

CIAIAC

Comisión de Investigación
de Accidentes e Incidentes
de Aviación Civil

TECHNICAL REPORT

A-055/2001

Accident to aircraft
FAIRCHILD SA-226-AT,
«Metro II», registration
EC-GDV, in the vicinity of
the Columbretes Islands
in the Mediterranean
Sea, on 10 October 2001



MINISTERIO
DE FOMENTO

Technical report

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TRANSPORTES

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DE ACCIDENTES E INCIDENTES
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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 Annex 13 to the Convention on International Civil Aviation, the investigation has exclusively a technical nature, without having been targeted at the declaration or assignment of blame or liability. The investigation has been 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 has originally been issued in Spanish language. This English translation is provided for information purposes only.

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Abbreviations

00 °C	Degrees centigrade
BKN	Broken cloud (5-7 oktas)
CPU	Central Processing Unit
E	East
FAA	Federal Aviation Administration (USA)
FEW	Few clouds (1-2 oktas)
FL	Flight Level (flying level in hundreds of feet)
ft	Feet
GPS	Global Positioning System by satellite
h	Hour(s)
hh:mm:ss	Hours:minutes:seconds
IFR	Instrument Flight Rules
JAR	Joint Aviation Requirements applicable in JAA countries
kg	Kilogramme(s)
km	Kilometre(s)
kt	Knot(s)
lb	Pound(s)
m	Metre(s)
METAR	Aerodrome routine meteorological report
NM	Nautical Mile(s)
MTOW	Maximum Take-Off Weight
N	North
ICAO	International Civil Aviation Organization
OPS	Operating requirements
OVC	Overcast (more than 7 oktas)
PGT	Public Goods Transport
PPT	Public Passenger Transport
ROV	Remotely Operated Vehicle
SCT	Scattered cloud (3-4 oktas)
SHP	Shaft horse power
TAF	Aerodrome Forecast
TACC	Terminal Area Control Centre
TV	Television
UTC	Co-ordinated Universal Time
W	West

Synopsis

Owner:	Air Atlantic, S. L.
Operator:	Flightline, S. L.
Aircraft:	Fairchild SA-226-AT
Date of the accident:	10-10-2001
Time of the accident:	10:42 h ¹
Place of the accident:	Co-ordinates 39° 59' 06" N/00° 32' 05" E, 10 NM to the NW of the Columbretes Islands in the Mediterranean Sea
Persons on board:	2 crew and 8 passengers
Type of operation:	Non-scheduled international commercial passenger transport flight
Date of approval:	28 September 2005

Accident description

The aircraft was carrying out flight FTL 101 from Barcelona Airport in Spain to Oran Airport, Algeria. Northwest of the Columbretes Islands the aircraft crashed into the sea; the wreckage was located on the surface and at the bottom of the sea but the occupants were not found.

Although it has not been possible to establish the cause of the accident, a total loss of the electricity supply, which the crew was unable to restore and which was caused by the aircraft being struck by lightning whilst flying in a storm, is considered to be the most probable cause.

¹ Unless indicated otherwise, all times in this report are local (LT). UTC is two hours less than local time.

1. FACTUAL INFORMATION

1.1. History of the flight

On the day of the accident, 10 October 2001, aircraft Fairchild model SA-226-AT «Merlin IV», registration EC-GDV, widely known as «Metro II» or «SW2» in reference to the company Swearingen, the aircraft designer which gave rise to the well-known «Metros» and subsequently merged with Fairchild Aircraft Corp., had been hired to carry out a non-scheduled international commercial flight for the transport of passengers between the airports of Barcelona in Spain and Oran in Algeria.

According to the Flight Plan submitted, the flight, number FTL 101, would be carried out in IFR conditions, departing at 10:00 h, with an estimated duration of two hours, speed of 220 kt and level FL 190, with two crew members and eight passengers on board. The planned route was Barcelona - EBROX - B28 (Airway) - VLC (Valencia) - A34 (Airway) - MAGAL - A34 (Airway) - HAMRA - MOS - Oran. The aircraft refuelled for an operational range of 3 hours and 30 minutes.

According to the available log of communications with the Barcelona Airport control tower, the aircraft took off at 10:18:20 h.

During the first part of the flight, the aircraft flew in the direction of Valencia, contacting the successive traffic control sectors without reporting any anomalies.

The last radio contact was at 10:38:17 h, to acknowledge the Valencia Terminal Area Control Centre (TACC) controller's authorization of the request to «turn 20° to the left to avoid». Within the context of the radio contact, it can be deduced that this was to avoid clouds as in the response, the controller authorized the manoeuvre indicating that it should «go back towards Valencia as soon as it is free from clouds».

In addition, the radar track of the last part of the flight is available, from which it can be established that the last display of a radar echo on the controllers' screen was at 10:41:59 h, at position 40° 10' 34" N/01° 10' 24" E (azimuth 062° from the Valencia radar antenna, distance 81.8 NM).

Figure A-1 reproduces the flight's planned route and the actual route of the last part of the flight, reconstructed on the basis of the available radar track.

Realising the loss of radio contact and of display on the controllers' radar screens, the air traffic control towers tried to establish new radio contact with the aircraft, even using as relay some of the aircraft flying in the area. When they did not obtain a positive result they alerted the Search and Rescue Services.

The corresponding rescue operations in which a total of eight aircraft participated (4 aeroplanes and 4 helicopters) continued until 13 October, when it was decided that there was no longer any likelihood of rescuing survivors. During these operations, scattered wreckage was located and recovered in a radius of 10 NM.

Later, other aircraft wreckage was recovered by fishing vessels in the area, mainly consisting of pieces of bulkhead and interior panelling and remains of seats, as well as some personal belongings, which were completely deteriorated.

1.2. Injuries to persons

Injuries	Crew	Passengers	Total in the aircraft	Others
Fatal	2	8	10	
Serious				
Minor				Not applicable
None				Not applicable
TOTAL	2	8	10	

1.3. Damage to aircraft

The aircraft was completely destroyed in the accident and the wreckage sank in the sea.

1.4. Other damage

None.

1.5. Personnel information

1.5.1. Pilot in command

Age/Sex: 33 years/Male
Nationality: Spanish
License: Commercial pilot
Date of Issue: 15-11-1995

Renewal date: 19-03-2001

Ratings: — SA-226-AT/TC/227 aircraft (validity: 20-02-2002)
— Instrument rating, aeroplane (validity: 20-02-2002)
— SA-226/AT/TC/227 aircraft flying instructor (validity: 16-03-2004)

Last medical examination: 26-01-2001

Next medical examination: 26-01-2002

Flying hours: — Last 48 h: 2:50 h
— Last 40 days: 59 h (1-09-2001 to 9-10-2001)
— Last 100 days: 145:20 h (1-09-2001 to 9-10-2001)
— Total: Not available

1.5.2. *Co-pilot*

Age/Sex: 43 years/Male

Nacionality: Spanish

License: Commercial pilot

Date of Issue: 16-03-1995

Renewal date: 30-10-2001

Ratings: — SA-226-AT/TC/227 aircraft (validity: 20-12-2001)
— Instrument rating, aeroplane (validity: 20-12-2001)

Flying hours: — Last 48 h: 2:50 h
— Last 40 days: 70:15 h (1-09-2001 to 9-10-2001)
— Last 100 days: 109:55 h (1-09-2001 to 9-10-2001)
— Total: Not available

1.6. Aircraft information

The aircraft model SA-226-AT «Merlin IV», which was developed shortly after the merger of Swearingen and Fairchild Aircraft Corp., was an adaptation of the generic «Metro» model for the transport of 19 passengers, considered by the company to be the ideal number for its use as an executive and «commuter» aircraft. This is the reason why the model is sometimes referred to as «Metro II» or «SW II».

