approximate probable trajectory taken by the accident aircraft (see Appendix 2).

1.17. Organizational and management information

1.17.1. *Operations manual of the operator*

The contract between the operator and the government of Galicia specifies that the aircraft must have a water-carrying capacity of 2,200 kg.

The same contract specifies that the pilots must have at least 1,000 hours of total flying experience, 500 of them as captain and 100 fighting forest fires.
It stipulates a 12-minute lead time between receiving the fire warning and being airborne.

The Operations Manual (OM) specifies the refresher training courses and the proficiency tests the company's crews must pass.

No specific normal operating or emergency procedures for the base at Beariz are listed. There is also no mention of the requirements Dromader PZL M18A pilots must meet when flying under overload conditions.

The aircraft captain is solely responsible for planning and executing the flight in accordance with the regulations in the manual.

It was noted that no cards with check lists which can serve as a ready reference in flight were contained among the aircraft's diverse documentation. The contents of these cards should present an abbreviated version of the procedures detailed at length in the flight manual.

1.18. Additional information

1.18.1. *Differences between the 5,300-kg MTOW certificates*

In its firefighting variant with a 5,300-kg MTOW, the aircraft was flying in Spain under the stipulations of STC 83-S. The modification which covered the design for that MTOW of 5,300 kg was also covered by EASA type certificate A.056 and issued by the EASA to the aircraft manufacturer. There were differences among the conditions of the certificates which fundamentally affected the airworthiness limitations, takeoff speeds and the skills and experience required of the pilots.

Namely, under STC 83-S, turns with up to a 30° bank angle were allowed at takeoff weights over 5,000 kg, while in Supplement 16 to the AFM, which was applicable to the 5,300-kg MTOW design modification considered by the EASA type certificate, a maximum bank angle of 15° + 5° was specified.

Moreover, the conditions in STC 83-S and the operations manual did not list any special requirements for pilots engaged in firefighting missions with high MTOW. Supplement 16 to the AFM, however, establishes the following pilot qualifications:

> «Having regard to the specific pilotage of the aircraft in the overload fire-fighting version with the weight of 5,300 kg, the pilot must have the following qualifications:
>
> — total flown time – 2,000 hours
> — Authorization to conduct agricultural operations
> — 1,000 flown hours in agricultural and fire-fighting operations, including 200 hours on the PZL M18A»

It also specifies that pilot-instructors who grant other pilots the authorization to engage in firefighting missions must have taken a training course at the facilities of the manufacturer, WSK PZL MIELEC, under the supervision of instructor-test pilots.

1.18.2. *Previous actions taken by the CIAIAC and the EASA at the start of summer, 2006*

Based on the investigation into another accident involving the same type of aircraft (see CIAIAC A-52/2005) and on the differences between the certificates attesting to the airworthiness of that aircraft, the CIAIAC issued safety recommendation 36/06 on 26 July 2006 to the EASA for it to review the conditions under which Airworthiness Type Certificates, like the one that covered the basic design modifications for a 5,300-kg MTOW (EASA Type Certificate A.056), were approved.

The EASA issued an emergency airworthiness directive (see Appendix 4) on 27 July 2006, revoking the flying conditions established for the PZL M18A in various STCs issued by the Spanish DGAC and adopting the conditions of Supplement 16 to the Polish version of the AFM.

1.18.3. *Terms of the service contract for preventing and fighting fires between the operator and the government of Galicia*

The fire prevention and extinguishing duties being carried out by the operator were governed by a three-year contract with the government of Galicia and valid for 2005, 2006 and 2007. At the time the contract bids were being accepted, in February of 2005, the plan was for the airplanes to operate continuously for a minimum of three (3) months in that year during the fire season. For 2006, the contract covered the entire fire campaign period and spanned a minimum of 5 months a year.

According to that contract, when the base infrastructure lacked the ancillary operating resources needed, the operator had to provide them. Among the resources specifically mentioned was the requirement to have a wind cone to indicate wind strength and direction. Ancillary resources also had to include equipment for comparing weather data so as to determine if actual conditions were worse than those required for operations.

Regarding the aircraft and pilots, the contract specifies that the aircraft must have a water-carrying capacity of 2,200 kg and that the pilots must have at least 1,000 h of total flying experience, 500 of them as captain and 100 fighting forest fires. It stipulates a 12-minute lead time between receiving the fire warning and being airborne.

