Air Accident Investigation Unit Ireland

FORMAL REPORT

ACCIDENT
Fairchild Aircraft Corporation
SA 227-BC Metro III, EC-ITP
Cork Airport, Ireland
10 February 2011

An Roinn Iompair
Turasóireachta agus Spóirt

Department of Transport,
Tourism and Sport

Foreword

This safety investigation is exclusively of a technical nature and the Final Report reflects the determination of the AAIU regarding the circumstances of this occurrence and its probable causes.

In accordance with the provisions of Annex 13[1] of the International Civil Aviation Convention, Regulation (EU) No 996/2010[2] of the European Parliament and the Council, and Statutory Instrument No. 460 of 2009[3], safety investigations are in no case concerned with apportioning blame or liability. They are independent of, separate from and without prejudice to any judicial or administrative proceedings to apportion blame or liability. The sole objective of this safety investigation and Final Report is the prevention of accidents and incidents.

Accordingly, it is inappropriate that AAIU Reports should be used to assign fault or blame or determine liability, since neither the safety investigation nor the reporting process has been undertaken for that purpose.

Extracts from this Report may be published providing that the source is acknowledged, the material is accurately reproduced and that it is not used in a derogatory or misleading context.

[1] **ICAO Annex 13**: International Civil Aviation Organization, Annex 13 to the Convention on International Civil Aviation, Air Accident and Incident Investigation.
[2] **Regulation (EU) No 996/2010** of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation.
[3] **SI 460 of 2009**: Air Navigation (Notification and Investigation of Accidents, Serious Incidents and Incidents) Regulations 2009.

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In accordance with Annex 13 to the Convention on International Civil Aviation, Regulation (EU) No 996/2010 and the provisions of SI 460 of 2009, the Chief Inspector of Air Accidents on 10 February 2011, appointed Mr Leo Murray as the Investigator-in-Charge to carry out an Investigation into this Accident and prepare a Report.

Operator:	Flightline S.L.
Manufacturer:	Fairchild Aircraft Corporation
Model:	SA 227-BC Metro III
Nationality:	Spain
Registration:	EC-ITP
Serial Number:	BC-789B
Location:	Cork Airport (EICK), Co. Cork, Ireland
Date / Time (UTC)[4]	10 February 2011 @ 09.50 hrs

SYNOPSIS

On 10 February 2011, a Fairchild SA 227-BC Metro III registered EC-ITP, was operating a scheduled commercial air transport flight from Belfast City (EGAC) to Cork (EICK) with 2 Flight Crew members and 10 passengers on board. At 09.50 hrs during the third attempt to land at EICK in low visibility conditions, control was lost and the aircraft impacted the runway. The aircraft came to rest inverted in soft ground to the right of the runway surface. Post impact fires occurred in both engine nacelles which were extinguished by the Airport Fire Service (AFS). Six persons, including both pilots, were fatally injured. Four passengers were seriously injured and two received minor injuries.

As a result of this Investigation 11 Safety Recommendations have been made.

[4] **UTC**: Coordinated Universal Time (equivalent to local time between 31 Oct 2010 and 27 March 2011).

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NOTIFICATION

Cork Air Traffic Control (ATC) notified the AAIU at 10.05 hrs. Four Inspectors of Air Accidents deployed to Cork Airport, two by Irish Air Corps helicopter and two by road. A fifth Inspector joined the Investigation later that day. The Investigation was conducted in accordance with the provisions of ICAO Annex 13, Regulation (EU) No 996/2010 and Statutory Instrument SI No. 460 of 2009.

On notification of the accident, the following States appointed Accredited Representatives, Advisors and Experts to the Investigation: The *Comisión de Investigación de Accidéntes e Incidentes de Aviación Civil* (CIAIAC) of Spain, as State of Registry and the Operator; the National Transportation Safety Board (NTSB) and Federal Aviation Administration (FAA) of the United States, as State of Design and Manufacture; the Air Accidents Investigation Branch (AAIB) of the United Kingdom as a State which suffered fatalities and provided expertise; the Ministry of Transport, Aviation Incidents and Accidents Investigation (AIAI) Israel, as State of Type Certificate Holder.

INVESTIGATION TEAM

Ireland:
Leo Murray (Investigator-in-Charge)

Jurgen Whyte (Chief Inspector of Air Accidents), Thomas Moloney (Inspector of Air Accidents-Engineering), Paddy Judge (Inspector of Air Accidents-Operations), Paul Farrell (Inspector of Air Accidents-Engineering), Graham Liddy (Inspector of Air Accidents-Engineering, retired).

Donal Lamont and John Sullivan of the Irish Aviation Authority (IAA) were appointed as Advisers.

Spain:
Juan Antonio Plaza Rubio (Accredited Representative), Arturo Yañez Otero (Adviser), CIAIAC.

United States:
Daniel Bower (Accredited Representative), David Helson and Robert Swaim (Advisers) NTSB; T.R. Proven (Adviser) FAA.

United Kingdom:
Geraint Herbert (Accredited Representative), Andrew Robinson and Chris Scott (Advisers) AAIB.

Israel:
Itzhak Raz (Accredited Representative) AIAI.

European Aviation Safety Agency (EASA):
Bernard Bourdon (Adviser).

PREAMBLE

The aircraft, EC-ITP (**Photo No. 1**) was owned by a Spanish bank and leased to a Spanish undertaking (Linéas Aéreas de Andalucía, trading as Air Lada). As it was the entity with direct control of the aircraft, Air Lada is henceforth referred to as the 'Owner'.

It was subleased to and operated by a different Spanish Company (Flightline S.L.), the holder of an Air Operator Certificate (AOC) henceforth referred to in the Report as the 'Operator'.

The undertaking selling the passenger air transport service was an Isle of Man based company (Manx2), henceforth referred to in the Report as the 'Ticket Seller'.

Maintenance for the aircraft was provided by another Spanish Company (BCP Aerotecnics S.L.), henceforth referred to in the Report as the 'Maintenance Provider'.

Flights operated by EC-ITP and its sister Metro III EC-GPS in the UK, Ireland and the Isle of Man are referred to as the 'Operation'.

The Flight Crew are referred to in the Report as the Commander and the Co-pilot using capitalised terms. References using non-capitalised terms are generic.

Photo No. 1: EC-ITP at Seville Airport on 18 January 2011
(© *Antonio Muñiz Zaragüeta via Airliners.net*)

1. FACTUAL INFORMATION

1.1 History of the Flight

During the night before the accident (9-10 February 2011), EC-ITP operated a night cargo charter, from Belfast Aldergrove (EGAA) to Edinburgh (EGPH), to Inverness (EGPE) and back to EGAA. This was under a night cargo contract between the Owner and Air Charter Service for the UK Royal Mail. The sectors were operated by a different flight crew to the crew involved in the accident. The cargo operation required the removal of passenger seats prior to flight. The aircraft arrived back at EGAA at 05.10 hrs where passenger seats were re-installed by the flight crew who had operated the cargo flight.

The accident Flight Crew, which consisted of the Commander and the Co-pilot, commenced duty at EGAA at 06.15 hrs on the 10 February 2011. The Flight Crew downloaded flight documentation including meteorological information for Belfast City Airport (EGAC), Cork Airport (EICK), and Dublin (EIDW) in a handling agent's briefing office at 06.25 hrs.

The aircraft departed EGAA, as flight number FLT4113[5], at 06.40 hrs on a short positioning flight to EGAC with the Commander as Pilot Flying (PF). The aircraft was empty on this sector. The aircraft arrived on stand at 07.15 hrs, leaving the Flight Crew with a 35 minute turnaround.

A fuel uplift of 800 litres (L) was made, with a total fuel quantity of 3,000 lbs being recorded in the aircraft Technical Log. This fuel load was sufficient for the planned round trip to EICK and back to EGAC with required reserves. The flight plan specified Waterford Airport (EIWF) as the alternate airport for the sector to EICK. No second alternate was nominated on the flight log or on the ATC flight plan which had been filed in the office of a Fixed Based Operator (FBO)[6] in Billund, Denmark, at 03.31 hrs earlier that morning. Boarding of passengers was delayed due to the Flight Crew working on the passenger seats in the cabin. When the Flight Crew completed this task, the ten passengers boarded the aircraft and took their seats at random as seating was not assigned. Due to the limited number of passenger seats installed in the aircraft, no cabin crew were carried on the flight, nor were they required by regulation. The required safety briefing was given to the passengers prior to the flight by the Co-pilot.

The accident flight (FLT400C) was recorded airborne by the Flight Crew at 08.10 hrs and climbed to Flight Level (FL) 120. The aircraft Technical Log indicated that the Co-pilot was PF with the Commander acting as Pilot Not Flying (PNF). At 08.34 hrs the aircraft established communications with Shannon Air Traffic Control and handover to Cork Approach Control was made at 08.48 hrs. At that time, Cork ATIS[7] was broadcasting that Runway (RWY) 35 was active and that Low Visibility Procedures (LVPs) were in operation.

[5] **FLT**: The ICAO Airline code for Flightline S.L., the Operator.
[6] **FBO**: A company granted the right to operate on an airport and provide aeronautical services.
[7] **ATIS**: Automated Terminal Information Service, broadcasting the latest actual meteorological conditions.

Cork Approach informed the Flight Crew that RWY 35 was the active runway and that a CAT II[8] approach was available for RWY 17. The IRVRs[9] on RWY 17 were passed by Cork Approach and were below the required minima[10] for CAT I operations.

The aircraft first established on the Instrument Landing System (ILS) approach to RWY 17 at 08.58 hrs and was handed over to Cork Tower. The IRVRs passed by Cork Tower at 09.00 hrs were still below those required. The approach was continued beyond the Outer Marker equivalent point. Descent was continued below the Decision Height[11] (DH) of 200 ft and a missed approach[12] was carried out at 09.03 hrs. The lowest height recorded by the TAWS[13] on this approach was 101 ft.

Radar vectors were given by Cork Approach and a second ILS approach was then conducted to RWY 35, the reciprocal runway. Communications with ATC revealed that the Flight Crew considered that an approach to RWY 35, with the sun behind the aircraft, might make visual acquisition of the runway easier. The aircraft was handed over to Cork Tower at 09.10:45 hrs, 8 nautical miles (NM) from touchdown. The IRVRs passed by Cork Tower were below the required minima; the approach was continued beyond the Outer Marker equivalent point. The aircraft descended below the DH and a missed approach was carried out at 09.14 hrs. The lowest height recorded on this approach was 91 ft.

At 09.15 hrs the Flight Crew requested to enter a holding pattern for *'fifteen to twenty minutes'* to see if the weather conditions would improve. The aircraft took up the holding pattern at ROVAL,[14] and maintained an altitude of 3,000 ft. While in the hold, the Flight Crew requested the weather for EIWF. Cork Approach provided the weather conditions at EIWF, which were below required minima. The Flight Crew then nominated Shannon Airport (EINN) as an alternate and requested its weather information. EINN weather was obtained and passed by Cork Approach; the conditions were also below required minima. Weather for Dublin Airport (EIDW), which was passed to the Flight Crew at 09.35 hrs, was operational but with poor visibility. During these exchanges, Cork Approach also offered to obtain the weather for Kerry Airport (EIKY). The conditions at EIKY were duly reported as good, with visibility in excess of 10 kilometres. At approximately 09.33 hrs, with EC-ITP still in the ROVAL hold, the IRVR values on RWY 17 at EICK began to improve. Following a further slight improvement at 09.39 hrs, but with conditions still below the required minima, the Flight Crew elected to attempt another approach to RWY 17.

[8] **CAT II**: Category II ILS approach used in low-visibility conditions by suitably equipped aircraft and appropriately qualified flight crew; CAT I requires higher visibility.
[9] **IRVR**: Instrument Runway Visual Range (sometimes abbreviated to RVR), measured in metres adjacent to the Touchdown, Mid-point and Stop-end points on the runway. Touchdown is the limiting or controlling value.
[10] **Minima**: Aerodrome operating minima, expressed in terms of visibility and/or runway visual range and decision altitude/height (DA/H) as appropriate to the category of the approach (Section 1.8.3 ILS Minima).
[11] **Decision Height**: A specified height in a precision approach or approach with vertical guidance at which a missed approach must be initiated if the required visual reference to continue the approach has not been established.
[12] **Missed Approach**: Where an approach is discontinued and the aircraft climbs according to a prescribed procedure determined and published by the Regulatory Authority.
[13] **TAWS**: Terrain Awareness Warning System.
[14] **ROVAL**: A reporting point on the RWY 17 ILS at 7.9 NM DME.

At 09.45:22 hrs the aircraft reported established on the ILS RWY 17. At this point the aircraft was configured with landing gear down and flaps selected to ½. At 09.45:26 hrs, when EC-ITP was at 11 NM DME[15] on the ILS, the IRVR (Touchdown) improved to 550 m (the required minimum), which was passed to the Flight Crew by Cork Approach. At 09.45:38 hrs, the flight was handed over to the Cork Tower and the Flight Crew reported to the Tower at 09.46:00 hrs passing 9 NM DME. The final IRVRs passed to EC-ITP at 09.46:15 hrs were 500/400/400, which were again below the required minima. The approach was continued beyond the Outer Marker equivalent point. As previously briefed by the Commander, he operated the power levers during the latter part of the approach.

Descent of the aircraft was continued below DH. This was followed by a reduction in power and a significant roll to the left. Just below 100 ft radio altitude, a go-around was called by the PNF which was acknowledged by the PF. Coincident with the application of go-around power by the PNF, control of the aircraft was lost. The aircraft rolled rapidly to the right beyond the vertical which brought the right wingtip into contact with the runway surface. The aircraft continued to roll and impacted the runway inverted. The stall warning sounded continuously during the final seven seconds of the CVR[16] recording. Impact occurred at approximately 09.50:34 hrs. The accident occurred in daylight, but under conditions of fog.

1.1.1 CCTV Images

The Investigation examined CCTV recordings from EICK and obtained two images at the time of the impact. Camera No. 35, situated adjacent to Stand 11 on the northwest corner of the main terminal building, was orientated in a westerly direction with a field of view of approximately 30 degrees. The first image (**Photo No. 2**) shows a first flash of fire which lasted less than 1 second. The second image (**Photo No. 3**) showed a smaller flash event that was recorded 0.82 seconds later. The distance from the impact point to the camera was approximately 375 metres (m). The distance from a grass area just visible at the edge of the apron was 170 m.

Photo No. 2: Initial flash fire

Photo No. 3: Second flash fire

[15] **DME**: Distance Measuring Equipment.
[16] **CVR**: Cockpit Voice Recorder.