The «Metro» concept was applied to a series of models which have been in production for more than 35 years, with a total of more than one thousand aircraft delivered. This concept has become one of the most well-known and widely used in the «up to 20 passengers» segment.

In particular, this model is a low wing, retractable undercarriage, circular fuselage, pressurized metal aeroplane, propelled by two Garrett TPE 331 turbopropeller engines with Hartzell TCB 3TN three-blade propellers. Its main characteristics are:

— Wingspan:	12.57 m
— Length:	18.08 m
— Height:	5.07 m
— Wing surface:	28.7 m ²
— Maximum operating speed:	248 kt
— Fuel capacity:	648 US gallons (2,452.7 litres) useable
— Ceiling:	31,000 ft
— Passenger capacity:	19 (max.)

The FAA aircraft type certificate for the original SA-226-AT model is dated 27-09-1970; subsequently, it has been updated in different editions to include new engine-propeller unit variations and other changes.

1.6.1. *Aircraft identification*

Make:	Fairchild Aircraft Corp.
Model:	SA-226-AT
Serial number:	AT-043
Year of manufacture:	1976
Registration:	EC-GDV
MTOW:	12,499 lb (5,670 kg)
Operator:	Flightline

1.6.2. *Airworthiness certificate*

Number:	3874
Class:	Normal
Use:	Public Passenger Transport Public Cargo Transport
Technical performance:	Normal. Ideal aircraft for flying in any environmental conditions
Date issued:	07-11-1995
Renewal date:	11-12-2000
Expiry date:	10-12-2001

1.6.3. *Maintenance log*

Total flight hours: 11,950 h

The aircraft's maintenance log for the two months prior to the accident has been analyzed. From this, the following deductions can be made:

1. Control of the limited life parts or scheduled inspection elements shows that they were all within the life limits or the authorized period.
2. During these two months, the aircraft made a total of 101 flights in 149 hours, 50 minutes. The last recorded flight was made on the same day as the accident, 10 October 2001, with a duration of 1 hour 15 minutes and completed the cycle (flight) no. 13723. The crew, which was different to that of the accident, did not record any anomalies in the aircraft's Logbook.
3. During the two months in question, two service checks were carried out, as defined in the «Phase Inspection Manual», on 18 September and 7 October, with satisfactory results.
4. Abnormalities recorded in the aircraft's Logbook in the period in question were: change of batteries (14 August), change of nose wheels (1 September) and of the main undercarriage (29 September), correction of a hydraulic leak and corresponding system correction and bleeding (4 September) and replacement, due to a fault, of a COM/VHF transceiver (27 September).

1.6.4. *Engines*

Make:	Airesearch Garrett Corp.	
Model:	TPE-331-10UA-511G (P/N: 3103230-1)	
Power:	1,100 SHP	
Serial number:	No. 1: P-54048	No. 2: P-54307
Total hours:	No. 1: 16941	No. 2: 13045
Date of last general inspection:	No. 1: 01-04-1998	No. 2: 05-04-1995
Hours since last general inspection:	No. 1: 1443	No. 2: 4424
Potential up to general inspection:	No. 1: 5557	No. 2: 2576

1.6.5. *Propellers*

Make:	Hartzel
Model:	HC-B3TN-5M

Serial number:	No. 1: BV4562	No. 2: BUA20351
Date of last general inspection:	No. 1: 15-09-2000	No. 2: 05-02-1999
Hours since last general inspection:	No. 1: 906	No. 2: 1896
Potential up to general inspection:	No. 1: 2094	No. 2: 1104

1.6.6. *Aircraft station*

As appears in the Aircraft Station License, issued on 3 November 1995 and with the same validity periods as the Airworthiness Certificate, the aircraft was equipped with the radioelectric units as detailed below:

- Two COLLINS VHF 20B communications equipment.
- Two COLLINS 30A navigating equipment.
- Two COLLINS 51YZA ADF.
- One COLLINS DME 40.
- Two COLLINS TDR 90 transponders.
- One R.C.A. AVQ 21 radar.
- One COLLINS ALT 50A radioaltimeter.
- One NARCO ELT 10 emergency locator transmitter.

It should be noted that the R.C.A. AVQ 21 radar is a high-power, monochromatic display model.

1.7. **Meteorological information**

Forecast low-level significant weather maps corresponding to 08:00 and 14:00 h on the day of the accident, supplied by the official meteorological services and the METAR data of the airports of Barcelona, Reus, Palma de Mallorca, Valencia and Alicante, between 09:00 and 12:30 h, show meteorological conditions in the area which correspond to the existence of a storm of the type known as a «cold front». These storms are typical for this area of the Mediterranean at this time of year and are characterized by a frontal region which is colder than the periphery at any level, no associated fronts and a reduction in temperature from the outside in. They usually bring rain, turbulence and localized heavy storms, at times accompanied by large lightning displays.

According to the forecast low-level significant weather map corresponding to 08:00 h, the forecasts in the area of the accident were of showers and storms, which in some

localized areas could be very heavy, with the consequent loss of visibility and, in general, turbulence and moderate icing above level 140.

The aerodrome forecast (TAF) corresponding to the Valencia Airport for the period between 10:00 and 19:00 h forecast the likelihood of storms with rainfall, cumulonimbus clouds with their base at 2,000 ft and a visibility of 1,000 m.

Similarly, a significant meteorological forecast (SIGMET) had been issued for the Barcelona FIR/UIR, valid between 06:30 and 12:30 h, which forecast isolated contained cumulonimbus clouds with their tops at flying level 330.

Cloud reflectivity images taken by the Barcelona and Valencia radars at 10:10 and 10:30 h (08:10 and 08:30 UTC) can be seen in Appendix B. Moderate to strong storm activity, in accordance with the forecasts, is observed in the area where the accident occurred.

1.8. Aids to navigation

The aircraft was certified for IFR flights and, consequently, was equipped with the required navigation installation.

Ground installations functioned correctly throughout the flight.

Radar information from the Secondary Surveillance Radar (SSR) and recorded in the Valencia TACC is available. There is no record of the aircraft being within Primary Radar coverage nor have any records of this flight been found in the corresponding system.

According to the available radar track of the flight, which used number FTL 101, the aircraft, identified by code 5360, assigned to its transponder, in general followed the route set out in its Flight Plan, although instead of being in airway B-28 at the moment of the accident it was flying over the neighbouring area LED21.

Radar track data in the minutes immediately prior to the accident are summarised in the adjacent table. From this data it can be deduced that the flight progressed normally until 10:41:59 h, at least according to the presented data, and in the following contact the data reading corresponding to flight FTL 101 disappeared completely.

Similarly, the display on the controllers' screens also disappeared. Figure A-2 (Appendix A) gives a representation of these screens at the two moments indicated, 10:41:59 and 10:42:01.

The disappearance of the display on the radar screen is subsequent to the last radio contact, at 10:38:17 h, by 3 minutes, 42 seconds.

Local time (UTC + 2)	Radar data	
	Level	Speed
10:39:00	131↑	210
10:40:00	133↑	210
10:40:30	130↓	200
10:41:00	127↓	230
10:41:30	129	230
10:41:45	129	220
10:41:55	129	220
10:41:59	129	220
10:42:01	—	—

After that no further contact could be made with the aircraft, either by radio or radar.

According to the data obtained by the radar and marked directly on one of the available on-screen displays, the aircraft's position, at 10:41:59 h, was 40° 10' 34" N/ 1° 10' 24" E (azimuth 62°, distance 81.8 NM from the Valencia antenna).

1.9. Communications

As indicated in the previous section, the aircraft was equipped with the communications equipment required for carrying out flights under IFR rules, meaning that it had a double communications system.