1.18.4. *Information on temporary aerodromes*[2]

According to the information provided by the DGAC, the responsibility over temporary aerodromes lies in most cases with the autonomous administrations (except the autonomous cities of Ceuta and Melilla), as established by the different Statutes of Autonomy, and the jurisdiction of the State General Administration is limited to the provisions of Article 9 of Law 21/2003 on Aerial Safety, which requires that the ministries of Public Works and Defence jointly issue a binding written asessment on the compatibility of the airspace.

The DGAC also reported that they have been communicating with the Autonomous Administrations for several years to make them aware of the need to adopt a proactive stance regarding their responsibilities, and also to report any irregular situation noted.

The DGAC also stated that they have shown the Autonomous Administrations their willingness to collaborate when requested according to their available resources. One of those collaborations is to prepare draft technical norms that could be used as a basis for the different regional regulations. The DGAC has been working on those norms for several months, using the advice of industry operators, pilots and engineers.

1.19. Useful or effective investigation techniques

Not applicable.

[2] The CIAIAC's report on the incident involving aircraft EC-FMX, on 13 october 2004 at Casarrubios del Monte Aerodrome (ref. CIAIAC IN-064/2004) can be used as additional information on legislation applicable to private aerodromes.

2. ANALYSIS

2.1. Evolution of the flight

A contingent of three Domader aircraft stationed at the Beariz Aerodrome took part in the firefighting efforts on the afternoon of 7 June 2005. The wind relative to runway 35, which was to be used for the takeoff, was tailwind below 10 kt, visibility was greater than 10 km and general weather conditions were good for VFR operations.

The runway at Beariz, which is situated in a mountainous region, is long enough to accommodate a fully-loaded PZL M18A, though the operation is complicated by the forced use of runway 35, even under tailwind conditions, due to the existence of obstacles to the south, and by the need to turn right immediately after takeoff to avoid obstacles to the north.

Due to the urgent nature of this type of operation, the pre-flight preparations of aircraft EC-FDN may have been rushed so as to comply with the departure and on-station time requirements. In this sense, it is noted that the weight of the water load may have resulted in a violation of the MTOW, and that the overhead and instrument lights were on while the taxi lights were off. In observing the positions of the cockpit controls, it should also be noted that the stall warning system was off-line. All this may be indicative of a rush to be airborne without rigorously adhering to normal operating procedures.

The flight lasted just over a minute. The aircraft accelerated and took off with tailwind, then started a 270° turn, sharper than usual according to the estimate of the pilot who preceded it, possibly obligated by the obstacles to be avoided.

The necessary airspeeds depend on the aircraft's weight, and are also influenced by the flying conditions in the turn. According to the information received and the evidence found, the turn radius may have been approximately 400 m, which yields a bank angle of 30°. In principle, increasing this radius by 150 m would still have allowed the aircraft to clear the obstacles with a lower bank angle, while staying further away from critical turn conditions.

Under these flying conditions, the aircraft suddenly plunged to the ground. The impact marks indicate a nose down attitude and a high speed.

No anomalies were observed in the aircraft's structure or systems; specifically, the continuity in the flight control cables allows the hypothesis of a malfunction in said cables to be discarded.

2.2. Performance of the power plant

The position of the carburetor butterfly (open) and the regulator control indicate that takeoff power had been selected. In contrast to these indications, the positions of the

throttle and propeller pitch levers in the cockpit, both full back and jammed by the impact, were not consistent with takeoff power being selected. These positions may have been altered in respect to their in-flight position, however, by the tension in the transmitting cables that resulted when the engine detached on impact.

The position of the engine controls notwithstanding, the axial detachment of a cylinder for causes unrelated to its impact with the ground was surprising when it was discovered early in the investigation. Equally surprising were the buckling deformations in two of the propeller blades, which called into question whether the engine was turning over normally at the time of impact.

An engine cylinder did in fact detach suddenly when the propeller touched the ground. When the engine was dismantled it became clear that the engine locked when the crankshaft shifted and the master connecting rod jammed against a counterweight. This sudden lock occurred as the ignition and explosion were taking place inside the cylinder with the valves closed. When the piston did not give way, as it was prevented from doing so by the crankshaft, the force of the explosion on the cylinder head launched the cylinder body against the ground, which stopped its movement within a few centimeters.