1.1.2 Passenger Interviews

The Investigation conducted interviews with the surviving passengers after the accident. All persons described their account of the flight, what they observed and in particular, their account of the final moments of the flight. The following comments are relevant:

Passenger A, seated mid-cabin on the left hand side:

'*I do remember looking out and the ground was just feet from below us and it was grass, it was definitely not tarmac. And the Pilot then gave the plane thrust, to come up out of the cloud. And at that stage the cloud was right to the ground. I feel that the plane... immediately after the thrust, veered to the right and tilted... the right hand of the wing caught the ground first and after that it was just mayhem... I couldn't breathe because all the mud had come up into the fuselage... I do remember pushing the mud away and then being able to breathe...*'

Passenger B, seated mid-cabin on the right hand side:

'*…we came through the cloud or fog…we were probably no more than about 30 feet off the ground. We seemed to be coming in at a bit of an obtuse angle… I was looking out the window, I sensed that we pulled up and banked hard to the right. As we banked, the wing I was sitting next to, the tip of the wing hit …*'

Passenger C, seated towards the rear of the cabin on the left hand side:

'…there was a big turn, I think to the right…I just remember feeling this huge shift to the right'

Passenger D, seated towards the front of the cabin on the right hand side:

'…it felt to me like the plane had gone at a ninety degree angle and was facing towards the ground.'

Passenger E, seated mid cabin on the right hand side:

'*It was cloudy, it didn't clear or anything and then it felt like a normal landing and then everything just crumpled basically'.*

Passenger F, seated mid cabin on the left hand side, had no recollection of the final approach and impact.

1.1.3 Handling Agent

The Handling Agent at EGAC stated: *'The crew remained on board the aircraft as far as I am aware. I took out the passenger figures that had been passed from check-in agent to the crew aboard the aircraft. The 2 crew members were down towards the back of the aircraft with torches on the floor. The crew asked me to call the passengers to the gate and hold them till they advised me they were ready to board.*

The passengers were waiting a while at the gate so I went out to see if they were ready. The crew were working at fixing seats with the captain in a seat by the exit row and the first officer on the floor securing the seats in place. As far as I'm aware this aircraft had done a mail flight from BFS [Belfast Aldergrove] *and the seats would have been removed for this reason. Once the crew had finished securing the seats they gave me clearance to board, the fuelling had also been completed at this time …The doors were closed at 0750 with all passengers on board. The flight went off stand at 0757 and airborne at 0812.'*

1.2 Injuries to Persons

Injuries	Crew	Passengers	Others
Fatal	2	4	0
Serious	0	4	0
Minor /None	0	2	

1.3 Damage to Aircraft

The aircraft was destroyed.

1.4 Other Damage

The runway surface was damaged by the aircraft propellers during the impact sequence. Following recovery of the wreckage, the runway surface was repaired and cleaned by the Airport Authority prior to re-opening. The grass area adjacent to the runway was disrupted by the aircraft leaving the runway and transitioning across the soft ground. The area around the accident site was further disrupted by the subsequent rescue and recovery operations.

1.5 Personnel Information

1.5.1 General

Both Flight Crew members were employed by the Owner. All training and checking was conducted by the Operator. The Flight Crew were CAT I qualified and had not been approved for CAT II operations.

1.5.2 Aircraft Commander

The Commander (male, aged 31 years) held a JAA[17] Commercial Pilot Licence (CPL, Aeroplanes) issued in Spain. His SA 226/227[18] type rating was valid to 30 June 2011 (date of test 12 June 2010) and he held a Class I medical certificate valid to 7 May 2011. The Commander's personal logbook, together with the Operator's records, showed a total flying time of 1,801 hours with 1,600 hours on type.

[17] **JAA**: Joint Aviation Authorities.
[18] **SA 226/227**: Type designations of the Metro II and Metro III respectively.

The Commander began flying in 2007 and completed his basic training on single and multi-engine piston types; his total general aviation flight time was 201 hours. He then completed an SA 226/227 type rating with a Type Rating Training Organisation (TRTO) in Barcelona and commenced employment as a co-pilot on the type.

Records show that between June 2007 and December 2009 he flew as co-pilot with three Spanish SA 227 operators, flying concurrently for all three operators in the first half of 2009. He commenced flying with the Operator in early December 2009. Between 7 December 2009 and 16 December 2009, his personal logbook showed that he completed nine sectors totalling 15 hours 10 minutes as P1/S (Pilot-in-Command under Supervision). This command training was discontinued and he returned to flying as a co-pilot.

According to the Operator's procedures a candidate must satisfy certain criteria prior to promotion to commander. Records provided to the Investigation show that the Commander satisfied these requirements with approximately 1,575 hours experience as a co-pilot in January 2011.

He flew as a co-pilot for the Operator until 2 February 2011 when he completed an Operator Proficiency Check (OPC), during which he occupied the left hand seat. This OPC took place at Reus (LERS), Spain and was recorded as lasting 40 minutes, during which two landings were completed. The Operator's Operations Manual (OM) Part B, Section 2.1.5, requires 2 hours of actual flight time with a minimum of 4 touchdowns/landings for an OPC relating to appointment to commander.

Following seven sectors under supervision, he completed two Line Check (LC) sectors; one sector on 4 February 2013 (22.20-00.00 hrs) and the second the following day (02.15 - 04.00 hrs) and was promoted to the rank of commander. Following this he travelled from Spain to Belfast. His first flight in command was on 6 February 2011, four days prior to the accident.

Records show that the Commander operated as a co-pilot into EICK on 61 occasions between 8 September 2010 and 30 January 2011. Between the 6 February 2011 and 9 February 2011, he operated into EICK on 7 occasions as Commander. The Investigation found no records of a diversion for operational or weather reasons on any of these flights into EICK. In addition, his logbook showed that he had never operated into either EIWF or EIKY. The Commander underwent the following checks:

Check Type	Route/Place	Date
Operator Proficiency Check	Seville-Seville	6 Feb 2010
Line Check	Barcelona-Seville	4 May 2010
Line Check	Madrid-Ronaldsway	7 May 2010
Licence Proficiency Check	Ronaldsway	12 June 2010
Operator Proficiency Check	Reus	2 Feb 2011
Line Check	Barcelona-Madrid	4 Feb 2011
Line Check	Madrid-Barcelona	5 Feb 2011

Flying Experience:

Total all types:	1,801 hours
Total on type:	1,600 hours
Total on type in Command (P1):	25 hours
Last 90 days:	191 hours
Last 28 days:	71 hours
Last 24 hours:	5 hours

Duty Time up to accident:	3 hours 55 mins
Rest period prior to duty:	11 hours 15 mins

1.5.3 Co-pilot

The Co-pilot (male, aged 27 years) held a JAA CPL (Aeroplanes) issued in the United Kingdom. He held ratings for Multi Engine Piston (land), valid to 6 October 2011, and an SA 227AC type rating valid to 10 November 2011. His Class I medical certificate was valid to 19 October 2011.

The Co-pilot had been employed as a cargo agent and later as a flight dispatcher with a handling agent in Leeds-Bradford from June 2007 to September 2010. He underwent his basic flying training at an FTO[19] in the UK and subsequently obtained an SA 227 type rating with a Spanish operator (TRTO). He was employed as a co-pilot with that operator from September 2010 to December 2010 and accumulated a total of 270 hours on type. He underwent an initial OPC with the Operator on 8 January 2011, this check lasted 30 minutes (flight time). Following this check, Operator records show that all of his flights were with line captains who were not instructors. Although at the time of the accident he had flown 19 hours with the Operator, a Line Check required under OM Part D, 2.1.3.4 had not been completed.

Flying Experience:

Total all types:	539 hours
Total on type:	289 hours
Last 90 days:	19 hours
Last 28 days:	18 hours
Last 24 hours:	5 hours

Duty Time up to accident:	3 hours 55 mins
Rest period prior to duty:	11 hours 15 mins

The Co-pilot's *curriculum vitae*, dated 22 December 2010, indicated that he had studied Italian at one stage but contained no evidence of competency in Spanish.

[19] **FTO**: Flight Training Organisation.

1.5.4 Duty and Rest Periods

A total of seven pilots, comprising three captains and two co-pilots in addition to the accident Flight Crew, were assigned to the UK-Ireland operation. The Operator required flight crews to report for duty at least 45 minutes prior to departure to complete pre-flight duties. The Investigation had considerable difficulty in establishing the actual flights carried out by these pilots in the days prior to the accident. The aircraft Technical Log and flight documentation provided by the Operator did not correspond to electronic records subsequently provided to the Investigation. In one case the carbon copy of the Original Technical Log page supplied to the Investigation showed additional flight crew names against the third sector operated. The Investigation used signed operational flight documentation, such as the aircraft Technical Log and Loadsheets, to help determine the flights operated by each pilot. A record of flights which were crewed by either the Commander or Co-pilot (from 6 February 2011) are detailed in **Appendix A**.

The Co-pilot's roster for February showed him '*Libre*' ('Free') between 8-12 February 2011. As another co-pilot requested a change of duty on 9 February, the Co-pilot's duties were changed and he was required to operate the scheduled flights on 9 and 10 February 2011. The identity of the co-pilot was not noted in the flight paperwork of the short positioning flight between EGAA and EGAC (FTL4113) on 9 February 2011. The Investigation is satisfied that the Co-pilot operated this flight and subsequently the two return flights to Cork. The two other possible candidates forwarded copies of their personal logbooks to the Investigation which showed they did not operate the sector. One of these co-pilots also forwarded boarding card evidence that he returned to Spain as a passenger on a commercial flight that morning. On 8 and 9 February 2011, the days prior to the accident, the Investigation found inconsistencies in the documentation supplied by the Operator regarding the identity of the operating crew members including that of the Co-pilot.

The Operator provided electronic records indicating that on 8 February 2011, EC-ITP was positioned from Seville (LEZL) at 06.00 hrs to Barcelona (LEBL) arriving at 08.35 hrs. At 15.30 hrs, the aircraft was positioned to the Isle of Man (EGNS) arriving at 19.05 hrs. The aircraft Technical Log shows that a different flight crew (including the Co-pilot involved in the accident) then positioned the aircraft to EGAA and subsequently operated a night mail charter to EGPH, returning to EGAA at 01.25 hrs on 9 February 2011. The records supplied by the Operator showed that the flight crew that commenced duty in Seville also operated the night mail sectors. The Investigation obtained statements from the pilots involved on the night mail charter and is satisfied that the Co-pilot did not operate these night mail sectors on this date. Evidence shows he operated the scheduled flights to Cork on 9 February 2011, the day before the accident. A passenger boarding at EGAC took a photograph of the aircraft showing the Co-pilot and witnessed him loading passenger bags in the hold prior to departure.

In a statement made by the partner of the Co-pilot, she recalled that '*he did not have very much rest. He was working on a defined route incorporating some night-time flights carrying post*'.

She last spoke to her partner by telephone around 23.00 hrs on 9 February 2011, as he was about to retire for the night. Evidence shows that the Flight Crew spent the night prior to the accident in accommodation provided by the Ticket Seller in Belfast.

Flights for all flight crew operating the accident aircraft EC-ITP between 5-10 February 2011 and the sister aircraft EC-GPS between 1-8 February 2011 are detailed in **Appendix B**.

1.5.5 ATC Personnel

The Licences and Ratings of the Cork Approach, Air Movements and Surface Movements Controllers were appropriate to their positions and were valid at the time of the accident.

1.6 Aircraft Information

1.6.1 General

The SA 227 Metro III is a 19/20-seat pressurised airliner of low-wing cantilever layout powered by two TPE331 turbo-propeller engines. The Metro III differs from the Metro II with a 3.05 m increase in wingspan, more powerful engines driving four-blade propellers, new fire prevention and containment features and other minor changes. The standard Metro III is certificated for operation at a MTOW of 14,500 lbs; an optional high gross weight version of the Metro III (as indicated by a B suffix to the manufacturers serial number) is certified for operation at 16,000 lbs (subject to modification ECP 437). The general dimensions and arrangement are illustrated in **Figure No. 1**.

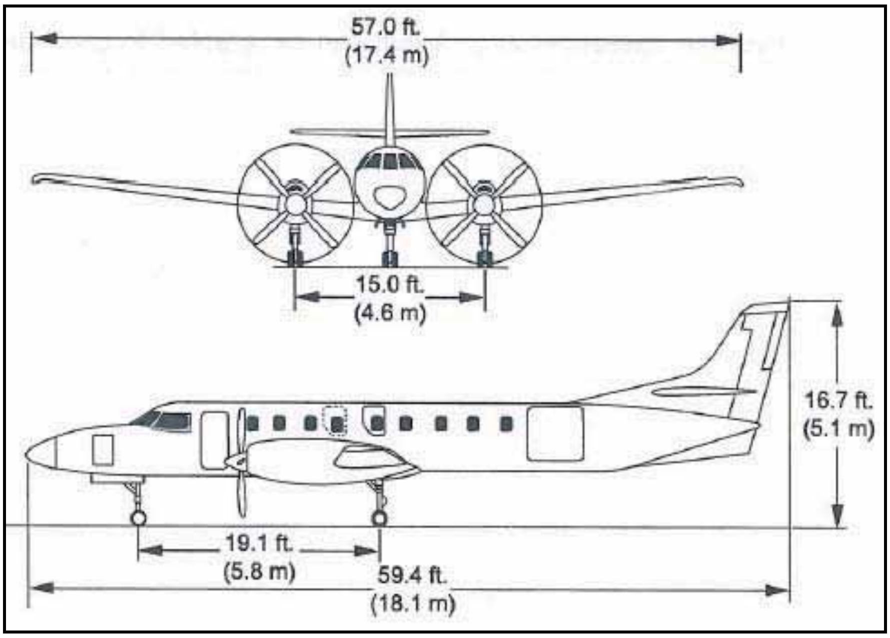

Figure No. 1: Fairchild SA227-BC Metro III General Arrangement
(*SA 227-BC Airplane Flight Manual*)

1.6.1.1 Airframe

The wing is a cantilever, low-wing layout with an all-metal, two-spar failsafe structure of aluminium alloy constructed in one piece. The main spar beams have laminated caps, the centre-section being constructed of titanium. The wing and tailplane leading edges are equipped with Goodrich de-icing boots with an automatic bleed air cycling system allowing certification for flight into known icing conditions. The tailplane and fin are of all-metal cantilever construction. The fuselage is a semi-monocoque fail-safe structure of 2024 aluminium alloy, flush riveted. Access to the passenger compartment is provided by a door at the front, on the left hand side at the position of Row 1. This door is equipped with integral steps.

1.6.1.2 Standard Seating Layout

There are various seating options available. The standard passenger configuration comprises 19 seats, arranged either side of a central aisle. Baggage is located in a compartment at the rear of the aircraft accessed by an upward-hinging door. The baggage compartment is separated from the passenger compartment by a removable partition. Operationally, seats may be arranged to provide additional baggage space in a 17-seat layout, or seats may be removed altogether for all-cargo work.

There are three emergency exits; one on the port side adjacent to Row 6 and two on the starboard side adjacent to Rows 5 and 6. Emergency break-in markings are located externally at overwing and aft positions of the cabin. The standard 19-seat passenger layout uses a seat pitch of 30 inches. The Airplane Flight Manual (AFM) Section 5-13 states that configurations are not restricted to only those shown in the AFM and there is no minimum number of passenger seats required. The seating layout of EC-ITP is described in **Section 1.6.2.1**.