There is no news nor are there any findings of a fault either in the aircraft's communications system or in the control centres with which it made contact during the flight up until the moment communications were lost. Nor were any emergency calls made from the aircraft.

According to the available records of the communications with the different control centres en route, the aircraft took off from runway 20 of Barcelona Airport at 10:18:20 h (the said airport's Control Tower), was authorized, at its request, to maintain level FL 130 and, shortly afterwards (10:23:56 h), to make a direct flight to Valencia (Barcelona Area Control, South Sector) and was transferred to the Lerida Sector (10:28:57 h) which, in turn, at 10:34:07, transferred it to Valencia, which confirmed radar contact with the aircraft (10:35:58 h).

Five seconds later, at 10:36:03 h, the flight crew ask again to the Valencia TACC Control if it is possible to proceed directly to any of the MAGAL or HAMRA points, which

they had already requested from the Lerida Sector of Barcelona Area Control, without confirmation, and shortly afterwards (10:38:08 h), on not receiving authorization, the crew ask if they can «turn 20° to the left to avoid» (from the context, it is assumed clouds). Control authorizes this change, indicating that they must «go back towards Valencia as soon as it is free from clouds».

The «roger» to this authorization, at 10:38:17 h, is the last communication received from the aircraft, which then did not respond to the repeated calls made directly from this and other controls en route or using other aircraft flying in the vicinity as relays. One of the controllers has indicated that he thought he heard the word «water» in a message which could have come from this aircraft and which was muffled by a simultaneous message from another aircraft, but it has not been possible to confirm this.

1.10. Aerodrome information

Not applicable.

1.11. Flight recorders

The aircraft was not equipped with either cockpit voice recorder or flight data recorder, as these are not required for aircraft of its type owing to the fact that it has a certified maximum take-off weight of 12,499 lb (5,669.5 kg).

These recorders are not compulsory for this type of aircraft, for either the ICAO in its Annex 6 or for the JAR-OPS operational requirements, paragraphs 1,700 and onwards (cockpit voice recorder) and 1,715 and onwards (flight data recorder).

1.12. Wreckage and impact information

The first pieces of wreckage were located and recovered by the Official Search and Rescue Services on the morning of 12 October during the operation which began after the DETRESFA declaration, officially made at 11:30 h on the same day as the accident, although in reality it was made earlier by telephone at 10:45 h.

This wreckage was located and recovered two days after the accident at the co-ordinates 39° 59' 6" N/0° 32' 5" E, floating on the sea, and consisted mainly of various pieces of the interior panelling, metal plate, one including an electric light full of water, a cable, a very deteriorated briefcase or document bag and the remains of a seat.

Other wreckage has been picked up by fishing boats operating in the area at later dates. The distance between this wreckage and the other wreckage found earlier

was less than 20 km and is considered irrelevant and caused by waves and marine currents.

The largest findings were made by three fishing boats on the date and in the area indicated below (the co-ordinates indicated correspond to the mean points of trawling carried out by the fishing boats):

- 26-10-2001: 40° 13' 13" N/00° 59' 45" E
- 31-10-2001: 40° 8' 32" N/1° 8' 4" E
- 07-11-2001: 40° 12' 10" N/1° 2' 19" E

The position of these findings is represented in Figure A-3 (Appendix A), which also includes the positions of the wreckage recovered in the search and rescue operations, the co-ordinates of the centre of the largest concentration of located wreckage and the limits of the area covered during the submarine search described below (section 1.16 of this report).

Virtually no major aircraft components have been recovered, the largest and most relevant pieces being the almost complete vertical tail fin (Figure C-1), a large piece of the rudder bar, part of the left aileron (Figure C-2), door and window wreckage (Figure C-3), control column wreckage (Figure C-4) and the wreckage of several seats. Amongst these are those of the pilots (Figures C-5 and C-6) which, as can be seen in the figure, appear with the guide bent upwards in the middle and the vertical backrest forced backwards, indicating the direction of the impact with the sea. The control columns and the recovered piece of vertical tail fin are also bent in the same direction.

With the exception of those indicated, most of the items of wreckage recovered by the fishing boats are not very large pieces of metal plate and some aircraft equipment which is not relevant, in addition to some personal belongings, lifesaving jackets and flight document bag, all very deteriorated.

Apart from the indication of the backward direction of the deformation of the cabin elements and vertical tail fin, the most interesting aspect of these findings is that they were all made within an area which spanned 6 to 7 km in diameter.

In principle, this would demonstrate that the aircraft did not disintegrate, at least not entirely, at a great height above sea level.

1.13. Medical and pathological information

Not available. As already indicated, the aircraft sank in the Mediterranean Sea and the remains of the occupants could not be recovered, except for organic evidence on some of the recovered objects.

1.14. Fire

There is no evidence of the presence of fire in the recovered aircraft wreckage. Consequently, it is considered that there was no fire in the aircraft during the accident.

1.15. Survival aspects

Given the accident's characteristics, its occurrence during stormy weather with turbulence, the size, type and state of the wreckage and the sinking of the aircraft in the sea before its location, it can be considered that the occupants' chances of survival were extremely limited.

The actual situation is that no identifiable remains of any of the occupants were found either during the search and rescue operations, or in the submarine investigations carried out or during the «trawling» of nets by fishing boats.

1.16. Tests and research

The aircraft wreckage was found during the rescue operations carried out by the Search and Rescue Service on the days following the accident, from 10 to 13 October, by chance as a result of being caught up in the tackle of some fishing boats in the area between 26 and 31 October and on 7 November, and through a submarine search operation carried out by a specialized company between 19 and 30 November 2001, the results of which the investigation has had access to.

For the submarine location activities a catamaran was used, which was equipped with side scan sonar, the transducer of which was towed behind at a distance of some 30-75 m, so as to avoid interference from the catamaran itself, and a remotely operated vehicle (ROV), also towable and with depth control from the catamaran, equipped with two closed-circuit TV cameras for observing the sea bed. The TV circuit monitors were on board the catamaran where recording equipment was also available for storing images for subsequent analysis. The vehicle also carried two fixed 100 W and two mobile 75 W floodlights for lighting up the sea bed.

The side scan sonar was supplemented with a differential GPS system and a computer processing unit (CPU) in order to calculate the catamaran's position and path as well as the position and shadow in the scanning of detected objects so as to be able to establish their dimensions. The system has an accuracy of 1 to 3 m and can operate up to a depth of 500 m.

The remotely operated vehicle (ROV) was used when the sonar picked up the largest echos, which could be aircraft wreckage, in order to inspect them using the closed-circuit TV.

During the eleven days that this operation lasted, from 19 to 30 November as indicated above, a total of nine expeditions were made of which, due to bad weather, seven were full days of searching and the other two only partial. The scanned area was between the co-ordinates 40° 8' 52" N and 40° 13' 10" N latitude and 1° 1' 36" E and 1° 5' E longitude, covering approximately 27 km² at a 100 m sonar range and 0.34 km² at a 50 m range. The latter allows greater signal amplification and was used especially in the areas where the fishing boats had already found wreckage.

Due to this operation, aircraft wreckage was located but no remains of the occupants were found.

The final report on the work carried out indicates that:

- More than one hundred pieces of wreckage were inspected, generally of a small size, the largest of which being 3 m long and 1 m wide;
- Amongst the wreckage, an engine, part of the undercarriage, a seat, safety belts, books, cases, remains of bunches of cables, etc. were identified;
- The wreckage was located at a depth of between 90 and 100 m, scattered in an area, with the largest concentration corresponding to a 1,800 m² circle, centred at an approximate geographical situation of 40° 12' 20" N and 1° 3' 25" E (Fig. A-3).

The report concludes that «the impression drawn from the inspection of these findings, based on their size, composition and dispersion, is that the aircraft practically disintegrated, almost certainly on impact with the sea».