The fracture of the cylinder mounts attest to the violence of the explosion, and therefore indicate that the mixture was rich and that the engine was turning over at full power instants before the impact.

This assessment is corroborated by the normal appearance of the engine components and of the combustion chamber surfaces, as noted when the engine was dismantled in the workshop.

2.3. Takeoff weight estimation

In Section 1.6.5 , the takeoff weight was estimated at 5,392 kg, derived from the basic weight listed on the Specification Sheet, the 2000-kg water load which the aircraft was reportedly carrying and the weight of the full tanks of fuel.

The actual data and conditions from the aircraft's last weighing were not available, however. Nor is there any supplementary information to confirm whether the basic weight includes the weight of the drainable engine oil and of other possible weight variables. A more accurate determination of these variables could lead to a higher actual takeoff weight for the aircraft.

The estimated value of 5,392 kg is slightly above the MTOW of 5,300 kg. The performance of the aircraft would, in that case, be only slightly affected by the extra weight, but it would contribute to lower the already narrow safety margins usually available for this type of operation.

Operating requirements, operator's procedures

The less restrictive limitations found in STC-83S with respect to those imposed by Supplement 16 to the manufacturer's AFM concerning banking in turns allowed for the planning of overly aggressive maneuvers without regard for the dangers they entailed.

Adhering to the instructions imposed by the manufacturer requires that this aircraft be flown by an experienced pilot at a precise airspeed of 170 kph when in its overload configuration, with banks in turns of fewer than 15°.

In light of these requirements, it is concluded that possibly:

— The 5,300-kg MTOW was slightly exceeded.
— 30° bank was used in the turn, equivalent to a turn radius of some 400 m.
— Upon climbing, the aircraft encountered wind, possibly on the order of 17 kt, which affected the ability to maintain airspeed during the turn.
— The pilot's accumulated experience, though considerable, still did not meet the standards set by the manufacturer.

Given these weight and attitude conditions, a stall may have resulted from which the pilot, flying low, was not able to recover in time.

It may not be common knowledge among operators of this type of aircraft that these firefighting missions are almost always flown in conditions very near the limits of the aircraft, and that excess weight and steep bank angles in excess of 15° reduce the safety margins.

The inadequate planning and execution of this operation may have been influenced by the lack of knowledge concerning this aircraft's actual limitations which, although published in Supplement 16 to its AFM in 1993, may have somehow been obscured and overshadowed by the less demanding conditions of the supplementary type certificate that covered its operation.

The study and analysis of various type design approvals of this aircraft discovered discrepancies that have been addressed with the issuance of CIAIAC safety recommendation REC 36/06 and the resulting EASA emergency airworthiness directive 2006-0229-E.

As for this operator's operations manual, it was noted that although the aircraft routinely operated out of certain aerodromes, there were no aircraft performance tables or operating procedures (takeoffs, landings, patterns, etc.) tailored to these bases. It also did not include the crew or situation requirements specific to this type of operation. Complying with the crew selection and authorization requirements for operating in overload conditions listed in the limitations of Supplement 16 to the AFM could avoid having inexperienced pilots assigned to high-risk operations.

In order to analyze the operation, the normal operating procedures in the AFM were studied. Since consulting the AFM in flight is usually cumbersome, the investigation looked into the availability of other cards and checklists in the cockpit to serve as a quick reference for the pilot. It was discovered that no such documentation was in use at the company.

The company manuals should, therefore, describe the normal procedures for this type of aircraft within the scope of the official limitations, supplemented with the operating cards for the aerodromes where they are usually based. It would be advisable, therefore, to correct these deficiencies, and a recommendation is issued to this effect.

2.4. Conditions at the base in Beariz

The base at Beariz has only very basic resources to aid in operations, and there is no record of any specialized studies having been performed prior to its commissioning. As already mentioned, existing winds on the day of the accident were somewhat strong according to eyewitness estimates at the scene and the data collected at nearby stations, which provided values in excess of those estimates. The ambient temperature was also high, which had a negative effect on the aircraft's performance versus that obtained under standard atmospheric conditions. The operation lacked the accurate wind and temperature data necessary for proper pre-flight planning.

According to the conditions governing the relationship between the operator and the Galician government, the resources needed for the operation, and specifically those used to gather meteorological data, were the responsibility of the operator, there being only a wind cone at Beariz. This served as an obstacle to gaining the knowledge necessary to correctly carry out operations, and could be added to the other operator deficiencies already noted in this report, though the proper assessment of these conditions by the contracting authority could also be called into question.