1.6.1.3 Engines

The aircraft is powered by two Honeywell TPE331-12UHR-701G turboprop engines. These engines comprise a fixed shaft with a two-stage centrifugal compressor driven by a three-stage axial-flow turbine, a single reverse-flow annular combustor and an integral reduction gearbox that drives the propeller. The engine has a maximum continuous rating of 1,050 shaft horse power (SHP) with maximum take-off power rated at 1,100 SHP with a limit of 5 minutes.

1.6.1.4 Propellers

The SA 227-BC is equipped with two McCauley 4HFR34C652 four-blade, constant-speed, full-feathering, reversible pitch aluminium propellers, each with four B-L106LA-0 aluminium blades. The propeller operates at a constant-speed with automatic synchrophasing. Full feathering capability and reversing (Beta control)[20] are standard.

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[20] **Beta control**: Enabling manual selection of reverse pitch for ground operations.

The propeller is a single-acting unit in which hydraulic pressure opposes the force of springs and counterweights in the hub to produce the correct pitch for a given engine load. Hydraulic pressure moves the blades towards low pitch, increasing the speed (RPM). Springs and counterweights move the blades toward high pitch, decreasing RPM. The source of hydraulic pressure for operation is engine oil boosted by a governor gear pump.

1.6.1.5 Engine Controls

Engine power output (torque) is controlled by two power levers; the left power lever incorporates a thumb-operated button to engage the nosewheel steering. Propeller RPM is controlled by two speed (RPM) levers situated to the right of the power levers. Engine controls are illustrated in **Figure No. 2**.

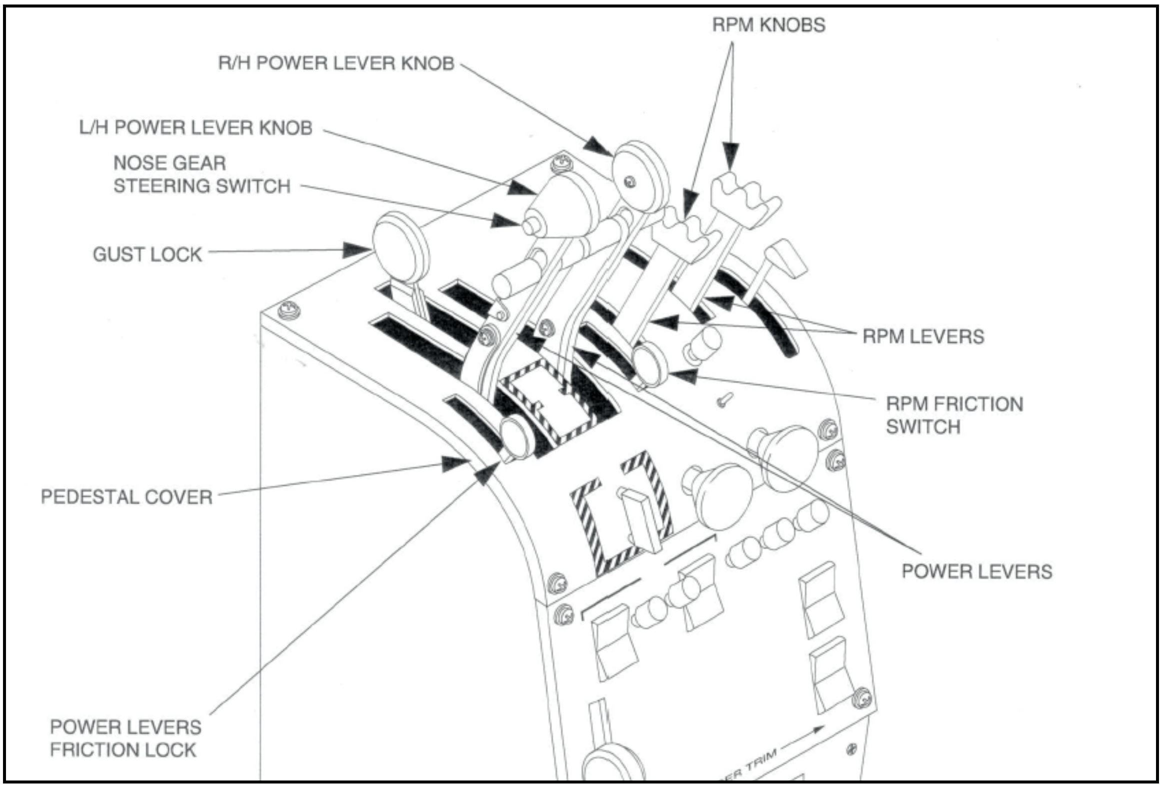

Figure No. 2: Engine control quadrant (*SA 227 Maintenance Manual*)

Mechanical latches on each power lever prevent inadvertent selection of the propellers into the Beta range while airborne, by movement of the power levers below Flight Idle. On the ground, operation of the power levers in the Beta range is selected by raising finger lift knobs against spring pressure which raises spring clips permitting retardation of the power levers below the Flight Idle stop (**Figure No. 3**). Operation in the Beta range on the ground is used for the selection of reverse thrust.

The operation of the propellers in Beta range during flight is prohibited by the Manufacturer in the Limitations Section of the AFM as follows:

WARNING

- **PROPELLER REVERSING IN FLIGHT IS PROHIBITED**

- **DO NOT RETARD POWER LEVERS AFT OF THE FLIGHT IDLE GATE IN FLIGHT. SUCH POSITIONING MAY LEAD TO LOSS OF AIRPLANE CONTROL OR MAY RESULT IN AN ENGINE OVERSPEED CONDITION AND CONSEQUENT LOSS OF ENGINE POWER.**

Furthermore, operation in the Beta range will result in the propellers providing reverse thrust proportional to the retardation of the power levers. Engine manufacturer documentation states that '*setting one or more of the power levers below Flight Idle in-flight produces high drag conditions which may result in excessive airspeed deceleration, and may induce an uncontrollable roll rate due to asymmetric thrust and drag'.*

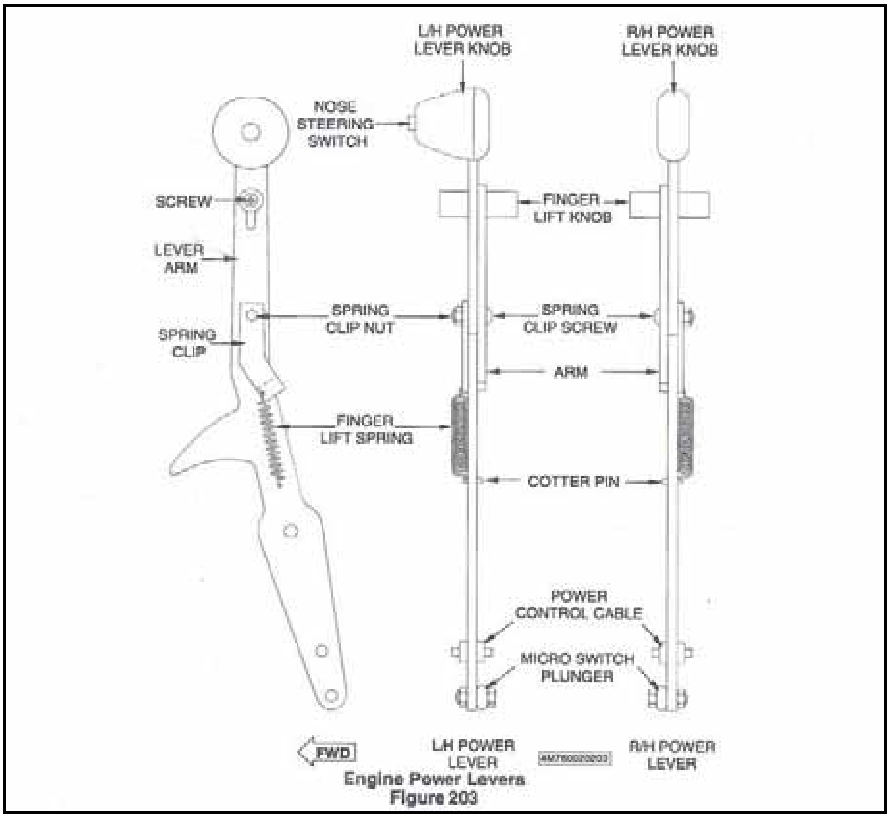

Figure No. 3: Engine Power Levers and Beta mode latch (finger lift knobs) mechanism in the raised position (*SA 227 Maintenance Manual*)

1.6.1.6 Flight Controls

The ailerons, elevators and rudder are manually operated from either the pilot or co-pilot position by a conventional control wheel and rudder pedal arrangement. Aileron and rudder trim controls are located on the aft central pedestal.

The flaps are operated by a single lever on the right side of the engine control pedestal. The flaps are electrically controlled and hydraulically actuated. Left and right flaps are interconnected for symmetrical lift during deployment. Flap position is indicated by a gauge on the co-pilot main instrument panel.

1.6.1.7 Fuel

Fuel is carried in integral wing tanks, each with a useable capacity of 324 US Gallons (USG) giving a total useable fuel capacity of 648 USG (2,453 litres). The aircraft was certified to use a variety of fuel grades including Jet A-1 (a grade of AVTUR).

1.6.1.8 Annunciator Panel

An annunciator panel, located in the upper centre section of the instrument panel, is interconnected to numerous aircraft systems and is utilised to monitor systems operation. The annunciator panel contains eighteen red warning lights to indicate system failure, eighteen amber caution lights to indicate failures of a less serious nature and twelve green lights to indicate systems on and/or operating. The annunciator panel has a press-to-test switch located on the left side of the annunciator panel.

Operation of the propellers in the Beta range causes illumination of the L and R Beta (amber) lights on the annunciator panel. Once the power levers are advanced beyond the Flight Idle stop this light extinguishes.

1.6.1.9 Stall Avoidance System

A Stall Avoidance System (SAS) is incorporated in the aircraft to warn the flight crew of an impending stall, aurally by means of a warning horn and visually by means of a SAS Indicator situated on the glareshield in the direct view of the commander. The system also provides for actual stall avoidance by means of a stick pusher which applies a forward force of approximately 65 lbs to the elevator control. The SAS is armed once airborne. The aural warning horn sounds at about seven knots above stall speed and the stick pusher is automatically engaged approximately one knot before the actual stall.

A SAS computer receives signals from the Angle of Attack (AOA) transmitter, flap position compensator and SAS test switch, and processes these signals to control the SAS Indicator, stall warning horn and stick pusher servo.

Data extracted from the Airplane Flight Manual (AFM) shows that the zero thrust stall speed, at a weight of 13,700 lbs (the estimated weight of EC-ITP at the time of the accident) with landing gear down, flaps ½ and bank angle zero is 88 Kts Indicated Airspeed (KIAS). With the same configuration, this increases to 99 KIAS at 40 degrees of bank.

1.6.2 EC-ITP Information

EC-ITP (MSN BC-789B), an SA 227-BC variant, was manufactured in 1992 by Fairchild Aircraft Corporation as part of an order for an operator in Mexico. The aircraft was the second Metro III acquired by the Owner, the first aircraft being EC-GPS.

The aircraft was first registered in Spain on 22 January 2004 (Certificate of Registration No. 6817). The most recent Airworthiness Review Certificate (ARC) was issued on 15 October 2010. On the day of the accident, the aircraft Technical Log (Page 00110) showed that it had flown a total of 34,653 hours and 34,156 cycles. As a transposition error of plus 2,000 hours had been made two days earlier on page 00108 a total of 32,653 hours should have been recorded. A Status Report for EC-ITP dated 8 February 2011 obtained from the Operator, indicated that the aircraft had completed 32,647 hours and 34,647 landings (cycles).

1.6.2.1 Seating layout in EC-ITP

Both EC-ITP and EC-GPS were reconfigured to meet the requirements of the Operation. This necessitated removal of all the passenger seats to facilitate mail/cargo flights by night and the re-installation of the seats to facilitate passenger flights by day.

The Investigation was informed by the Operator that two of the commanders on the Operation were trained and authorized in the re-configuration of the SA 226/227 which involved the removal and re-installation of passenger seats. Neither the Commander nor the Co-pilot were so authorized. The Investigation notes that under the terms of Part 145[21].A.30(j)4 Personnel Requirements, the replacement of passenger and cabin crew seats, seat-belts and harnesses in aircraft operating away from a supported location is restricted to holders of a valid JAR FCL Flight Engineers Licence. Furthermore, these procedures should be specified in the maintenance organisation exposition and be accepted by the competent authority. No evidence of such acceptance was provided to the Investigation.

At the time of the accident, EC-ITP was configured with an 18-seat passenger layout, with 9 seats installed instead of 10 on the right-hand side, which was the maximum allowed passenger capacity approved by *Agencia Estatal de Seguridad Aérea* (AESA). The Operator's OM Part B, Section 1, shows the standard 19-seat passenger configuration together with the standard cargo configuration. In addition, the most recent weighing report for EC-ITP on 12 November 2010, showed that the aircraft was weighed in the 19-seat configuration.

[21] **Part 145**: Commission Regulation (EC) No 2042/2003, Annex II, establishes the requirements to be met by an organisation to qualify for the issue or continuation of an approval for the maintenance of aircraft and components.

Regulation (EC) No 1702/2003 states that '*The design of an individual aircraft, which is on the register of a member State before 28 September 2003, shall be deemed to have been approved in accordance with this Regulation when…(ii) all changes to this basic design which are not under the responsibility of the type-certificate holder, have been approved;…*'. The Investigation was not provided with such an approval. The Operator was unable to provide the Investigation with an approved drawing e.g. a Layout of Passenger Accommodation (LOPA) to show that the 18-seat configuration was approved for this aircraft.

The seat pitch on the right-hand side commenced at 20 inches with a pitch of 38 inches provided adjacent to the aft emergency (escape) exit at the position of seat 5R. Seats behind 5R to the aft bulkhead were arranged with a pitch of 33 inches (**Figure No. 4**).