In addition, the available information indicates that the area in which the wreckage was located is very close to the edge of a platform beyond which the sea's depth increases considerably. It is considered possible that marine currents have moved all the pieces of wreckage larger than those found to this area, and for that reason they have not been found.

The Figures in Appendix C include a view of some of the most relevant wreckage located during this search.

1.17. Organizational and management information

Not relevant for this accident investigation.

1.18. Additional information

In the investigation made into other accidents involving aircraft of the «Metro» and «Merlin» generic types, manufactured either by Fairchild or Swearingen, the history of

one has been found, which occurred to an SA-227-AC «Metro III» aircraft on 8 February 1988, during a flight from Hannover to Dusseldorf in Germany.

According to the accident report issued by the German Accident Investigation Office (FUS), during the initial approach to the destination airport in the middle of a storm, there was a complete failure of the electrical system, the aircraft then went into an uncontrolled descent and, after two minutes flying in the storm, it disintegrated in the air. The conclusions establish that the electrical failure, caused by the impact of a lightning strike, had significantly contributed to the accident on producing, in instrumental landing conditions, loss of cabin lighting and instruments and making it impossible to activate the flaps and the elevator trim.

The investigation of this accident gave rise to a Safety Recommendation, as a result of which the U.S. FAA issued Airworthiness Directive AD 90-03-19R1, applicable, amongst others, to Model SA-226-AT (serial numbers AT001 to AT074), to avoid the unnoticed disconnection of the battery bar connector, which could produce a non-recoverable loss of electric energy in the aircraft. Basically, the Directive establishes that the diode between the terminals of the battery bar contactor should be disassembled within 100 h of TIS (Time in Service) as from its effectivity date, 15 August 1990.

Despite the above and subsequently, in Information V 98 of November 1991, the FUS informed about a new complete electric energy supply failure after a lightning strike to a model SA-227 «Metro III» during a climb from FL 140 in IFR conditions. According to this information, in this case the problem could be solved, restoring the energy supply through a good working co-ordination in the cockpit and strict observance of the procedure in the case of «Total Electrical Failure», particularly regarding the order in which the switches are activated, as included amongst the emergency procedures in the Flight Manual.

In this information, the FUS indicates that, given the electricity supply system's construction characteristics, the danger of a total electrical failure as a result of a lightning impact continues to exist in models SA-226-AT, SA226-TC and other versions, including SA-227-AC, «Metro III». Recommendations are included for pilots who operate this type of aircraft in the sense that they know and familiarise themselves with the procedure for this situation, included amongst the «Emergency Procedures» in the aircraft's Flight Manual, carrying out periodically the necessary tests on a simulator or in aircraft training.

1.19. Useful or effective investigation techniques

As indicated in section 1.16 «Tests and research», access to special submarine search techniques has been available during this accident investigation.

2. ANALYSIS

2.1. Progress of the flight

The information that is known on the flight's progress is basically contained in section 1.1 of this report.

The aircraft was hired to carry out a non-scheduled passenger transport flight from Barcelona to Oran in Algeria, on 10 October 2001, the day of the accident. The aircraft was a SA-226-AT «Merlin IV», widely known as «Metro II» or «SW2», in reference to the company Swearingen, which subsequently merged with Fairchild, the official manufacturer.

Given the meteorological conditions of the area to be flown over, the flight was planned, as indicated in the Flight Plan, as IFR, with departure at 10:00 h, an estimated duration of two hours, a speed of 220 kt, level FL 190 and with the route indicated in section 1.1. The flight code number was FTL 101.

The aircraft, with two crew and eight passengers on board and an endurance of 3 hours, 30 minutes, took off from Barcelona Airport at 10:18:20 h.

The flight proceeded normally, without news or signs of any failure until the last radio communication at 10:38:17 h. In this communication the aircraft confirmed reception (responding with the Spanish word «recibido» or «roger») of the authorization from control to turn 20° to the left on the condition of flying again in the direction of Valencia as soon as it was free of clouds.

The last display on the civil controllers' radar screen was recorded 3 minutes and 42 seconds after the last radio communication, at 10:41:59 h. At that moment and according to the radar data the aircraft's position was 40° 10' 34" N/1° 10' 24" E.

According to the reconstruction made using the radar tracking data (see Figure A-1, Appendix A), at that moment the aircraft was approximately at a distance of 22 NM from airway B-28 and had already turned the authorized 20° to the left.

After the contacts indicated, no further contact was possible, not even using other aircraft flying in the vicinity as relays. Consequently, the phase of emergency was declared and the search and rescue services were activated.

In spite of the aerial and marine teams involved in the consequent operations, no aircraft wreckage was recovered until two days after the accident. No remains of the aircraft's occupants were ever found. Later on other items of wreckage were recovered in the nets of fishing boats working in the area. Of all of them, the most explanatory were the pieces of vertical tail fin, rudder bar and right aileron as well as the pilots' seats,

which were bent backwards, although they did not allow the causes of the accident to be established. With the idea of being able to establish these causes, it was decided to organize the submarine search described in section 1.16 of this report.

This operation resulted in the location of more than one hundred objects, including an engine, part of the undercarriage and seat wreckage, but the majority of them were pieces of plating and metal parts as well as some highly deteriorated personal belongings. This wreckage was located, for the most part, concentrated in a small area of 1,800 m² at a depth of between 90 and 100 m, on the edge of a platform beyond which the depth becomes considerably deeper.

None of the aircraft's larger components, such as wings, fuselage, etc. or relevant pieces which could have allowed the causes of the accident to be accurately established have been located or recovered. It is assumed that the reason for this is that they have been dragged beyond the platform's edge.

2.2. Accident considerations

2.2.1. *Process of the accident*

In order to analyze the accident, the three last stages which led up to it will be considered:

1st Stage. From the last radio contact to the loss of radar display

The last radio contact occurs at 10:38:17 h when the aircraft confirms «roger» to the ATC authorization to turn 20° to the left, and the loss of radar display happens at 10:41:59 h, 3 minutes, 42 seconds later. During this interval, and as can be seen in the reconstruction of the radar route in Figures A-1 and A-2a, the aircraft carries out this manoeuvre and continues flying in the new direction.

It is considered that no emergencies occurred during this interval and that the aircraft simply did not need to make new contact with control, given the fact that it did not carry out any warning manoeuvres and the aircraft's communications system, equipped with double transceiver, is considered to be safe, with a complete failure being very improbable and, consequently, it should have continued to be operational.

2nd Stage. Loss of display on the controllers' screen

As can be seen in Figures A-2a and 2b (Appendix A), this loss occurred suddenly between 10:41:59 and 10:42:01 h, an interval of less than two seconds, at the position 40° 10' 34" N/1° 10' 24" E.

Except in the event of ground equipment failure, which did not occur, such a sudden loss of contact in the civil air traffic controllers' radar screen display can only be due either to the aircraft's disappearance, caused for example by an explosion, or to a total electric energy supply failure in the aircraft. In this case, the transponder signal disappears and, consequently, identification and the display on the civil air traffic controllers' screen is lost.

Of course, the loss of electric energy supply would give rise to the loss of the aircraft's communications.

3rd Stage. Location and analysis of wreckage

Figure A-3 indicates the position of the aircraft wreckage, of both that recovered and that located during the submarine search carried out. The geographical positions indicated for the recovered wreckage correspond to the fishing boat's mean trawling points on the day of recovery.

As can be seen, the wreckage was found in a very localized area, the majority of it being concentrated within an 1,800 m² circle, with its centre at the position 40° 12' 20" N/1° 3' 25" E, and at a depth of between 90 and 100 m. The exception of wreckage recovered on the surface at a greater distance is considered due to waves and marine currents, given that the wreckage found floating on the sea was light-weight (panel and seat wreckage).