The base at Beariz is used routinely for aircraft operations during the Galician Autonomous Community's firefighting campaign. Its seasonal use does not give it the status of a permanent aerodrome, and it is not subject to complying with aviation requirements since the conditions that must be met by temporary aerodromes, out of which aircraft like the Dromader operate, are not regulated. Despite this seasonal status, the base at Beariz is expected to stage regular aircraft operations on a continuous basis for at least five (5) months a year, providing a public service in firefighting and fire prevention for the government of Galicia.

The circumstances at Beariz are similar to those normally seen in other parts of the territory, where public, state, autonomous or municipal authorities own the aerodromes from which firefighting and, more generally, environmental defense and conservation activities are staged in the interest of public safety. As in the case of Beariz, these facil-

ities, being used only seasonally, may not be equipped with the necessary infrastructure to support aerial operations and their commissioning may have lacked a previous aviation evaluation. Keeping in mind the growing importance these types of operations have assumed, the heightened social awareness in matters of environmental protection and the services that authorities must provide as a consequence, it would be advisable for the air bases which stage these operations to be adequately planned and equipped, and not be forced to rely exclusively on the resources obtained by the operators as the need arises, without an accurate evaluation of their suitability.

According to the information gathered, the DGAC has tried several times, together with the Autonomous Administrations, to address the situation regarding installations which, as is the case with temporary aerodromes, are one of the topics that must be regulated within the region. However, those attempts did not succeed. It is therefore advisable that the State General Administration firmly deal with the problem and that the aeronautical authority provide effective support to the public agencies that own these facilities in defining and evaluating the equipment necessary to adequately carry out aerial operations from these bases.

3. CONCLUSIONS

3.1. Findings

— At the time of the accident, two different airworthiness approvals were in effect for operating with a 5,300-kg MTOW. One was EASA Type Certificate A.056, which allows turns with a maximum bank of just 15° + 5° and only after a series of conditions has been met, and the other was Supplemental Type Certificate 83-S, issued by the DGAC in Spain and which allowed turns of up to 30° with a MTOW above 5,000 kg and sets no limitations on the pilot.
— The pilot had a valid license and was approved for the flight.
— The aircraft had an airworthiness certificate whose validity had been extended for one month and covered the type of operation in question.
— The VMC were adequate for the operation being carried out.
— Two other aircraft with the same characteristics and under similar weight conditions preceded the accident aircraft, taking off and executing the 270° turn normally.
— The aircraft weight may have been marginally over the 5,300-kg MTOW.
— The pilot did not have the minimum flying experience specified by the manufacturer, which is duplicated in the conditions of EASA type certificate A.056.
— Moments before the accident, the aircraft in question was flying in a turn with a bank angle of 30° or more.
— The stall-warning system was disconnected.
— No malfunctions affecting the flight were indicated by the tests carried out on the aircraft's components. The engine was operating at a high power output at the time of impact.
— The impact with the ground took place with the airplane at a 60° dive angle and a high vertical descent speed.

3.2. Causes

The most likely cause of the accident was a stall as the aircraft was executing a turn while climbing after the takeoff, with a high bank angle and an airspeed below that required to maintain the flight attitude.

Factors contributing to the accident are the limitations of the supplemental type certificate under which the aircraft was operating which allowed turns with up to a 30° bank with the aircraft above 5,000 kg MTOW, and possibly excess weight at takeoff.

4. SAFETY RECOMMENDATIONS

REC 27/07. It is recommended that the operator establish aircraft performance tables and operating procedures (takeoffs, landings, patterns, turns, correct weight estimates, etc.) adapted for each base according to pilot experience and the specific characteristics of the operation.

REC 28/07. It is recommended that the DGAC provide support to public administrations which own airbases, whether used temporarily or seasonally, from which activities of a firefighting, fire prevention or environmental protection nature are carried out in the interest of public safety. This support is to consist of determining and evaluating the conditions said aerodromes must fulfill to stage and conduct operations.