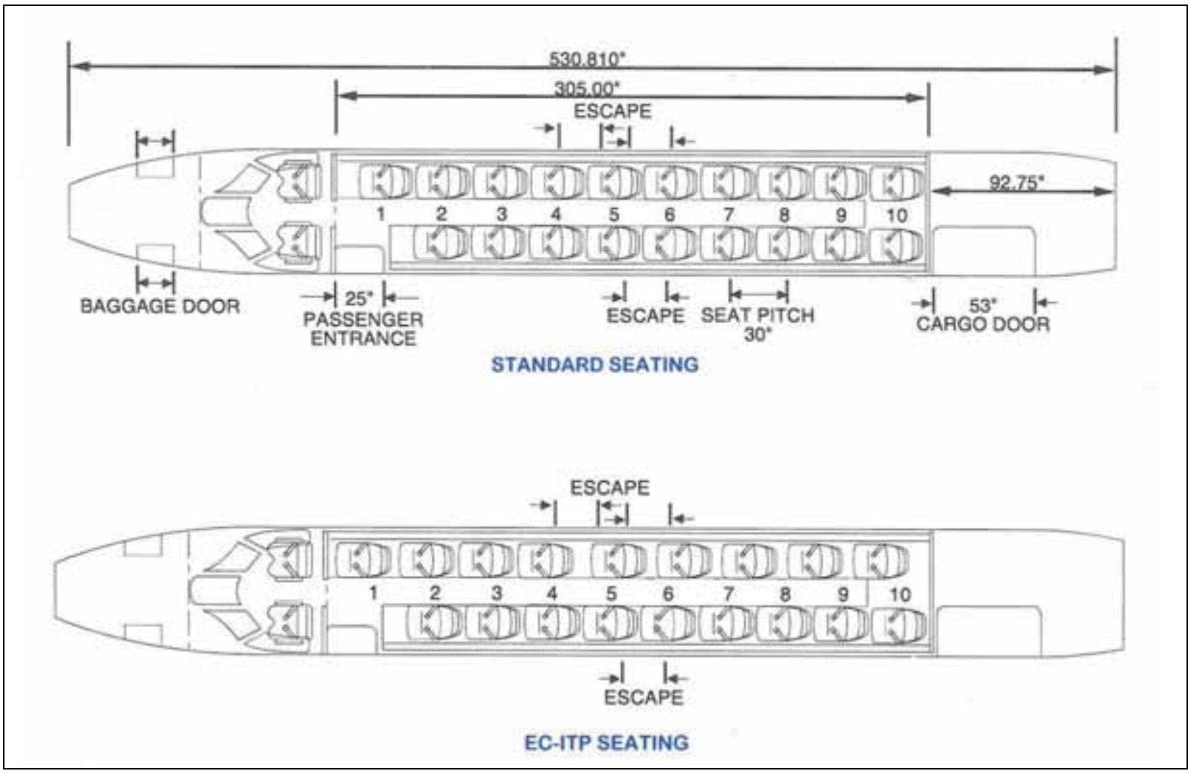

Figure No. 4: Standard 19-seat passenger layout and non-standard 18-seat layout as found on EC-ITP (*adapted from SA 227 AFM*)

1.6.2.2 Radio and Navigational Equipment

EC-ITP was equipped with the following radio and navigational equipment: 2 Transceivers (Collins VHF-22C), 2 Navigation Receivers (Collins VIR-32), 1 DME (Collins DME-42), 1 ADF Receiver (Collins ADF-60A), 1 Marker Beacon Receiver (Collins), and 2 Transponders (Honeywell MST67A, 1 Radio Altimeter (Collins ALT 55), 1 Weather Radar (Bendix King RDS-81) and 1 Emergency Locator Transmitter (Kannad ELT 406 AF).

EC-ITP was not equipped with an autopilot or a flight director system and as such was approved for CAT I approaches only.

1.6.3 Weight and Balance

EC-ITP was last weighed on 12 November 2010, in accordance with Aircraft Maintenance Manual (AMM) Chapter 08-10-00, fully equipped in 19-seat configuration excluding operating crew and fuel. The weight calculated was 9,820 lbs with the Centre of Gravity calculated at 260.77 inches aft of datum. The Operational Empty Weight (OEW) used was 10,190 lbs on all operational Weight and Balance sheets. EC-ITP was certified for high gross weight operations up to a max take-off weight of 16,000 lbs. The Centre of Gravity limits were between 257 inches and 277 inches aft of datum up to a weight of 11,000 lbs; the forward limit reduces to approximately 263 inches at a weight of 16,000 lbs.

On the accident flight, the passenger manifest showed that a total of 10 persons were carried, with 2 pieces of baggage in the aft hold in an 18-seat configuration. Total fuel at engine start was recorded in the aircraft Technical Log at 3,000 lbs following an uplift of 800 Litres of Jet A-1. The actual take-off weight was recorded as 15,010 lbs.

The aircraft weight at the time of the accident is estimated at 13,700 lbs based on the flight log and AFM information. The Centre of Gravity at the time of the accident is estimated to have been 262 inches aft of datum and was within the above limits.

An incorrect MTOW of 14,500 lbs was printed on the Operator's Weight & Balance Sheet for EC-ITP (Rev 1, dated 23 November 2010). This was the correct MTOW for EC-GPS (the Owner's other Metro III which was the primary aircraft used in the UK-Ireland operation).

1.6.4 Previous Events Involving EC-ITP

Prior to the accident at EICK, EC-ITP was involved in two significant events:

In the early hours of 21 May 2004, EC-ITP was involved in a take-off incident at Palma de Mallorca Airport (LEPA). On take-off the aircraft accelerated normally to 60 kts, when the nose wheel steering (NWS) system was deactivated the aircraft veered to the right. The take-off was abandoned and reverse thrust applied but the aircraft departed the runway and incurred minor damage which was later repaired. CIAIAC Report IN-026/2004 refers.

On 8 November 2009 EC-ITP suffered a heavy landing at Barcelona. As a result the aircraft was ferried to an overhaul facility in Cologne for repair. This work was completed and the aircraft returned to service in October 2010, four months prior to the accident.

1.6.5 Maintenance

The Investigation carried out a review of the continuing airworthiness management and maintenance arrangements of EC-ITP for compliance with the requirements of Annex I to Commission Regulation (EC) No 2042/2003. This Regulation, dated 20 November 2003, sets out the requirements regarding the continuing airworthiness of aircraft, aeronautical products, parts and appliances, and the approval of organisations and personnel involved in these tasks.

It ‘*establishes common technical requirements and administrative procedures for ensuring the continuing airworthiness of aircraft, including any component for installation thereto, which are registered in a Member State… The provisions of this Regulation related to commercial air transport are applicable to licensed air carriers as defined by Community law*’. The Investigation examined the period from when EC-ITP entered service with the Operator until the date of the accident. This review of maintenance arrangements is detailed in **Appendix C** (**Table No. 1**), which outlines the review process, identifies the areas subject to analysis and sets out the Operator’s compliance with Annex I to Commission Regulation (EC) No 2042/2003. This review carried out by the Investigation identified a total of 14 non-compliances which are detailed in **Appendix C** (**Table No. 2**).

The revision of the Regulation in force at the date of the accident, and used as the basis for this review, was Commission Regulation (EC) No 2042/2003 of 20 November 2003 as amended up to and including Commission Regulation (EC) No 962/2010 of 26 October 2010 (Amendment M5) including Decision No 2003/19/RM of 28 November 2003 as amended up to and including Decision No 2010/006/R of 31 August 2010. Article 3 of Commission Regulation (EC) No 2042/2003 of 20 November 2003 specifies that the continuing airworthiness of aircraft and components shall be ensured in accordance with the provisions of Annex I of the Regulation (known as and hereinafter referred to as Part M). It further specifies that organisations and personnel involved in the continuing airworthiness of aircraft and components, including maintenance, shall comply with the provisions of Annex I of the Regulation.

The Operator held an Air Operator Certificate (AOC) issued by AESA, the Civil Aviation Authority for Spain, and conducted commercial air transport operations in Europe and North Africa with a mixed fleet consisting of Fairchild SA 226, Fairchild SA 227 (registrations EC-GPS and EC-ITP) and Embraer 120 Brasilia aircraft. The scheduled operation between the UK and Ireland was normally carried out using EC-GPS. On the day of the accident EC-GPS was undergoing scheduled maintenance and was replaced by the accident aircraft, EC-ITP.

Maintenance support for the two Fairchild SA 227 aircraft, registrations EC-GPS and EC-ITP, was contracted to a Part 145 approved maintenance organisation based in Barcelona, Spain (the Maintenance Provider).

1.6.5.1 Maintenance History of EC-ITP

Following the heavy landing event in November 2009, EC-ITP underwent maintenance at an approved Part 145 facility in Cologne Germany between January and October 2010. The aircraft was certified as ready for release to service on a Log Book Certificate dated 11 October 2010. All arrangements in support of this maintenance visit were conducted by the Owner directly with the maintenance organisation in Cologne.

The Part 145 organisation in Cologne, being also a Part M Subpart G approved CAMO[22], made an Airworthiness Review Certificate (ARC) recommendation on 11 October 2010 to AESA with the ARC being issued on 15 October 2010.

Part 145 facility Work Order 105470 dated 24 November 2009 (heavy landing repair), Work Order 107716-10 dated 28 December 2009 (routine work) and Work Order 117154-10 dated 30 August 2010 (for repairs) were performed simultaneously prior to the release to service.

The LH engine installed on the aircraft when it commenced the maintenance visit at Cologne was a loaner. The maintenance records provided to the Investigation show that this engine was removed and another loaner engine S/N P-70204 was installed on the LH side on 15 July 2010. Some of the maintenance records show a different S/N for the installed engine, however the Investigation is satisfied that this was due to a typographical error.

The maintenance records show that the RH engine S/N P70189 was removed from the aircraft on 27 April 2010 '*for access to repair area*'. The records show that the same engine was re-installed on the RH side on 13 July 2010.

1.6.5.2 Continuing Airworthiness Management

As required by Regulation (EC) No 2042/2003, Part M, the Operator was approved by AESA, the Competent Authority for Spain, as a Part M Subpart G organisation, to manage the continuing airworthiness arrangements of the Fairchild SA 226/227 aircraft type. Part M also requires an operator performing commercial air transport to be approved to perform maintenance in accordance with Part 145, or to contract the performance of such maintenance to an approved Part 145 organisation.

The Operator elected to contract all maintenance for EC-ITP and EC-GPS to the Maintenance Provider, a Part 145 approved organisation based in Barcelona. The Operator remained responsible under their Part M Subpart G approval for determining all maintenance required to be accomplished. This included coordinating and arranging for this maintenance to be accomplished and certified by an appropriately approved maintenance organisation and for updating and maintaining the required aircraft maintenance records.

For scheduled maintenance this would normally be achieved through the provision of work packages or work orders from the Part M Subpart G organisation to the contracted maintenance provider. For defects and unscheduled maintenance arising during the operation of the aircraft, these tasks should be recorded in the Technical Log and brought to the attention of the maintenance provider by the Part M Subpart G organisation.

[22] **CAMO**: Continuing Airworthiness Management Organisation.

The practicalities of how this is achieved on a day to day basis and the support arrangements required to perform this maintenance should be established by the Part M Subpart G organisation. The requirement for maintenance support of the aircraft in service must also be considered by the Part M Subpart G organisation and should there be a need to perform on-going scheduled maintenance, an approved line maintenance base should be established.

The details of these arrangements should be set out in the Operator's Part M Subpart G Continuing Airworthiness Management Exposition (CAME) and be captured under the relevant provisions of the maintenance contract. These procedures should also be reflected in the Maintenance Provider's maintenance organisation exposition (MOE) procedures.

1.6.5.3 Aircraft Maintenance Contract

The Maintenance & Assistance Agreement between the Operator and the Maintenance Provider based in Barcelona, was reviewed for compliance with Part M, M.A.708 requirements. This contract was signed on 9 November 2009 and was effective, at the time of the accident, for EC-ITP as evidenced in Annex I to the contract. With some minor exceptions, the contract was structured to demonstrate compliance with the layout and requirements of AMC[23] to Part M; *App XI* to AMC to M.A.708(c).

Annex III to the contract, signed by the Maintenance Provider, the Owner and the Operator on 22 March 2010, provides *'…to establish the economical conditions of the aforesaid agreement…'* This Annex III includes a third party, the Owner, who accepted and ratified the maintenance agreement and committed to pay all associated maintenance costs to the Maintenance Provider. The third Clause of Annex III states:

> *'Likewise the following will be at* [the Owner's] *expense: The expenses arising from the execution of maintenance, repair, revision, inspection, adjustment and/or checking operations of the aircraft and/or its components, outside the Maintenance Centre, including travel expenses and accommodation for displaced staff.'*

Maintenance support of the aircraft in connection with the Isle of Man, UK and Ireland operation was not included in the contract. Section 2.2, Line Maintenance, lists the Spanish line maintenance locations covered by the contract and additionally states '*Any other airport requested by the Operator, with the Maintainer's written approval*'.

1.6.5.4 Maintenance Programme

EC-ITP was added to the Operator's AOC on 15 November 2010 and included in the Operator's Maintenance Programme (Issue 1, Revision 0) of 21 December 2009, which was approved by AESA on 14 April 2010.

[23] **AMC**: Acceptable Means of Compliance.

Checks were required at the following intervals:

Type of Check	Check Interval
Service Check	75 flight hours
Phase 1 - 6 Checks	150 flight hours (based on 900 flight hours utilisation per year)
Base Check	2250, 4500, 6750 and 9000 flight hours
Avionic Functions	Every 2 years

There were no tasks in the approved Aircraft Maintenance Programme (AMP) until the 75 hour Service Check other than Pre-Flight Inspections. The Original Equipment Manufacturer (OEM) Maintenance requirements (Fairchild SA 227 Series, Phase and Letter Check Inspections) and the phasing options available to and chosen by the Operator were reviewed. Each Phase Check includes a Service Check.

The OEM recommends use of a Letter Check programme for aircraft utilisation below 800 flight hours annually and a Phase Inspection programme for aircraft utilisation above 800 flight hours, with all phases performed within a 12 month calendar period. The AMP for EC-ITP was based on a planned utilisation of 900 flight hours per year. The OEM recommends that an annual inspection consisting of letter checks A to D or detailed inspections listed in Zone 1 to Zone 10 be accomplished when an aircraft has been in storage, has operated less than 200 flight hours in a 12 month period, transferred between operators and when changing from Letter Checks to Phase Inspections.

A Pre-Flight Inspection was required prior to the first flight of each day with the approved procedure detailed in the Airplane Flight Manual (AFM). A daily inspection was mentioned in the CAME as the CAMO managed other types of aircraft with this inspection, but not in the AMP.

1.6.5.5 Recent Maintenance Checks Performed

During the rectification work carried out in Cologne, Phase Checks 1 to 6 and an Annual Inspection (Form 505) were completed and certified on 11 October 2010. As part of this inspection, Zone 9R Right Engine (Item 18) required an inspection of the P_{T2}/T_{T2} sensor '*for damage, condition and security*'. This inspection was carried out and certified.

An Engine Ground Run Worksheet (Form 503), which is part of the aircraft Manufacturer's Phase Inspection Manual, was used as the template to carry out and record an engine ground run operational check following the work carried out in Cologne. This included checks for power lever splits at reverse power – low RPM and at dry take-off power.

In the Introduction to the Phase Inspection Manual, the Manufacturer states the following: '*This Manual provides an inspection program outline, inspection schedules, inspection checklists, forms, and procedures.*

Forms are included for recording discrepancies found during inspections and for recording corrective actions taken. However, specific maintenance practices and procedures are excluded from this manual intentionally so as to separate the inspection program from other activities. Separate manuals are provided for maintenance, overhaul and operating procedures.'