2.2.2. Use of radar

The aircraft was equipped with high-power radar with monochromatic display, capable of detecting and displaying clouds and the meteorological phenomena associated with them.

The aircraft's maintenance records and flight logs corresponding to the two months prior to the date of the accident show no squawk or maintenance relating to anomalies in the radar, for which reason it is considered that the radar was in a condition to be efficiently used by the crew.

In fact, the crew requested authorization from the Valencia TACC to turn 20° to the left so as to avoid the clouds they were encountering. Taking into account the fact that in the cloud reflectivity images (Appendix B) it can be seen that towards the East of the aircraft's flight path the storm activity was lessening and there were clear patches of sky, it is possible that this change of route was requested based on the information displayed by the radar.

Nevertheless, it should be taken into account that although this type of equipment constitutes a good aid for the crew when flying in IMC, it cannot itself prevent an aircraft

from entering an area in which these meteorological conditions can pose a risk for the aircraft and/or its occupants.

2.2.3. *Establishment of the most probable cause*

The concentration of the located wreckage rules out the hypothesis of the aircraft exploding at a great height; its flight level at the moment of the loss of the on-screen display was FL129, and coincides with the conclusions of the submarine search report, which states that «the aircraft disintegrated, with almost complete certainty, on impact with the sea».

This circumstance leaves as the most probable hypothesis, and as the only possible explanation, that the aircraft, which was flying in the middle of a storm with turbulence and lightning, totally lost its electrical energy supply, possibly after being struck by lightning which produced, at least, this effect. As indicated in section 1.18, this effect had already occurred and been reported on in at least two previous cases. Only in the second of these was the aircraft saved and, as was reported, this was due to the crew's discipline and to following precisely the procedure included in the Flight Manual, particularly as regards the order of activation of the required automatic switches.

It has not been possible to accurately ascertain what happened in the aircraft after the possible lightning strike but it is considered that, even if there was no structural damage, the electricity supply failure and the impossibility of restoring it could have directly produced the loss of electric circuits, such as cabin lighting and instruments, navigation, control of the elevator trim, windscreen wipers and the anti-icing system of the control surfaces and propellers and that, particularly in view of the fact that the aircraft was flying in the middle of a storm with reduced visibility, strong turbulence and a considerable display of lightning, it indirectly produced an increase in workload in the cockpit and the possible spatial disorientation of the crew. All of this must have significantly contributed to the aircraft's fall.

This fall, as can also be seen in Figure A.3, must have occurred with a turn to the right, given the marked difference in length between the position of the point at which the radar display was lost and the positions of the located or recovered wreckage. This turn can only be explained by the existence of another failure caused by the aircraft being struck by lightning, but without ruling out the possibility of it being structural or because the aircraft reached undetermined pitch or roll angles that made it uncontrollable, due to the turbulence and lack of visibility already referred to and also to the crew's possible disorientation.

The backward bending, both of the part of the recovered vertical tail fin and the pilots' seats, indicates that the impact of the fuselage with the sea's surface must have occurred in an almost inverted flying position or at a very large pitch angle.

As regards the horizontal surfaces, wing and horizontal stabilizer with their associated elements, only the tip of the left aileron, one of the engines and a propeller blade were recovered or identified on the sea bed. Consequently, although it can be ascertained that part of them did not come off the aircraft until its impact with the water's surface or at a height just above it, it has not been possible to establish whether or not another part of them came off at a greater height, thereby substantially contributing to the impossibility of the crew to control the aircraft.

3. CONCLUSION

3.1. Findings

- The crew was in possession of the corresponding valid license and ratings corresponding to the aircraft used and the type of flight being carried out.
- The aircraft possessed the corresponding Airworthiness Certificate, valid on the date of the accident, it was being operated within the authorized limits and it had also satisfactorily passed the inspections indicated in its Maintenance Programme within their validity periods.
- The flight was being carried out under IFR rules and within a controlled air space.
- The meteorological conditions in the area indicated a storm of the type that is typical in the area at the beginning of autumn. In particular, in the accident, the aircraft was in the middle of an electrical storm with very heavy rainfall, given that the crew requested authorization to turn to the left.
- After having completed this turn, the sudden disappearance of the radar screen display between 10:41:59 and 10:42:01 h and the impossibility of recovering radio contact afterwards led to the consideration that the aircraft suffered, at least, total loss of electricity supply possibly caused by a lightning strike.
- The electricity supply was not restored and, consequently, failures occurred in the electrically-powered systems. These failures, together with other possible failures, which may have been caused by the impact of lightning but which it has not been possible to establish from the recovered wreckage, were considerably aggravated by the meteorological conditions with an electric storm, heavy rainfall, turbulence and reduced visibility in which the aircraft was flying and which resulted in its impact with the sea.

3.2. Causes

Although it has not been possible to establish the causes of the accident, taking into account the circumstances in which it occurred and the record of similar events in aircraft of the same type, it is considered that the probable cause of the accident was a total loss of electric supply, caused by a lightning strike in the middle of the storm in which the aircraft was flying, without the crew being able to restore it.

It is possible that the lightning strike produced other damage to the aircraft and/or led to or produced failures of its systems. This combination of circumstances, aggravated by the storm with heavy rainfall and turbulence and the associated lack of visibility, led to the aircraft's impact with the sea.

4. SAFETY RECOMMENDATIONS

None.