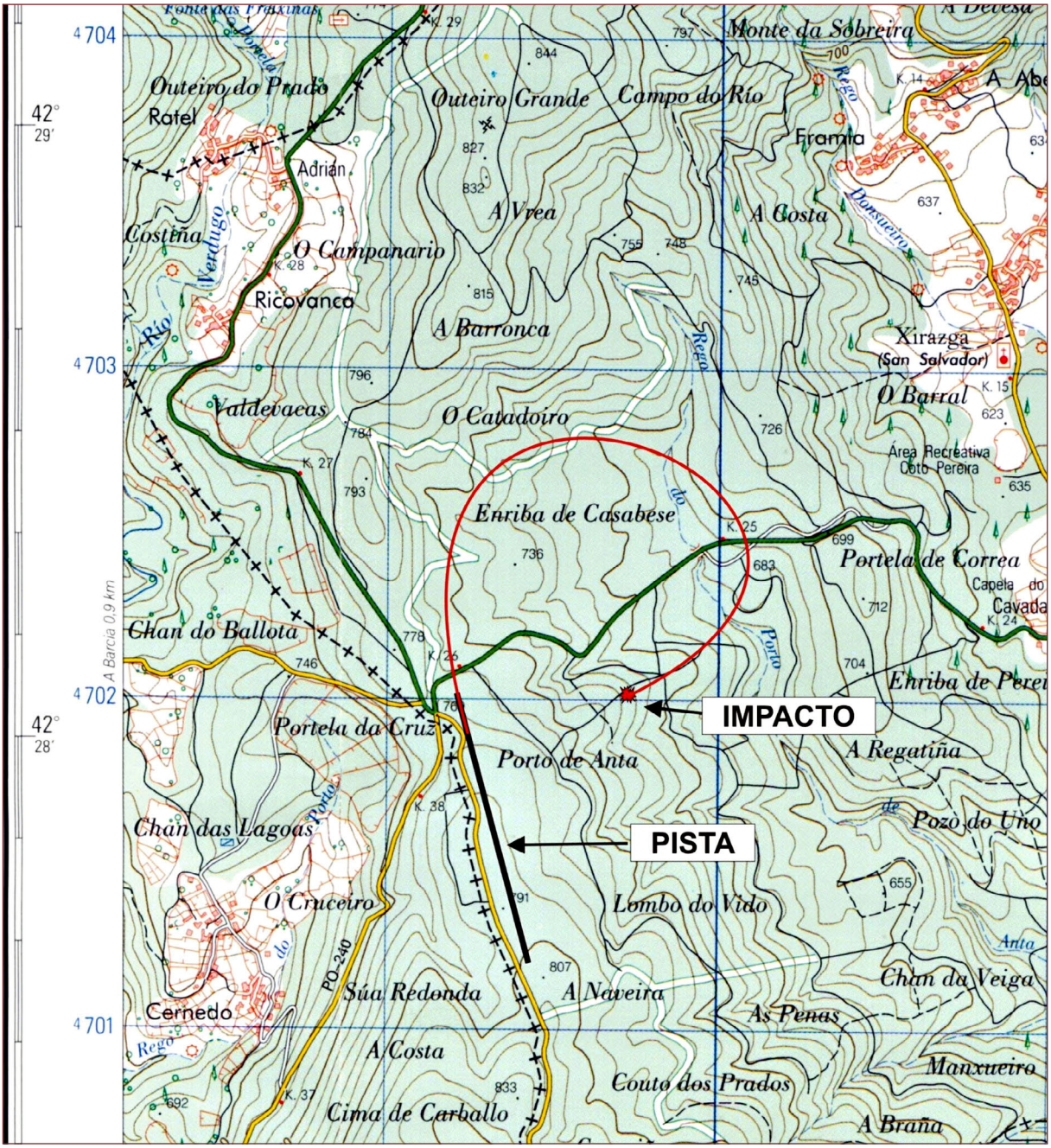
The DGAC has accepted this recommendation and has stated its willingness to collaborate with the Autonomous Administrations. To this end, the DGAC is trying to prepare draft technical norms to be used as a basis for the different autonomous norms.