The Manufacturer states that Form 503 *'is provided for the convenience of the Maintenance and Inspection Departments for guidance in engine operation prior to or following a check, inspection or maintenance*.' A note on Form 503 states '*This checklist is intended only as a guide. See Fairchild Aircraft Maintenance Manual, 71-00-00, Adjustment/test for complete check procedures.*'

AMM 71-00-00 does not reference Form 503 but does reference 71-00-30 Engine Ground Run (Adjustments) and 71-00-35 Engine Ground Run (Worksheet). The AMM states, with reference to 71-00-30, '*This section contains information for engine ground run, check, and adjustment/test procedures to verify the integrity of installed/replaced items*.'

AMM 71-00-30 Engine Ground Run (Adjustments) – Maintenance Practices, contains a check for a power lever split at Flight Idle in addition to checks at maximum and cruise power and in reverse power – low RPM. The Flight Idle power lever split check is not included in Form 503. The 71-00-30 requirement is for a split between the power levers at the pedestal not exceeding 0.05 of an inch at Flight Idle. No documentation was provided to the Investigation to show that a Flight Idle power lever split check was carried out during the rectification work and inspection performed in Cologne. The Investigation also notes that 71-00-30 does not specify a requirement to perform a repeat check at take-off power with the speed levers set to 97%. AMM 71-00-35 Engine Ground Run (Worksheet) – Maintenance Practices, is a checklist used to record the results and data arising from the ground run procedure documented in AMM 71-00-30.

A power lever split not exceeding 0.05 of an inch at the pedestal (as specified) was recorded on Form 503 at dry take-off power, with the speed levers set to high and with bleed air both off and on. A repeat check with the speed levers set to 97% and bleed air on is included on Form 503 but was not recorded. A power lever separation not exceeding 0.25 of an inch at the pedestal (as specified) was recorded during the reverse power – low RPM check. The Engine Ground Run Worksheet (Form 503) power lever split at dry take-off power extract is reproduced at **Appendix D**.

On 13 December 2010, a Service Check was carried out in the Isle of Man. On 15 January 2011, a 150 hour Phase Check 1 was completed at Barcelona. The most recent check was performed on 5 February 2011, when the aircraft was subject to a Service Check at Barcelona. The Service Check worksheet includes a requirement to check the P_{T2}/T_{T2} sensor for condition and security. This was signed off for both engines on the final Service Check at Barcelona. The aircraft total time on this date was recorded as 32,632.3 hours and 34,137 cycles. The Work Order detailing the tasks carried out during this Phase Maintenance Inspection is reproduced in **Appendix E**. Engine ground runs incorporating power lever split checks were not required to be carried out as part of the Service Checks or the Phase Check 1.

1.6.5.6 Line Maintenance

The aircraft was operated on the EGAC-EICK scheduled service without the establishment of a line maintenance station at either location. Any unscheduled maintenance tasks that arose required notification of those defects to the Operator in Barcelona. Any rectification or inspection work necessitated engineering personnel from the Maintenance Provider, also based at Barcelona, travelling to where the aircraft was situated or for unforeseen cases, the issuance of once off authorisations by the Maintenance Provider in accordance with Part 145.A.30(j)5 to qualifying personnel if such personnel were available at that location. Occasionally maintenance personnel were present in the Isle of Man carrying out scheduled maintenance tasks, as was the case on the day of the accident when the sister aircraft EC-GPS was undergoing scheduled maintenance there.

The Technical Logs for both Metro III aircraft on the Operator's AOC were inspected. No defects were recorded as having occurred to EC-ITP between 9 November 2010 (on re-entry into service following completion of hard landing repairs) and 10 February 2011, the day of the accident. Between 17 April 2010 and 8 February 2011, the Technical Log for EC-GPS showed two recorded defects, which occurred on 5 October 2010 and on 29 October 2010. Each defect required replacement of an Ignition Box; as a consequence of these defects the aircraft was out of service for two days on each occasion.

1.7 Meteorological Information

The flight documentation was e-mailed the previous evening by a service provider based in Malaga. The documentation contained both actual (METAR) and Terminal Area Forecast (TAF) weather information for EGAA, EGAC, EGNS and EICK. In addition, EIDW and EINN were listed as 'adequate airports' with METARs and TAFs also provided. The documentation showed that the search for this data was performed at 16.22 hrs on 9 February 2011, the day before the accident.

At 06.25 hrs, on the morning of the accident, the Flight Crew used the briefing facilities of a handling agent at EGAA to download the latest information. Meteorological and NOTAM information were downloaded from a meteorological briefing service based in Norway and contained METARs and TAFs for EGAA, EGAC, EICK, and EIDW. The documentation containing this information was recovered from the aircraft wreckage.

The METAR for EICK at 06.00 hrs indicated RVRs above required minima with adjacent fog present. The RVR trends and tempo had been highlighted by one of the Flight Crew. The TAF 24 hr. (forecast) for EICK showed a general visibility of 300 m in fog, broken cloud at 100 ft, but with visibility becoming in excess of 10 km between 09.00 and 11.00 hrs (**Graphic No. 1**).

Information for the nominated alternate, EIWF was unavailable at that time. Up to date weather information for EIWF was available through direct telephone contact with Waterford ATC from 07.15 hrs. The Air Traffic Services at Waterford stated that it did not receive enquires from any flight crew regarding the weather conditions that morning.

```
>>> EICK (CORK) <<<

METAR 100600Z 33006KT 0900N R17/1300U R35/1500U BCFG FEW002 04/04
      Q1011 TEMPO 0300

TAF 100500Z 1006/1106 VRB03KT 0300 FG BKN001 BECMG 1007/1009
          08005KT BECMG 1009/1011 11010KT 9999 NSW SCT010 BKN020 TEMPO
          1015/1021 5000 BR -RADZ BKN003 BECMG 1018/1020 14010KT BECMG
          1021/1024 19010KT BECMG 1100/1103 3000 -RADZ BR BKN003 TEMPO
          1103/1106 0300 FG OVC001

ILS LOCATOR OUTER RWY35 OB FREQ 362 KHZ COMPLETELY WITHDRAWN
                                            : NOTAM EI/A1584/10

>>> EIWF (WATERFORD) <<<

METAR NIL
TAF NIL
```

Graphic No. 1: Meteorological information for EICK and EIWF obtained by the Flight Crew at 06.25 hrs

Met Éireann, the Irish Meteorological Service, provided the following aftercast to the Investigation regarding the meteorological situation at EICK The area lay under the influence of a weak ridge of high pressure with a slack humid airflow dominating the weather features.

Wind:	090 degrees, at 8 kts (at surface) 110 degrees at 10 kts (at 2,000 ft)
Visibility:	Minimum visibility circa 350 m (with IRVR 17 of 600 m with no change, and IRVR 35 of 450 m with no change at 10.00 hrs UTC)
Weather:	Fog
Cloud:	Broken at 100 ft
Surface Temp/Dew Point:	5 °C /5 °C
MSL Pressure:	1011 hectoPascal (hPa)
Freezing Level:	Circa 4,000 ft

Due to fog and conditions of poor visibility, EICK had been operating under Low Visibility Procedures (LVP) from 15.50 hrs on 8 February 2011, two days prior to the accident. At 09.56 hrs, six minutes after the accident, the IRVR values of 650/550/550 m on RWY 17 exceeded CAT I minima, and by 10.08 hrs the visibility exceeded 2,000 m. The actual and forecast meteorological reports for EICK about the time of the accident were as follows:

```
Cork Airport (EICK)

METAR
EICK 100930Z 08005KT 050V110 0300 R17/0375N R35/0350N FG BKN001
04/04 Q1010 NOSIG=
EICK 101000Z 09008KT 0400 R17/0600N R35/0450N FG BKN001 05/05
Q1010 NOSIG=

TAF
EICK 100500Z 1006/1106 VRB03KT 0300 FG BKN001 BECMG 1007/1009
08005KT BECMG 1009/1011 11010KT 9999 NSW SCT010 BKN020 TEMPO
1015/1021 5000 BR –RADZ BKN003 BECMG 1018/1020 14010KT BECMG
1021/1024 19010KT BECMG 1100/1103 3000 –RADZ BR BKN003 TEMPO
1103/1106 0300 FG OVC001=
```

Actual and forecast meteorological reports for other airports about the time of the accident are presented in **Appendix F** together with a list of abbreviations used.

1.8 Aids to Navigation

1.8.1 General

A Doppler VOR[24] with co-located DME was located on the airfield, for en-route navigation and to facilitate non-precision approaches to all runways. RWY 17 and RWY 35 were both equipped with an ILS to facilitate precision approaches. The ILS on RWY 17 and RWY 35 comprised a localiser (LLZ), a glidepath (GP) and DME. The LLZ is used for guidance in azimuth along the extended runway centreline within precisely defined lateral displacement tolerances. The GP is used to provide guidance in elevation along a 3.0 degree glidepath to the ILS reference datum (touchdown point) within precisely defined vertical displacement tolerances. The DME provides ranging information to the runway threshold and is used in conjunction with the ILS to cross check altitude on an approach.

The ILS on RWY 17 was commissioned on 23 August 2004, all navigation and approach aids were subject to periodic calibration and continuous tolerance monitoring in service.

1.8.2 Serviceability of ILS Equipment

The LLZ and GP were manufactured by Normarc (Series 7000); the DME was manufactured by Feranu (Type 2020). Dual monitors are used for the LLZ, GP and DME to ensure the integrity of the radiated signal and to initiate a shutdown if the limits are exceeded (nominal width of the LLZ 5.26°, and nominal GP angle 3.00°).

The monitoring log files for LLZ, GP and DME RWY 17 show that all parameters were normal before and after the accident. In addition, there were no audio alarms from the ILS status panel during the final approach of EC-ITP nor were there any warning or failure indications.

[24] **VOR**: VHF Omnidirectional Radio Range.

An engineering intervention on the ILS switchover panel caused an unplanned interruption of the ILS RWY 17 at 08.48 hrs due to a reported loose ILS changeover switch. The system was restored to normal operation at 08.49 hrs, 9 minutes prior to the first approach of EC-ITP and approximately 1 hour prior to the accident.

The IRVR system did not display any technical warnings or alarm indications at the time of the accident. The time stamp for the recorded IRVR data received by the Investigation was 4.5 minutes slow, however the real-time data sent to ATC and passed to flight crew was unaffected.

The recent scheduled maintenance was an ILS weekly check carried out on 5 February 2011, an IRVR weekly check carried out on 2 February 2011 and an IRVR quarterly check carried out on 18 December 2010. The systems were operating normally on completion of the above inspections. A flight inspection was completed satisfactorily on ILS 17 on 6 October 2010.

On 11 February 2011, a post-accident flight check was completed on ILS 17; checks were completed on LLZ, GP and DME Transmitter No. 2 (the transmitter in service at the time of the accident. The inspection confirmed that ILS 17 conformed to specification. On 12 February 2011, three filter (linearity) checks were completed on IRVR 17 to determine its accuracy, the results were satisfactory. Accordingly, both the ILS and the IRVR system were operating normally and within specified tolerances at the time of the accident.

1.8.3 ILS Minima

IRVR transmissometers were installed on RWY 17. The transmissometers measure runway visibility at the touchdown, midpoint and stop-end positions and provide this information to ATC.

On RWY 17, when low visibility procedures are in force, a CAT II approach is available to suitably equipped aircraft flown by appropriately qualified flight crew. Only RWY 17 may be used for CAT II operations. The following minima were applicable for ILS (precision) approaches:

Runway	Category (CAT)	Decision Height (DH)	Minimum IRVR (Touchdown Zone)
17	II	100 ft	300 m
17	I	200 ft	550 m
35	I	200 ft	750 m

1.8.4 Low Visibility Procedures (LVPs)

LVPs apply at EICK when the cloud ceiling is below 200 ft and either the IRVR is less than 550 m or the meteorological visibility is less than 800 m. The IRVR values are given in the order of touchdown, midpoint and stop-end. During LVPs ATC procedures require that only changes to IRVR values are transmitted to aircraft on approach.

The aerodrome must be secured during LVP operations and all airfield perimeter gates locked with 'CAT II' locks. The Investigation confirmed that these procedures were complied with at the time of the accident and that no incursions were made to the protected area.

1.8.5 NOTAMs Regarding Navigation Aids

At the time of the accident, three NOTAMs were valid regarding navigation aids at EICK:

```
A1269/09    Cork ILS MM RWY 35 Completely withdrawn
            FROM: 19 Oct 2009 11:00       TO: Perm

A1270/09    Cork ILS OM RWY 35 Completely withdrawn
            FROM: 19 Oct 2009 11:00       TO: Perm

A1584/10    ILS Locator Outer RWY 35 OB Freq 362 kHz
            Completely withdrawn
            FROM: 1 Dec 2010 10:00         TO: Perm
```


These NOTAMs refer to the approach aids on RWY 35. The Middle Marker and Outer Marker were withdrawn from use permanently on 19 October 2010, with the 'OB' Locator withdrawn from use permanently on 1 December 2010. The availability of DME to provide a suitable fix during an approach permitted the permanent withdrawal of these navigation aids.

1.9 Communications

The accident aircraft communicated with the following ATC units during descent into EICK: Radar (118.800 MHz), Approach (119.900 MHz), and Tower (119.300 MHz). There was no failure or downgraded communication on the recordings of communications between the Flight Crew and ATC units at any point in the flight.

The AFTN[25] messages regarding the flight plan and progress of the flight between ATC units were routine. A transcript of communications with Shannon Control, Cork Approach, Tower and Ground are reproduced in **Appendix G**.

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[25] **AFTN**: Aeronautical Fixed Telecommunication Network.

The flight was under ATC radar coverage for its entire route, being controlled by Shannon ATC following handover from Aldergrove Radar, and prior to handover to Cork Approach radar during descent. Cork ATC has one Approach Radar Unit, manned by one Approach Controller (APP). The Tower comprises two positions, an Air Movements Controller (AMC), and a Surface Movements Controller (SMC). Flights intending to operate in controlled airspace must file a Flight Plan with ATC. For commercial scheduled operations, these plans are often filed as a Repetitive Flight Plan (RPL). The Flight Plan contains information pertinent to the safe control of the flight. Should the radar service be downgraded for any reason ATC have sufficient information to control the flight procedurally. The approach capability of a flight is not indicated on flight plans, and ATC is not provided with information regarding the approach minima required by a flight.

1.10 Aerodrome Information

Cork Airport is situated 3.5 NM South of Cork City at a mean elevation of 502 feet AMSL[26]. The main runway, RWY 17, consisted of a grooved concrete surface 2,133 metres in length by 45 metres wide aligned on a bearing of 165 degrees magnetic (°M). This runway was equipped with a Hi-Intensity CAT II Approach Lighting System (HIALS-II), Precision Approach Path Indicator (PAPI), threshold, centreline, edge and end lighting. RWY 35, on a reciprocal heading, was equipped with a Simple Approach Lighting System (SALS) and PAPI. Due to the standard of the approach lighting on RWY 35 higher approach minima applied.

The high intensity approach and runway lighting aids were fully operational and set at maximum brilliance during all three approaches conducted by EC-ITP.