APPENDICES

APPENDIX A
Aircraft path and position
of wreckage



Figure A-1. Planned and actual flight routes

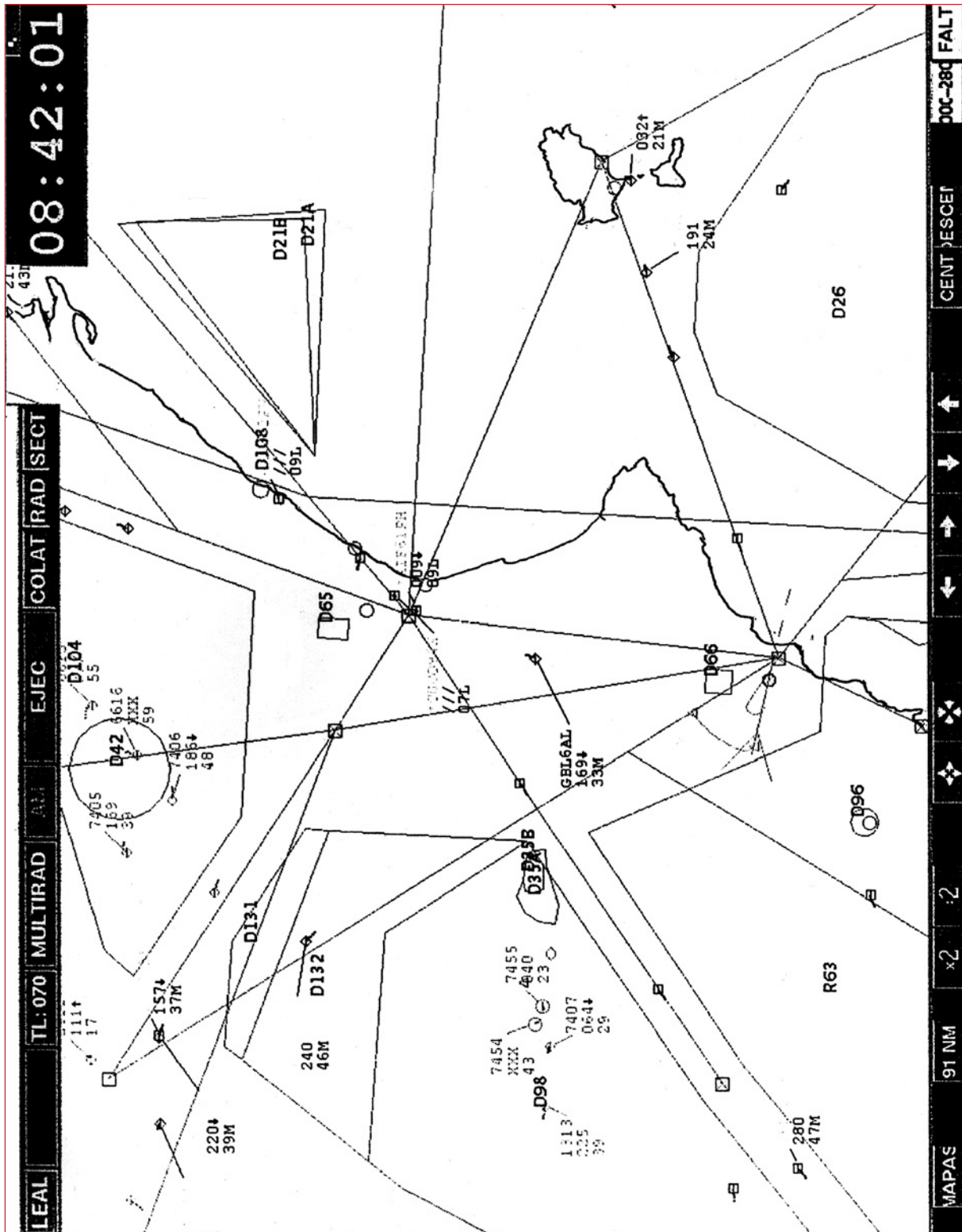


Figure A-2b. Display on radar screen at 08:42:01

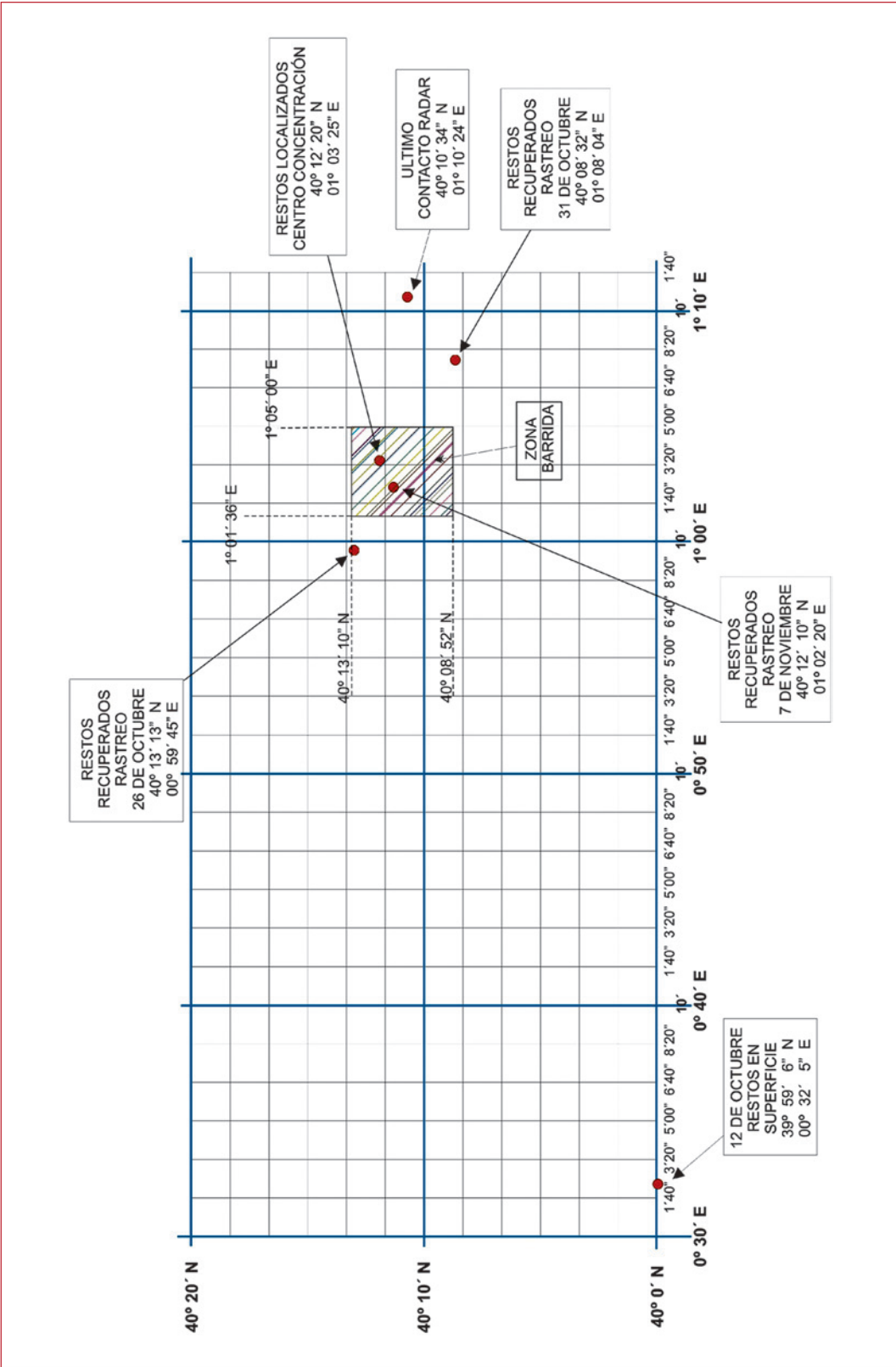


Figure A-3. Geographical positions of wreckage recovered or located on the sea bed