APPENDICES

APPENDIX 1
Aircraft wreckage


EC-FDN

APPENDIX 2
Aircraft's flight path


IMPACTO
PISTA
Outeiro do Prado
Ratel
Outeiro Grande
Campo do Río
Monte da Sobreira
Adrián
Costiña
O Campanario
Ricovanca
A Vrea
A Barronca
A Costa
Framia
Xirazga
(San Salvador)
O Barral
Área Recreativa
Coto Pereira
Valdevacas
O Cataduiro
Enriba de Casabese
Portela de Correa
Capela do
Cavada
Chan do Ballota
Portela da Cruz
Porto de Anta
A Regatiña
Pozo do Uno
Chan das Lagoas
O Cruceiro
Lombo do Vido
Súa Redonda
A Naveira
As Penas
Chan da Veiga
Cernedo
A Costa
Couto dos Prados
Manxueiro
Cima de Carballo
A Braña
Monte da Sobreira
Fonte das Fraxinas
A Barcia 0,9 km
PO-240
42° 29'
42° 28'
4 704
4 703
4 702
4 701

APPENDIX 3

Emergency Airworthiness Directive 2006-0229-E

EASA	EMERGENCY AIRWORTHINESS DIRECTIVE
	AD No : 2006 - 0229 –E **[Corrected]** **Date: 27 July 2006**

No person may operate an aircraft to which an Airworthiness Directive applies, except in accordance with the requirements of that Airworthiness Directive unless otherwise agreed with the Authority of the State of Registry.

Type Approval Holder's Name :	**Type/Model designation(s) :**
ADEFA AVIALSA BAQUERO SERVISIOS AÉREOS MARTIN ECHEVARRIA MARTINEZ RIDAO	PZL-M18, -M18A, operating in accordance with DGAC-Spain Supplemental Type Certificates No. 83-S, 87-S, 88-S, 89-S, 101-S, 102-S and 130-S

STC Numbers : DGAC-ES 83-S, 87-S, 88-S, 89-S, 101-S, 102-S and 130-S

Foreign AD : none

Supersedure : none

ATA 04	**Limitations – Change of Aircraft Flight Manual Supplement**
Manufacturer:	WSK PZL
Applicability:	PZL-M18, -M18A airplane any serial numbers that are operated up to a Maximum Take-off Weight of 5.300 Kg., in fire fighting operations, in accordance with the following DGAC-Spain STCs: No. 83-S (AVIALSA) No. 87-S (MARTIN ECHEVARRIA) No. 89-S & No. 101-S (MARTINEZ RIDAO) No. 88-S & 102-S (BAQUERO SERVICIOS AEREOS) No. 130-S (ADEFA).
Reason:	In the course of the investigation of an accident of a M18A operated in accordance with DGAC-Spain STC nr. 83-S, occurred in Spain on 4 September 2005, the Spanish Civil Aviation Accidents and Incidents Investigation Commission, having noted the differences in operational limitations that apply to the type design modification to operate up to 5300

1/2

	kg of MTOW in fire fighting operations, between the EASA.A.056 Type Certificate Data Sheets and associated documentation and the above mentioned STCs issued by DGAC Spain, has issued a draft Safety Recommendation to EASA, to revise these differences. EASA has decided that both sets of limitations must be standardised to those contained in the PZL Supplement nr. 16 to the Aircraft Flight Manual. [Correction: Compliance date corrected]
Effective Date:	28 July 2006
Compliance:	From the effective date of this AD, replace the Aircraft Flight Manual Supplements of the Spanish STCs quoted above by AFM Supplement No. 16 to Aircraft Flight Manual of PZL M18 "DROMADER", published by PZL, referenced in TCDS EASA.A.056. In addition to this, replace all placards located in the cockpit containing limitations associated with the Aircraft Flight Manual Supplements of the aforementioned Spanish STC,s by those established in AFM Supplement No. 16, to Aircraft Flight Manual of PZL M18 "DROMADER" published by PZL.
Ref. Publications:	AFM Supplement No. 16 to Aircraft Flight Manual of PZL M18 "DROMADER" published by PZL, referenced in the a/c TCDS EASA.A.056.
Remarks :	1. If requested and appropriately substantiated the responsible EASA manager for the related product has the authority to accept Alternative Method of Compliance (AMOCs) for this AD. 2. The safety assessment has requested not to implement the full consultation process and an immediate publication and notification. 3. Enquiries regarding this AD should be addressed to Mr. M. Capaccio, AD Focal Point, Certification Directorate, EASA. E-mail: ADs@easa.europa.eu 4. For any question concerning the technical content of the requirements in this AD, please contact Dirección General de Aviación Civil. Paseo de la Castellana, 67. 28071 Madrid Ph: +34 91597 8859; +34 91597 8641 ; Fax: +34 91597 8584

2/2