1.11 Flight Recorders

1.11.1 General

The Cockpit Voice Recorder (CVR) and Flight Data Recorder (FDR) were both recovered from the aircraft on the day of the accident. The FDR, a solid state device, was brought under escort to Dublin for data extraction by the AAIU. The CVR, a tape based device, was brought under escort to the UK for download by the AAIB.

1.11.2 Cockpit Voice Recorder

The Cockpit Voice Recorder System[27] consisted of the CVR unit itself and a control unit. The system is designed to provide multiple channels for recording transmitted or received voice signals that originate at the pilot's station, co-pilot's station, the public address system, and the cockpit area.

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[26] **AMSL**: Above mean sea level.

[27] **Cockpit Voice Recorder System**: The ATC exchanges with EC-ITP during the last 29 minutes of flight were also recorded on the tape-based CVR. The Investigation notes that the CVR timings of these recordings could vary by some seconds from the timings of the digital ATC recordings. This timing variation is a known artefact of tape-based CVRs.

The CVR fitted to EC-ITP was a Fairchild Model A100, P/N 93-A100-83, S/N 61573. It had been overhauled, inspected and installed in EC-ITP on 8 October 2010 replacing a defective CVR identified during maintenance.

The CVR recording comprised four tracks:

Track No.	Recorded Source	Notes
1	Passenger Address audio	Audio barely identifiable
2	Co-pilot audio	Recovered to good quality audio
3	Pilot audio (Commander)	Good quality audio
4	Area microphone	Good quality audio

On playback, Track 1 was barely identifiable even when played on maximum volume setting; faint audio was detected at the time of the event which appears to be consistent with the Track 3 file. Track 2 did not appear to have any valid audio recorded on initial playback; the tape was removed from the CVR and played back through hi-gain equipment which provided good quality audio. Track 3 had good quality audio recording consistent with a pilot position. Track 4 had good quality audio of engine sounds consistent with what is recorded by an area microphone.

The CVR recorded 28 minutes and 59 seconds until it ceased recording during impact. The recording commenced while the aircraft was entering the ROVAL hold prior to beginning the third and final approach. The CVR recording did not have dedicated time synchronisation data. Timings of CVR events were made relative to the end of the CVR recording in minutes and seconds, the extracts from the CVR are to the nearest second.

The recording begins with general conversation in a light-hearted tone. The Commander had difficulty in entering the ROVAL holding pattern in the GPS, the Co-pilot recalled: '*I did it once but I can't quite remember how I did it*'. Following receipt of EIWF (Waterford) weather a brief discussion ensued with the Co-pilot commenting '*it's worse than here*'. At 09.27 hrs, the Commander checked for nearby alternates, probably with reference to a chart. EIKY (Kerry) was first mentioned as a prospective alternate:

Time to end of CVR recording (min:sec)	Source	Transcript[Investigation notes]
23:22	Commander	*Nearest airport…Cork…this one that is VFR, this one is VFR, this one… which one is this one?*
23:14	Co-pilot	*VFR's not too bad if it's eh…*
23:11	Commander	*ILS…Kerry*

Cork Approach supplied the EINN (Shannon) weather to the Flight Crew at this time. EIDW (Dublin) weather was requested and ATC also offered to obtain weather for EIKY.

Shortly after this, a comment was made by the Commander regarding the fuel flow: *'We're burning around three hundred and fifty. Reduce a bit more the power, okay.' For holding I put flap one quarter okay…Maybe…if I can reduce a bit the fuel flow…I will be happier'*.

At this point the weather for EIKY was passed by Cork Approach Control while conditions at EIDW were being obtained. At this time a diversion to EIKY was still being considered by the Commander as shown by the following CVR extract:

Time to end of CVR recording (min:sec)	**Source**	**Transcript [Investigation notes]**
20:05	Commander	*Okay said ten kilometre or more or ten kilometre*
20:02	Co-pilot	*Ten kilometres or more yeah all the nines*
19:59	Commander	*Yeah but anyway its five and five here*
19:50	Commander	*To Kerry…to Kerry…*

There were no further comments until 09.32 hrs, when another commercial flight [Callsign #], also inbound to EICK, called enquiring as to the latest weather conditions:

Time to end of CVR recording (min:sec)	**Source**	**Transcript [Investigation notes]**
18:05	[Callsign #]	*Roger just over Strumble*[28] *at the moment working London what's the eh* [transmission clipped]
17:58	Approach	*Surface wind zero nine zero degrees seven knots, ah…visibility three hundred metres in fog, broken at one hundred, IRVR's runway one seven now is four hundred metres all round.*
17:42	[Callsign #]	*Eh does it look like there's any improvement on the way or is it well down?*
17:39	Commander	*See it's improving a little bit now it's four hundred*
17:37	Approach	*There's just a very slight improvement in the last couple of minutes from ah… from about three two five metres up to four hundred but ah it seems to be holding at that now again.*
17:28	[Callsign #]	*Okay and last question have you had any recent arrivals on one seven?*
17:24	Approach	*No arrivals I have one aircraft holding at ROVAL at the moment he's been holding for ten minutes or so at this stage*
17:17	[Callsign #]	*Okay we'll talk to you on the handover, thanks* [Callsign #]

[28] **Strumble**: Radio navigation aid on the Welsh coast.

17:12	Commander	*Well… fortunately its improving a little bit*
17:06	Commander	*I'm glad I'm lucky to have a good co-pilot my friend*
17:03	Co-pilot	[laughter]
16:55	Commander	*See Kerry is in about eleven minutes*
16:52	Co-pilot	*Yeah*
16:51	Commander	*Okay*
16:49	Co-pilot	*At least we know the weather's alright there so we've got it you know got it as a* [conversation crossed]

Cork Approach then copied the EIDW weather to the Flight Crew. The Commander decided to continue in the holding pattern at point ROVAL:

Time to end of CVR recording (min:sec)	**Source**	**Transcript [Investigation notes]**
16:04	Commander	*All copied ahh thank you very much and ah you said before that the weather is a little bit improving in eh in Cork?*
15:54	Approach	*Okay just a slight improvement here now the ah IRVRs are at four hundred metres all round*
15:46	Commander	*Okay in that case we will continue holding for for a little bit more and eh hopefully eh become better*
15:39	Approach	*Okay just another little improvement now at runway one seven, touchdown zone is four hundred and fifty, midpoint four hundred, stop end four hundred*
15:29	Commander	*All copied in that case we'll hold a little bit more and eh hopefully it's going to improve a little more, thank you*
15:23	Approach	*Roger, I'll keep you advised*

Following a discussion between the Flight Crew on an unrelated topic Kerry is again mentioned:

Time to end of CVR recording (min:sec)	**Source**	**Transcript [Investigation notes]**
12:54	Co-pilot	*Kerry's alright*
12:53	Commander	*It's alright okay so…In case we'll proceed in the beginning there*
12:47	Co-pilot	*Yeah*
12:42	Co-pilot	*I think its worth holding for a bit and then just seeing if it gets any better then*
12:40	Commander	*Sorry*

12:39	Co-pilot	*I think its worth holding for a bit if it's starting to get a bit…*
12:36	Commander	*Yeah*
12:23		[sound of a bag being zipped or unzipped]
12:15	Commander	*I always bring with me… brought with me… some notes…about the…alternative and all this kind of things and I never use it and now I don't have it here*
11:51	Co-pilot	*Is that the thing that's pinned up on the board in the office*
11:48	Commander	*Yeah exactly*

Shortly after this exchange the decision to attempt a third approach was made:

Time to end of CVR recording (min:sec)	**Source**	**Transcript [Investigation notes]**
10:58	Approach	*Flightavia four hundred Charlie Cork, another improvement now in the IRVR runway one seven touchdown zone five hundred metres, midpoint four hundred fifty, stop end four hundred*
10:45	Commander	*Okay eh in that case we'll proceed, do you confirm that is for the runway one seven*
10:37	Approach	*Affirm sir runway one seven touchdown zone five hundred metres*
10:33	Commander	*Okay in that case eh…any chance to proceed to vectors to perform one approach there...* [unintelligible]
10:26	Co-Pilot	*Yeah*
10:25	Approach	*Four hundred Charlie affirm no problem, you can turn left please heading three zero zero*
10:18	Commander	*Left heading three zero zero Flightavia four hundred Charlie*
10:14	Approach	*Affirm expect a right hand pattern then for runway one seven joining finals at about twelve miles or so*
10:08	Commander	*Okay right pattern no problem four hundred Charlie*

There followed routine exchanges between the Flight Crew and Cork Approach as the aircraft was positioned under radar guidance for an approach to RWY 17.

As the Flight Crew set the navigation receivers for the approach the Commander briefed regarding the approach with the DH and go-around height identified, but IRVRs were not included. Shortly afterwards he briefed the go-around actions and the application of power by himself as PNF:

Time to end of CVR recording (min:sec)	Source	Transcript [Investigation notes]
8:44	Commander	*… Okay go-around in case I apply power flap one quarter Okay go-around flap positive rate gear up OK four hundred feet we clean the plane and that's it*

At the commencement of the third approach the touchdown IRVR reached the required minimum of 550 m. The touchdown RVR of 550 m lasted for less than 1 minute and reduced below that required prior to the aircraft reaching the OM equivalent point:

Time to end of CVR recording (min:sec)	Source	Transcript [Investigation notes]
5:12	Approach	*Flightavia four hundred charlie roger clear for the approach you're eleven miles from touchdown IRVR now runway one seven touchdown zone at five hundred fifty metres*
5:03	Commander	*That sounds great thank you flightavia four hundred Charlie*

The final part of the transcript contains the final four and a half minutes of the CVR recording. The stall warning horn aural alarm sounded continuously during the final seven seconds.

Time to end of CVR recording (min:sec)	Source	Transcript [Investigation notes]
4:36	Commander	*Tower good morning again this Flightavia four hundred Charlie we're established nine miles inbound*
4:31	Tower	*Flightavia four hundred Charlie good morning to you again, you are cleared to land runway one seven, the wind is zero nine zero degrees niner knots*
4:24	Commander	*Cleared to land one seven, Flightavia four hundred Charlie*
4:22	Tower	*Touchdown RVRs five hundred midpoint four hundred stop end four hundred*
4:16	Commander	*Copied thank you very much*
4:15	Co-pilot	*It's gone down woa I want the other guy's RVRs they were better*
4:11	Commander	*Yeah fifty feet less*
4.09	Co-pilot	*Yeah*
4:00	Co-pilot	*Glideslope coming in*

3:56	Commander	*Not mine, ILS now, no this is is working very very well, okay capture perfectly glideslope coming*
3:45	Co-pilot	*Yeah…speeds okay*
3:42	Commander	*Yeah I took control of the power okay*
3:39	Co-pilot	*Yeah no problem that's fine yeah*
3:26	Commander	*Okay capture*
3:24	Co-pilot	*Capture*
2:55		[High pitched chime]
2:54	Commander	*Okay missed approach three thousand*
2:52	Co-pilot	*Thank you*
2:48	Commander	*So its half down three green*
2:44	Co-pilot	*Three greens*
2:44	Commander	*All the lights on and all is down okay*
2:37	Commander	*Aw yes now the weather it is much better*
2:34	Co-pilot	[laughter]
2:26	[unknown]	[low human humming of a musical melody for approximately 3 seconds]
2:10	Tower	*Zero niner zero degrees niner knots*
2:07	Commander	*Copied thank you*
2:05	Commander	*Okay…take all this*
2:02	Co-pilot	*Yes please*
1:53	Commander	*Okay loc capture very good…for this one*
1:48	Co-pilot	*Thank you*
1:39	Commander	*Okay very good localiser very good eh glideslope*
1:15	Commander	*Okay capture again very good…sorry it's eh six hundred for minimum*
1:09	Co-pilot	*Thank you*
0:57	Commander	*Okay five hundred for minimum*
0:45	Commander	*Three hundred for minimum*
0:38	Commander	*Watch out… glideslope*
0:36	Commander	*Two hundred for minimum*
0:33	Commander	*Localiser*
0:31	Commander	*Localiser…yeah*
0:28	Commander	*One hundred for minimum*
0:25	TAWS	'FIVE HUNDRED'
0:22	Commander	*Okay…* [unintelligible]
0:21	Commander	[unintelligible]
0:19	TAWS	'FOUR HUNDRED'
0:17	TAWS	'THREE HUNDRED'
0:15	TAWS	'MINIMUMS, MINIMUMS'
0:13	Commander	*Okay minimum…continue*
0:11	TAWS	'TWO HUNDRED'
0:10	Co-pilot	*Okay*

0:09		[Engine power reduction, with a coarse cyclic sound audible, followed by an increase in power approximately 3 seconds later]
0:07		[Stall warning tone begins and continues to the end of recording]
0:05	TAWS	'ONE HUNDRED'
0:04	Commander	*Go-around*
0:04	Co-pilot	*…round*
0:04	TAWS	'FIFTY'
0:02	TAWS	'FORTY'
0:02	Flight Crew	(Exclamation)
0:00		[End of recording]

1.11.3 Flight Data Recorder

The FDR fitted to EC-ITP was a Fairchild Model F1000, P/N S703-1000-00, S/N 00648, and was manufactured in June 1993. The FDR begins recording when the aircraft batteries are switched on and continues to record until the batteries are switched off. The unit, which was not damaged in the accident, was brought to the AAIU Recorder Laboratory for data extraction. To facilitate the conversion of data, an operator is required under Council Regulation (EEC) No 3922/91 as amended by Regulation (EC) No 859/2008, hereinafter referred to as EU-OPS, to make available information termed the 'data frame layout.'[29] Following several requests, the Operator was unable to supply this information to the Investigation. In the absence of this information, the Investigation developed a layout with the assistance of the NTSB. Using this layout, the Investigation was able to read the data recorded on the FDR and to decode it into relevant engineering units. The following table sets out the parameters which were decoded from the FDR recording:

Item	Parameter
1.	Pressure Altitude
2.	Left Engine N1 (% RPM)
3.	Left Engine N2 (Torque)
4.	Right Engine N1 (% RPM)
5.	Right Engine N2 (Torque)
6.	Flap Position
7.	Normal Acceleration
8.	Magnetic Heading
9.	Pitch Attitude
10.	Indicated Airspeed
11.	Roll Attitude

[29] **Data Frame Layout**: A document used to provide details of the programming method used by the data acquisition system, the location of parameters, number of bits used to encode parameters, type and method of encoding; the functions used to convert the recorded value into the actual physical value. For each parameter, the conversion function is checked with the calibration of the measuring and processing channel.

Recorded data for the last 106 hours of operation was recovered by the Investigation. Graphics of the FDR data (converted to engineering units) for the first approach and go-around, the second approach and go-around and the third approach and impact are reproduced in **Appendix H**.