APPENDIX B

Cloud reflectivity images

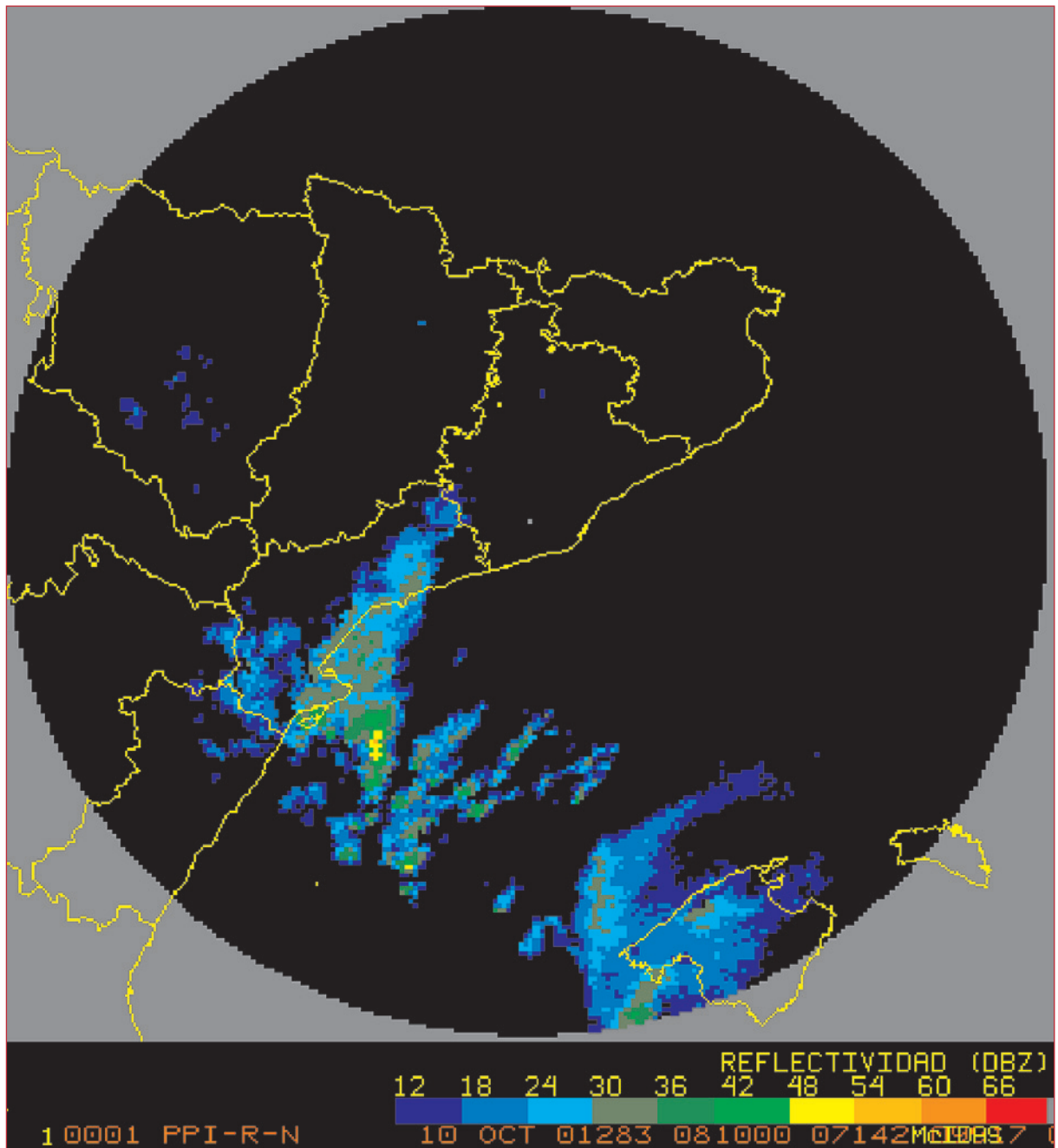


Figure B-1. *Barcelona radar, 10:10 h*

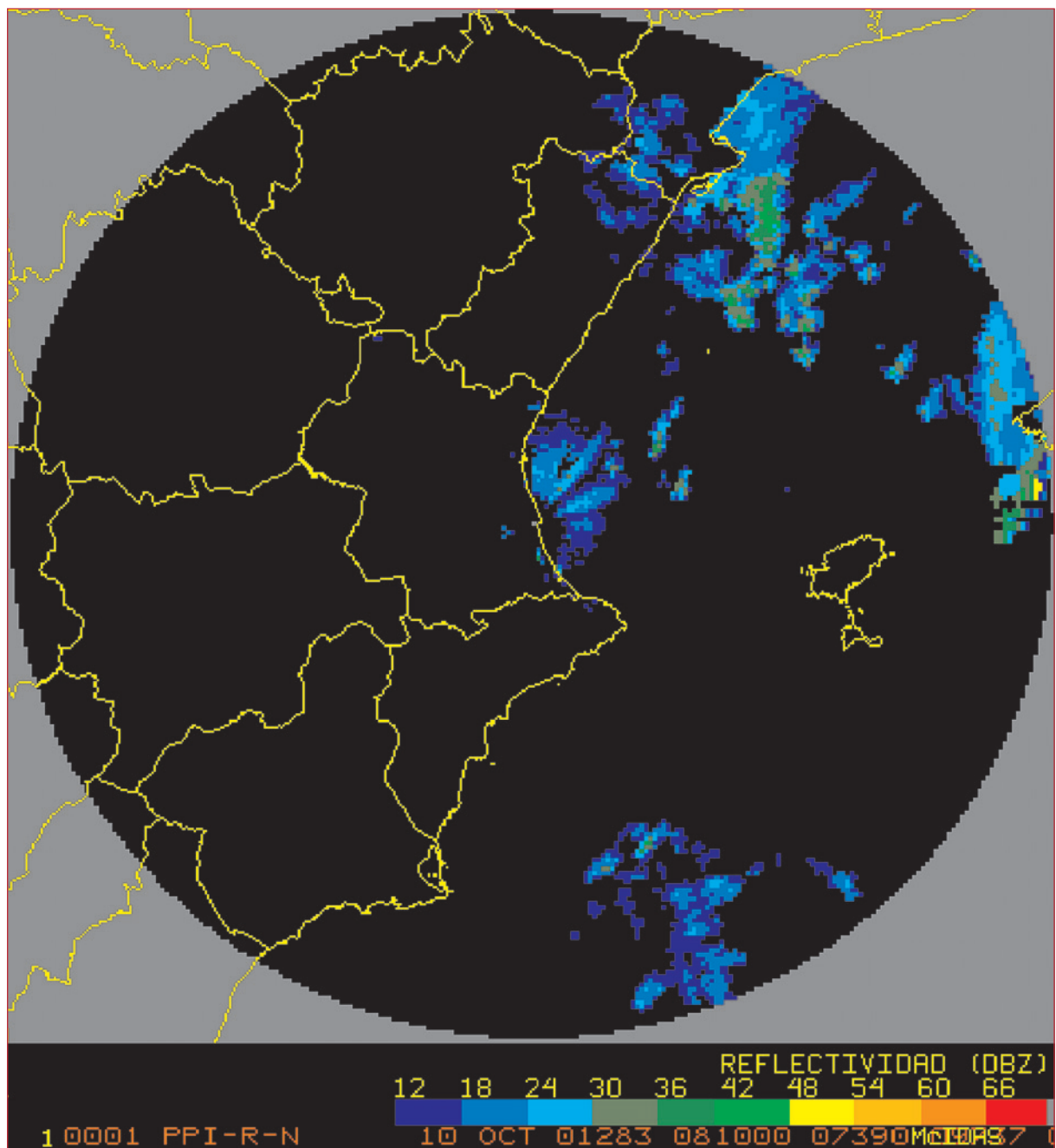


Figure B-2. Valencia radar, 10:10 h

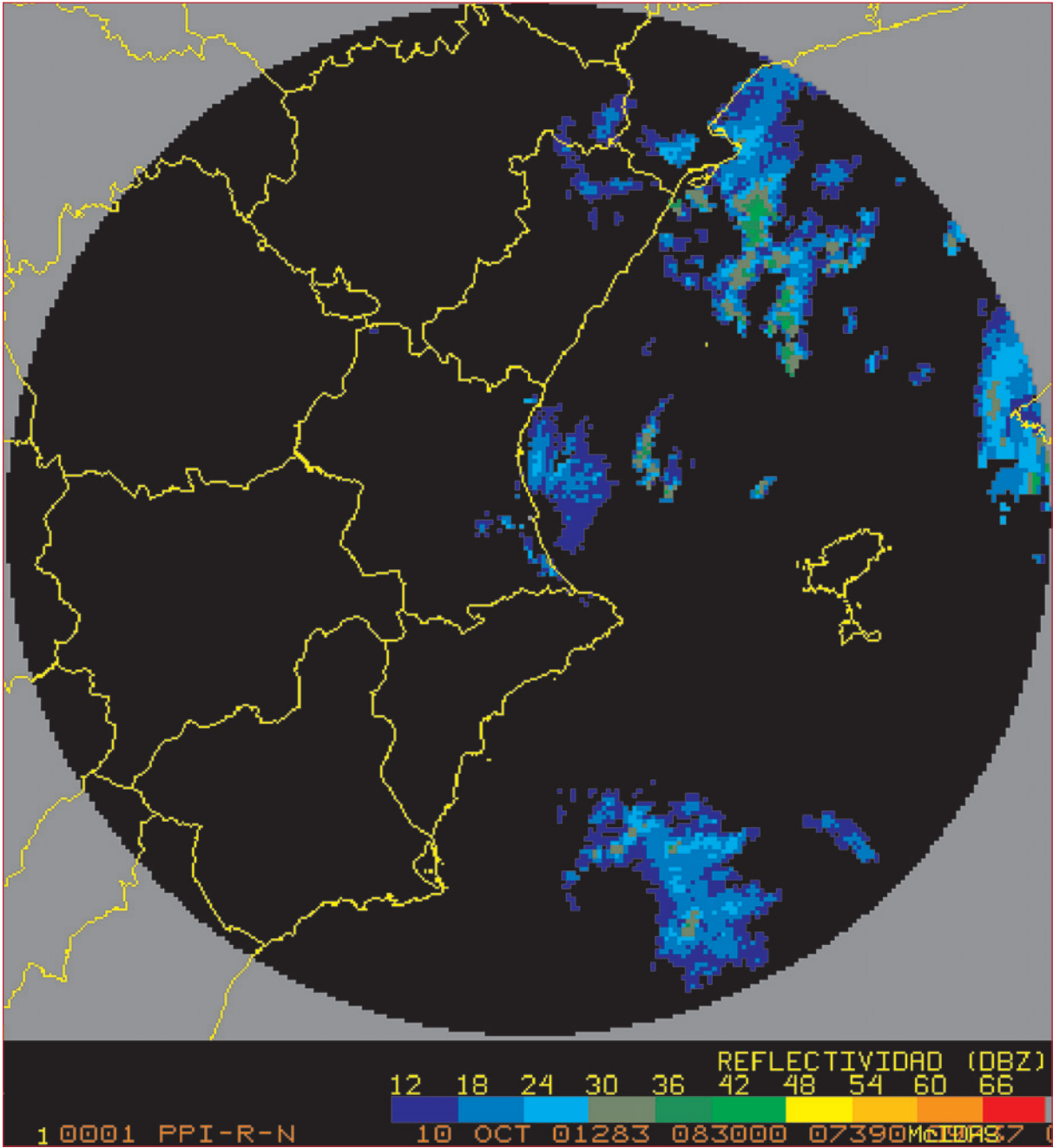


Figure B-4. Valencia radar, 10:30 h

APPENDIX C

Recovered wreckage



Figure C-1. *Vertical fin tail wreckage*



Figure C-2. *Right hand flap*