Inspecting the data for the two go-arounds and the accident approach showed only Flap 0, Flap 1 and Flap 2 readings. On the landing prior to the accident flight, and on many other landings in the earlier recordings, Flap 3 was also in evidence. The CVR recording contained references to 'quarter flap' and 'half flap', which corresponded to the Flap 1 and Flap 2 readings that were seen in the FDR data. Flap 3 corresponds to Full Flap setting.

The graph in **Figure No. 5** shows the final 20 seconds of relevant parameters recovered from FDR data. Aircraft heading, not shown for clarity, was consistent with the roll readings. Until approximately 9 seconds before impact, the indicated airspeed recorded by the FDR was consistent with engine power settings and expected aircraft performance. The first significant event was a reduction of delivered engine torque from both engines, commencing approximately 9 seconds before impact, accompanied by a decrease in airspeed.

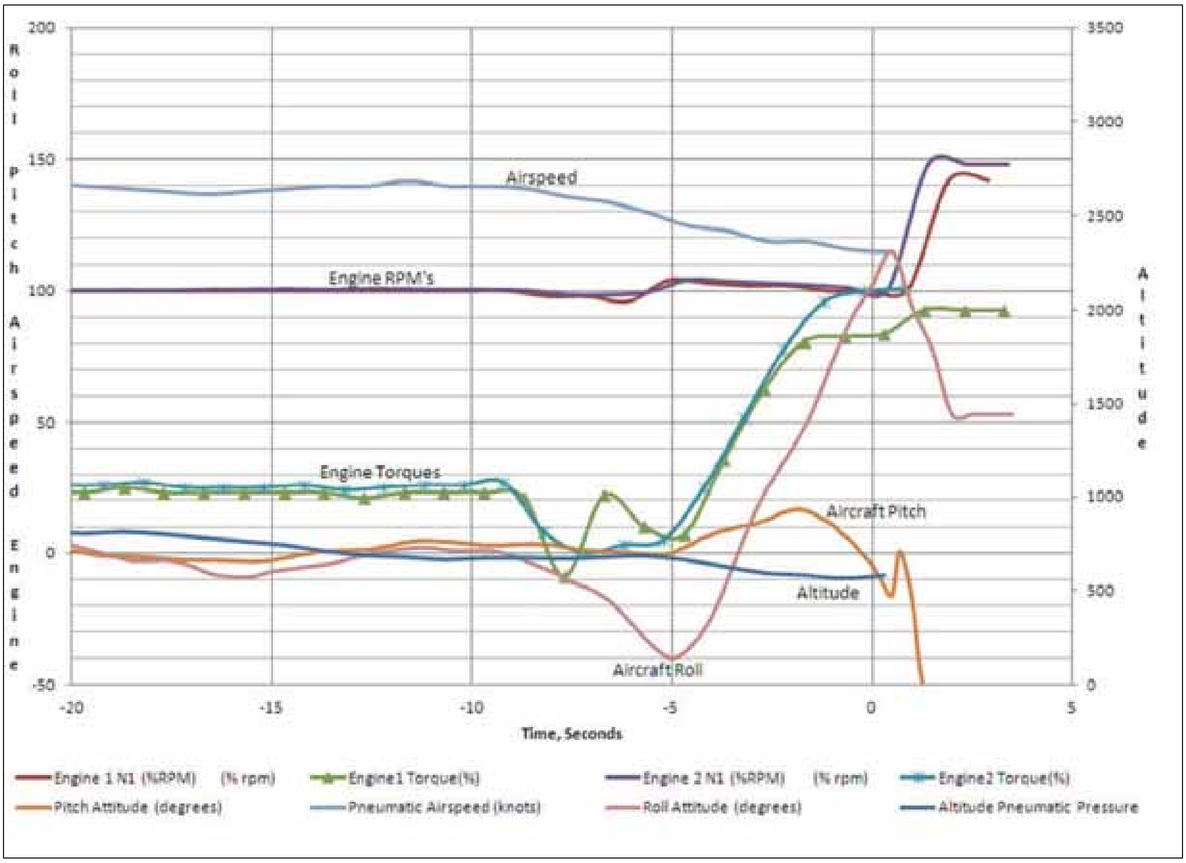


Figure No. 5: FDR data for final 20 seconds of recording

Coincident with the reducing torque values, the aircraft began a roll to 40 degrees to the left. As both engine torques increased (approximately 5 seconds before impact), the pitch attitude increased and the airspeed continued to decay. Concurrently, the aircraft commenced a roll to the right past the vertical as torque values increased towards 100%. Note that the x-axis represents time measured in seconds with the '0' point representing a time approximately one second before commencement of the impact sequence, when the values of recorded parameters became unreliable.

The mismatch and differences between the engine No. 1 and No. 2 torque curves are further discussed in **Section 1.16.4**, Recorded Engine Parameters during the Final Seconds of the Flight.

1.12 Wreckage and Impact Information

1.12.1 General

The aircraft wreckage was found in an inverted position, 189 m from the initial contact point and 72 m to the right of the runway centreline. All three landing gear legs were extended and undamaged. The forward fuselage was severely crushed; fire and impact damage occurred to both engines (**Photo No. 4)**.

Photo No. 4: Final resting position of EC-ITP

The debris field, which commenced from the runway centreline, included the outer section of the right wing, the nose radome and three propeller blades from the No. 2 engine which detached during the impact sequence. The top of the fuselage had fractured and opened during the impact sequence and, following departure from the paved area, a large quantity of wet soil/mud entered the forward cabin area through the opening.

The aircraft first contacted the runway 86 m from the threshold lights (which are approximately 5 m prior to the threshold marking). The initial contact point was narrow, 2.3 m long at an angle of 30 degrees and 2.2 m to the left of the runway centreline (**Photo No. 5**). The contact mark contained green glass fragments that matched the colour of the aircraft's right wingtip navigation light.

This initial contact point was taken as the datum for the wreckage plot and a reference line was defined along a heading of 195°M. The wreckage distribution and debris trail was recorded using direct measurement with reference from the datum and the centreline. Components were identified and tagged prior to recovery. A table of the debris field is reproduced in **Appendix I**.

A series of propeller witness marks from the right propeller began 19.8 m after the datum point and continued for 3 m. A large impact mark was located at 25.8 m; the centre of this area exhibited extensive scraping of the runway surface. Numerous small fragments of aircraft structure were found in this location together with a crushed wiper blade from the cockpit main window.

The debris field continued into the grass to the right of the runway, where the nose radome was found at 66.9 m and the outer right wing section at 96 m from the datum point. Two detached propeller blades from the No. 2 engine were found in the general debris field, at 10 and 23 m left of the reference line. A third blade was found adjacent to the runway centreline, 85 m left of the reference line.

An impact mark was evident towards the right edge of the runway; small fragments of red navigation lens material were found at the edge of this impact mark, indicating left wingtip contact. Evidence of fire on the main wreckage was limited to the engine nacelles of each engine and the area of the fractured right wing. No evidence of fire damage was found in the debris trail or the runway surface.

Photo No. 5: Point of initial wingtip contact (identified by the yellow reference mark), debris trail and final position of wreckage

1.12.2 Fuselage

The forward upper fuselage was severely crushed and flattened. The left side of the aircraft had a lengthwise fracture from the main entry door toward the cockpit. A witness mark from the left propeller was found in the middle of the fracture. The tip of a left propeller blade penetrated the wall of the forward cabin; the root of this blade remained attached to the propeller hub. Forward of the wing, the fuselage had partially torn toward the belly.

The cargo door, situated at the rear of the fuselage, had been forcibly opened by AFS personnel and was the primary route by which the passengers were extricated. The remnants of a divider wall from between the passengers and cargo was found outside of the aircraft; this had been removed by AFS personnel in order to provide access for the rescue of occupants.

During recovery of the wreckage the crown of the fuselage was found split, with the right end of the split terminating at the window which was forward of the cabin right hand over-wing emergency exit. Apart from the deformation associated with striking the ground inverted, the fuselage remained intact, aft of the split in the top of the fuselage. Once the forward fuselage was cut from the aft wreckage by the Investigation a crush line was visible. The angle of the crush line was determined by reference to the nose landing gear strut and was found to be 138 degrees right bank from the normal attitude.

The upper right of the radome, which had detached from the nose of the aircraft, had extensive abrasion externally and delamination internally. The lower left structure of the radome was relatively intact.

1.12.3 Wings

Both wings were extensively damaged outboard of the engine nacelles. The complete left wing remained attached to the fuselage. The left wing flaps, aileron, and spoiler panels were found relatively intact, other than impact damage to and around the inboard end of the inboard flap. The outboard portion of the left wing had been flattened and the leading edge was found creased. The top surface had the sharp scuffs consistent with runway contact. A general diagonal downward bend extended from the leading edge near the engine nacelle, toward the trailing edge of the wing tip. At the mid-span, the wing-skins aft of the leading edge had accordion-like crush damage. Fuel leaked from splits in the wing skins, primarily along the leading edge from the left wing fuel tank.

The portion of right wing and flap that remained attached to the fuselage ended several feet outboard of the right engine nacelle. Damage to the right wing had three distinct visible areas; the outboard section, the mid-section and the leading edge. The remnants of the wing attached to the nacelle had extensive fire damage (**Photo No. 6**). The structure had broken downwards at the outer end of the fractured wing.

Photo No. 6: Damage to right wing

The mid portion of the outer right wing was found as torn and crushed fragments. The leading edge had accordion-style crush damage. The outboard section of the right wing was found to have broken upward from the fragmented mid-section. This break was located at the end of the fuel carrying portion of the wing where the design bolted an extension to the fore and aft spars.

The break extended from the landing light cut-out in the leading edge to the outboard end of the aileron in the trailing edge. This piece of wreckage had clear crush damage at the tip of what had been the wing. The angle of the crush damage was 3 degrees past vertical for the bottom wing skin in right bank. In pitch, the leading edge was 20 degrees nose down and the trailing edge was 5 degrees nose down.

1.12.4 Engines

The engines remained attached to the wings, with the right engine and nacelle being more damaged than the left. The engine manufacturer was asked about the potential for non-volatile memory items that could be recovered. The manufacturer stated that no such devices were installed, nor were any such third-party devices installed.

The aircraft had a water injection system that provided the capability of increased thrust for take-off. The water tank component of the water injection system was situated in the nose compartment of the aircraft. The tank was fractured during the impact sequence.

Both engines were shipped to the manufacturer for further examination under the supervision of the Investigation.

1.12.4.1 Engine No. 1 (Left) S/N P-70204

The site examination revealed that the engine case had no uncontained failures. The accessories remained attached to the engine. The engine inlet was found packed full of soil. No metal splatters were found in the exhaust pipe and all of the turbine blades appeared intact. The blades and other components had a sooty appearance.

Following shipment to the Manufacturer, external examination confirmed that the engine was intact, with impact damage but with no evidence of uncontained failures or case breaches. The aft section of the engine exhibited light external fire/thermal damage with soot. Portions of the fuel manifold fire sleeve, located on the left-hand side, exhibited thermal damage but were intact. Electrical wire coverings showed no signs of thermal damage. The forward engine mounts, located on the accessory drive housing were intact. The engine truss was also intact and exhibited impact damage.

The engine was subject to a detailed strip inspection, including verification of part and serial numbers. The engine was disassembled in the following order: the Output Gear Case and Accessory Drive Housing; the Compressor Section, comprising the 1st and 2nd Stage compressor impeller and diffuser assemblies; the Combustion Section and the Turbine Section comprising 1st, 2nd and 3rd stage turbine rotors and stators.

In the Combustion Section, all fuel nozzles were in place with their bolts installed, safety-wired. One secondary fuel nozzle junction fracture was located at the bottom of the engine, the remaining fuel nozzles and fuel manifolds were undamaged. This fracture was consistent with impact damage.

1.12.4.2 Engine No. 2 (Right) S/N P-70189

The site examination revealed that this engine case also had no uncontained failures. The accessories remained attached to the engine. The engine inlet was found packed full of soil. The exhaust blades could not be moved by hand. The nacelle suffered significant distortion. In the exhaust pipe, no metal splatters were found and all of the blades appeared intact. The blades and general features had a slightly sooty appearance.

Following shipment to the Manufacturer, external examination confirmed that the engine was intact, with impact damage but with no evidence of uncontained failures or case breaches. The aft section of the engine exhibited external/thermal damage with soot. Some of the fire sleeves were not in place on the right-hand side exposing electrical wiring; the insulation on these electrical conductors was intact. The forward engine mounts were intact. The engine truss was intact but exhibited some impact damage.

One (lower-right) truss attachment bolt was missing and the bolt-hole area was covered in soot, consistent with the bolt being absent prior to the effects of fire. This did not affect the operation of the engine.

1.12.5 Propellers

The propeller blades were found attached to the hub of the Left Propeller assembly, however, blade No. 1 separated during the recovery operation. One blade remained attached to the hub of the Right Propeller assembly; the three other blades had separated during the impact sequence.

1.12.6 Flight Controls

The control columns and base were removed by the AFS in order to gain access to the occupants of the flight deck. The right hand grip of Co-pilot's control column was found fractured being retained only by internal wiring (**Photo No. 7**). The Commander's control column was unbroken. The rudder pedals at both pilot positions were intact.

The vertical stabiliser had a visual pitch trim indicator marking, showing the allowable position of the horizontal stabiliser for take-off (black band), and limits (red markings). The horizontal stabiliser was found to be positioned within the black band range and slightly towards a nose down trim setting.

Elevator and rudder control cable continuity was established from the tail to where the control cables had been severed by the AFS adjacent to the main cabin door.

Aileron control continuity was not established in its entirety due to the extensive damage sustained to the right wing and aileron which had severed.

Photo No. 7: Co-pilot control wheel showing fracture of right-hand control grip

The wing flaps were found partially extended, symmetrically on both sides. The flap surface deployment was measured at approximately 18 degrees relative to the flap zero position; this is consistent with a selected flap ½ position (Flap 2) and with FDR data.

All flight control surfaces were accounted for in the main wreckage.

1.12.7 Landing Gear

All three landing gear legs were found fully extended. The landing gear tyres showed no evidence of abnormal runway contact; the treads did not have diagonal scuffs or diagonal shoulder damage. All tyres were inflated. The left main landing gear inboard tyre was worn beyond the depth of the tread grooves, the other tyres had varying amounts of tread remaining. The landing gear selection lever was found in the down position, consistent with the position in which the landing gear was found.

1.12.8 Controls and Indicators

The engine control quadrant and control linkages were damaged by impact. As a result of this damage, the power levers and speed (RPM) levers were restricted in movement. The left Beta latch lever was found in the normal (down) position. The right Beta latch lever was found in the raised position (**Photo No. 8**). Both power levers were bent to the right. When the levers were straightened with minimal pressure, both mechanisms functioned correctly.

Photo No. 8: Left and Right Beta Latch lever positions

The quadrant with the flap selector and associated markings was destroyed by impact and no definitive information could be derived regarding the position of the flap selection lever. The flap position gauge indicated '0'.