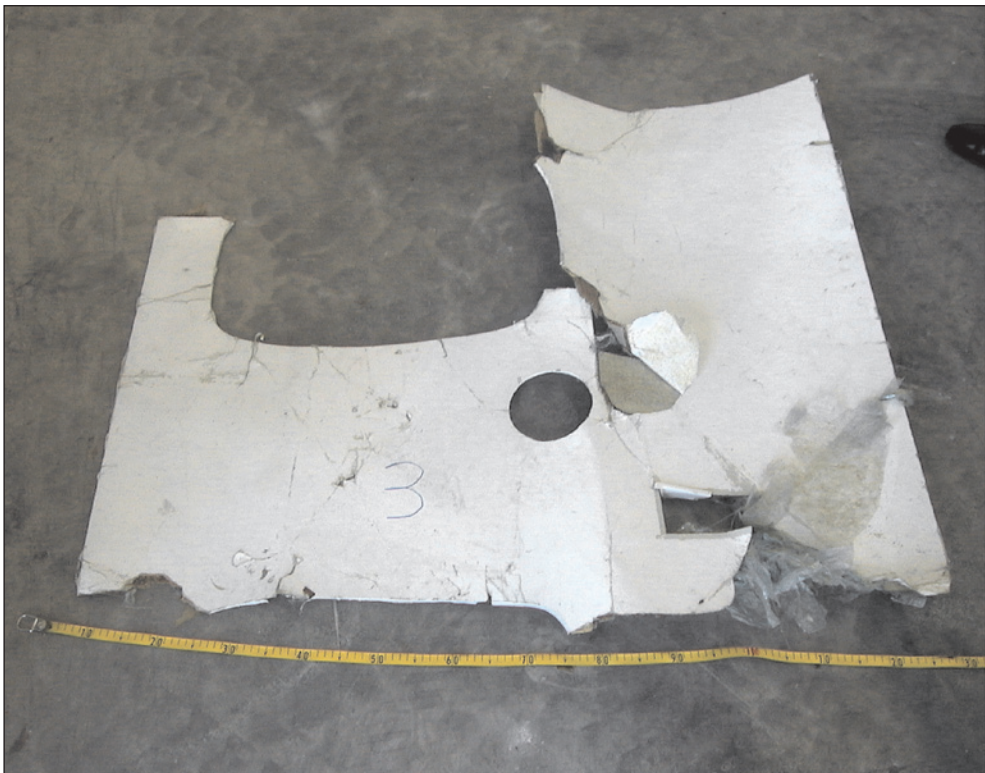


Figure C-3. *Window frame*



Figure C-4. *Control column and rod wreckage*



Figure C-5. *Cockpit seat*



Figure C-6. *Passenger cabin seat*

APPENDIX D

Submarine wreckage located

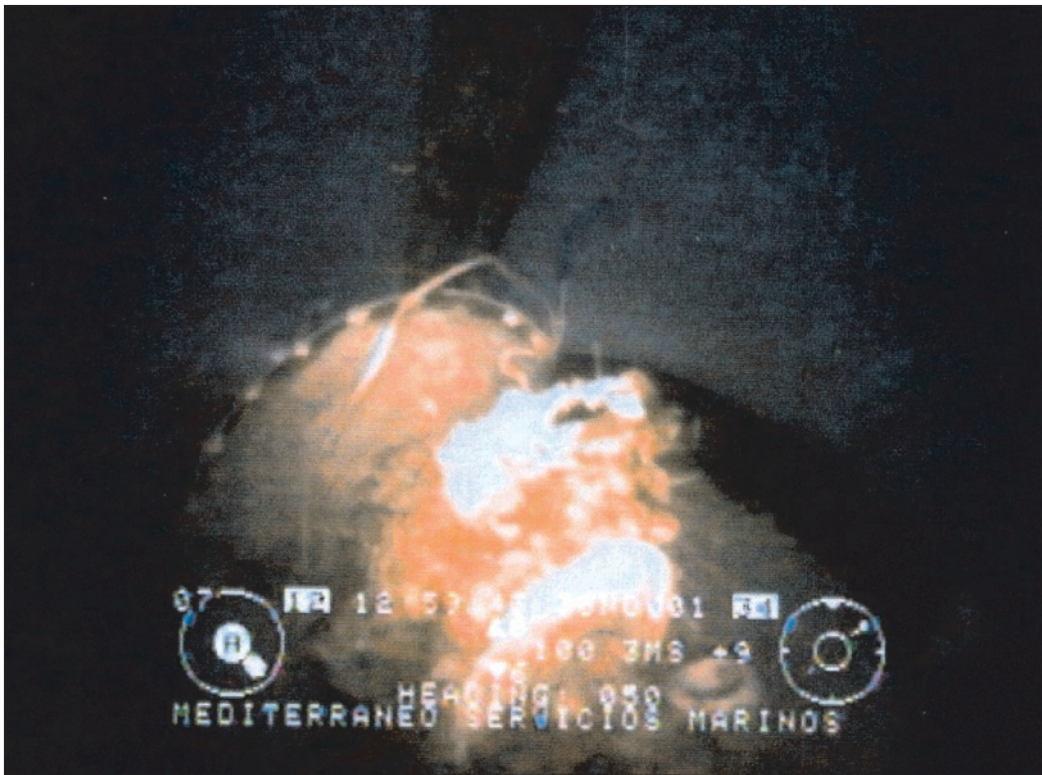


Figure D-1. *Engine wreckage*



Figure D-2. *Propeller blade wreckage*



Figure D-3. Cover



Figure D-4. Seat armrest