The Engine & Prop Heat switch positions were disrupted by impact. Light bulb analysis of the 'Left Intake Heat On' and 'Right Intake Heat On' lights on the annunciator panel showed that they were not illuminated at the time of impact, indicating that the respective Engine & Prop Heat switches were in the OFF positions.

Light bulb analysis of the Left & Right Beta lights showed they were not illuminated at impact.

1.12.9 Aircraft Documentation

Regulatory and operational documentation was found on board the aircraft during examination of the wreckage. This included the Aircraft Technical Log, the AFM, the Minimum Equipment List (MEL) and a complete set of *Jeppesen Airway Manuals* for operation in Europe and North Africa.

The current Certificate of Release to Service (CRS) for the aircraft, issued at the end of the last maintenance check was located in the Aircraft Log Book (*Cuaderno de Aeronave*) which is a document required by Spanish Law to be carried on board an aircraft and which records basic flight information including passenger numbers, flight origin and destination. It is not used to record aircraft defects.

The insurance certificate found in the wreckage of EC-ITP was valid until 23 February 2011. The certificate was issued to the Owner with the Operator named as '*additional Insured as operator*'. The document was headed with a policy number for the previous AOC holder.

A number of different operators' Emergency Safety Instructions cards were found on the aircraft. Those operators were Aerolitoral (Mexico), Topfly (Spain), Flightline (Spain) and Manx 2 (Isle of Man).

1.12.10 Recovery Operation

The aircraft wreckage came to rest in soft ground which became very water-logged by the amount of water agent used at the site. The aircraft batteries (located between each wing root and engine) were disconnected to de-power all electrical systems. The oxygen system was checked and the line from the oxygen supply bottle to the cockpit was found to be de-pressurised due to fracture.

Following examination of the flight controls, the outer section of the left horizontal stabiliser was removed to facilitate subsequent transport. Due to the nature of the soft ground, the wreckage was then lifted as a single unit using a 70-metre crane situated on the paved runway surface. Once secured on a low-loader, the wreckage was positioned to the cargo apron. The fuselage was then cut fore and aft of the wing carry-through structure for transportation. This cutting sequence reduced disturbance of the cockpit section, which was left in-situ on the low-loader following the initial lift operation. The rear fuselage section was lifted on to a second low-loader and the wing and centre section fuselage section was secured on a third low-loader.

The wreckage was transported under escort to the AAIU facility at Gormanston, County Meath, on the morning of 13 February 2011 for further detailed technical examination. On arrival the wreckage was orientated right-way-up with the centre section was stabilised by means of a scaffolding structure. Approximately 2 tonnes of soil were removed from the forward fuselage during its examination.

Access to the cockpit compartment was made using cutting and lifting equipment to facilitate inspection of the controls and removal of instrumentation and avionics equipment. Both engines and propellers were removed and crated for further examination in the United States.

1.13 Medical and Pathological Information

1.13.1 General

Post Mortem Reports for each of the deceased persons were made available to the Investigation by the Coroner for South and West Cork.

1.13.2 Flight Crew

Report No. C114/11 relating to the Aircraft Commander, states that the cause of death was due to: *'Severe head, chest and abdominal injuries due to blunt force trauma'*. The Toxicology Report showed that carbon monoxide, ethanol, prescribed drugs, or drugs of abuse were not detected. A NSAID[30] screen showed trace amounts of 'Ibuprofen'[31]. There were no recent fractures of the hand bones identified.

The Investigation recovered a number of Ibuprofen tablets from the Commander's flight bag sealed in foil packs. No tablets were used from the two foil packs recovered.

Report No. C118/11 relating to the Co-pilot, states that the cause of death was due to: '*Blunt force trauma to the head and thorax*'. Carbon monoxide, ethanol, prescribed drugs or drugs of abuse were not detected. Fractures of the hand and wrist bones were identified, also fractures to the right and left humeri.

1.13.3 Passengers

The Pathology Reports concerning the four deceased passengers contained information relating to their injuries which were consistent with those persons having being involved in an aircraft accident.

Four of the six passengers who survived suffered serious injuries consistent with having being involved in an aircraft accident.

1.14 Fire

On the day of the accident, Cork AFS provided ICAO Category 7[32] fire cover, with hydraulic cutting equipment, emergency lighting and other equipment available in compliance with these requirements. Four Rescue and Fire-Fighting (RFF) appliances attended the scene accompanied by an Incident Command vehicle. These appliances carried the following agents: Water, FFFP Foam[33], Monnex dry powder and BCF[34]. Various other Airport Police and Fire vehicles provided support at the scene as and when required.

[30] **NSAID**: Non-steroidal anti-inflammatory drug.
[31] **Ibuprofen**: Name of medication used for the management of pain, fever or inflammation.
[32] **Category 7**: Aircraft length between 39 and 49 m, fuselage width 5 m.
[33] **FFFP Foam**: Film-Forming Fluoro Protein Foam, a biodegradable type of fire-fighting agent.
[34] **BCF**: Bromochlorodifluoromethane, type of fire-fighting agent.

Approximately 5,000 L of water and 300 L of FFFP Foam were used to suppress and extinguish the fires at the accident site. A similar amount of water and foam was used to establish and maintain a foam blanket for post fire cover at the scene. No BCF or Monnex dry powder was used.

The ATC Fire Station crash alarm was activated at 09.52 hrs. Four RFF appliances were immediately deployed. The ATC personnel in the Tower were unable to provide any guidance as to the position of the aircraft due to the poor visibility. However, the AFS located the position of the wreckage by the glow of the engine fires. AFO 1 was the first vehicle to reach the accident site at 09.53:25 hrs. Rescue 1 and Rescue 2 arrived approximately 30 seconds later; Rescue 4 arrived at 09.54 hrs and Rescue 8 at 09.55 hrs. The outer portion of the right wing had separated on initial contact and the contents of the wing fuel tank ignited. Both engines suffered a post impact fire (**Photo No. 9** and **Photo No. 10**). The first two appliances to arrive achieved a rapid knockdown of the fires using the vehicle mounted monitors. The AFS then extinguished the fires using hand lines thereby preventing fire reaching the fuselage and the occupants.

During deployment, three RFF appliances left the paved area and entered soft ground attempting to manoeuvre closer to the wreckage. The vehicles were unable to proceed closer, however the range of the monitors was sufficient to reach the wreckage and achieve a rapid knockdown of the fires. Local Authority Fire and Ambulance Services also supported the rescue operation as part of the South Region Major Emergency Plan which was initially activated and subsequently downgraded when the number of casualties became known.

Photo No. 9: Left Engine Fire damage

Photo No. 10: Right Engine Fire damage

1.15 Survival Aspects

Two Flight Crew and four passengers were fatally injured in the accident. Six passengers were rescued and brought to hospital, four of these passengers suffered serious injuries, two had minor injuries.

The cockpit and forward cabin were severely crushed in the impact, thus greatly reducing the volume of survival space. Furthermore, the opening in the upper fuselage allowed large amounts of soil to enter the forward cabin as the aircraft transited the grass area (**Photo No. 11**).

Photo No. 11: Forward view of inverted passenger cabin following rescue operation

The AFS could not gain entry into the aircraft by normal means as the passenger door at the front left of the fuselage was severely crushed and could not be opened. The three emergency exits in the cabin were unusable due to crushing and were also blocked with soil from inside the cabin (**Photo No. 12**).

Photo No. 12: Starboard Emergency Exits

The AFS gained entry via the rear baggage hold, using rescue equipment to open the cargo hold door at the left rear side of the fuselage. AFS personnel then removed baggage and the partition between the hold and the cabin before gaining access to the casualties.

An opening was made aft of the left wing to provide better access. In addition, the fuselage fracture in the vicinity of the main entry door was further opened by the AFS. Access to the flight deck was gained by cutting away a portion of the fuselage and the lower cockpit area.

The two rearmost passenger seats, which had partially separated from the floor during the impact, were removed by the AFS. The AFS crew then worked forward into the cabin using cutting equipment in order to reach the passengers. The Aerodrome Fire Officer could not say with certainty which seats were affected directly as a result of impact, however numerous seats were removed by AFS personnel. The conditions in the forward section of the aircraft were poor in terms of access and visibility compounded by the large amount of soil inside the cabin.

As casualties were removed from the aircraft they were brought to a triage tent which was erected on the runway adjacent to the accident site. Casualties were then transferred to Cork Regional Hospital by Local Authority Ambulances for treatment.

AFS personnel removed all but two of the passenger seats to gain access to the casualties. In most cases the aisle-side seat legs were cut; some of the seats were forcibly wrenched free resulting in twists and fractures to the seat legs. Following recovery of the wreckage to the AAIU facility, the seats were examined. The Investigation compared the cut and fractured seat legs on the removed seats and established the location of each passenger seat in the cabin prior to the accident. The examination revealed a non-standard layout and seat pitch on the right hand side of the aircraft (**Figure No. 4**).

The two pilot seats were equipped with 4-point harnesses; both seats remained secured to the cockpit floor. The harnesses were found open (probably as a result of the rescue effort). Both harnesses were examined and were found to function correctly. All passenger seats were equipped with lap straps. Seven of these lap straps had cuts which were consistent with those made by the AFS in order to release occupants, a further five were found open. The remaining six were found still fastened and intact, indicating that these seats were probably unoccupied during the flight. No failures of lap strap or attachment fittings were identified.

1.16 Tests and Research

1.16.1 General

Following initial site examination and recovery of the wreckage to the AAIU facility at Gormanston, the following components were sent for detailed technical examination:

1. Left and right propeller assemblies.
2. Left (No. 1) and right (No. 2) engines.
3. Left and right engine accessories and control units.
4. Cockpit instrumentation, comprising the Attitude Indicators, Horizontal Situation Indicators, Navigation Receivers, Slaving Accessories and No. 1 Directional Gyro.
5. Terrain Awareness Warning System (TAWS).

1.16.2 Propellers

Following initial inspection at Gormanston, the propellers were crated and sent to the manufacturer for detailed examination and disassembly. The examination was supervised by the AAIU with the assistance of the NTSB Accredited Representative and technical Advisors.

On inspection, the serial numbers indicated on the propeller blade identification stickers were inconsistent with the serial numbers embossed on the blade hubs. The adhesive stickers on the propeller blades reflected the correct hub identification number and blade position number, but had the serial numbers for the blades of the opposite propeller assembly.

A detailed inspection of the propeller hubs and blades was carried out and the positions of the detached propeller blades relative to their respective hubs were established. Examination of the butt of the No. 2 blade of the Right Propeller assembly revealed that all 4 pitch change pin installation bolt shanks remained in their respective bolt holes. The butt of the blade exhibited eight impact marks situated around the circumference of the blade – one of which was a shallow, round-bottom mark located almost 190 degrees (clockwise looking at the butt of the blade) opposite to the pitch change pin.

Using an exemplar propeller to match the location of the round-bottom mark found on the propeller butt to a blade angle, a blade pitch angle of approximately +40 degrees was observed at the 30-inch reference station. Based on the aircraft parameters of airspeed (115 knots), altitude (579 feet), propeller speed (1,591 RPM – 100%) and torque (approximately 1,000 SHP), the calculated position of the propeller blade pitch was approximately +37 degrees at the 30-inch reference station at the moment of impact. Using the same methodology on Blade No. 3, a blade pitch angle of approximately +40 degrees was observed at the 30-inch reference station, consistent with the finding of the No. 2 blade.

Examination of the butt of No. 2 blade of the Left Propeller assembly revealed a smooth round bottom mark at an angle approximately 180 degrees opposite the pitch change pin for that blade. Again, using the exemplar propeller to match the location of the round-bottom mark to a blade angle, a blade pitch angle of approximately +40 degrees was observed at the 30-inch reference station. A summary of the Propeller Examination Report is reproduced in **Appendix J**.

1.16.3 Control and Accessories Examination

The Fuel Control Units (FCUs), Propeller Governors and P_{T2}/T_{T2} Sensors were sent to the component manufacturer for examination at their facility under supervision of the NTSB.

The respective FCUs and Fuel Pumps were removed as units and separated for visual examination; no fractures of the housings were noted. The Propeller Governors were intact and appeared undamaged. The drive shafts turned freely by hand, and the governor control input mechanisms moved freely by hand and sprang back when released. The magnetic chip detectors, fuel filters and oil filters were removed from their respective gear cases and revealed no evidence of visible debris. The function test reports on the FCUs, Propeller Governors and P_{T2}/T_{T2} sensors were forwarded to the Investigation.

With respect to the FCUs and Propeller Governors, some measured parameters were found to be outside the specifications for the unit under test. It was found that the units could be brought into their specified performance ranges with minor adjustments. Following discussions with the NTSB and Manufacturer's powerplant specialists, the Investigation is satisfied that these out of tolerance parameters would have had no significant effect on powerplant performance. During laboratory examination, an anomaly was found on the P_{T2}/T_{T2} sensor associated with the No. 2 engine. The testing associated with the P_{T2}/T_{T2} sensor is summarised in **Appendix K** and the effects of the anomaly are set out in **Section 1.16.4**.

Service Bulletin (SB) No. WG64039 was issued by the component manufacturer on 3 April 1989, relating to the P_{T2}/T_{T2} inlet sensor component. The SB stated: '*Recent experience has revealed that some sensors returned from service have extensive interface corrosion damage on the braze joints.'* Compliance with the SB was to be accomplished at the next engine overhaul or no later than 1 March 1991, in addition it was recommended that the interface corrosion inspection procedure be performed at each subsequent engine overhaul. The engine manufacturer issued SB TPE331-73-0176 on 29 September 1989 citing *'Slow or cool starts, fuel limiting at maximum power conditions and/or power splits may be caused by a faulty inlet temperature and pressure* [P_{T2}/T_{T2}] *sensor.'*

The P_{T2}/T_{T2} sensor (S/N 2495266) associated with the No. 2 engine was manufactured and approved on 1 December 1999 according to FAA Form 8130-3. This component was installed new on the engine on 30 December 1999. According to SBs WG64039 and TPE331-73-0176, the component did not require a field inspection until the next scheduled engine overhaul which had not become due at the time of the accident.

In addition, SB TPE331-73-0176 was updated on 14 November 2012. Among the updates was the addition of component manufacturer's P/N 8901-016 into the SB. In addition, the periodicity for compliance with the SB was amended to read '*at the next scheduled overhaul or major continuous airworthiness maintenance (CAM) inspection'*.

1.16.4 Recorded Engine Parameters during the Final Seconds of the Flight

Analysis of FDR data showed that, from the earliest available data (106 hours prior to the accident) there was a mismatch between the recorded torques being delivered by the two engines. In general, the data showed that the torque being delivered by No. 2 engine exceeded that being delivered by No. 1 engine by up to 5%. It was also noted that, as the power levers for both engines were being advanced prior to take-offs, the torque response for No. 2 engine was faster than that for No. 1 engine.

FDR data also showed that prior to and on the day of the accident, the power levers were manually adjusted in normal flight to compensate for the engine torque differential. The AMM (71-00-30) specifies a maximum power lever split at the pedestal of 0.05 inch (1.27 mm) at Flight Idle and at maximum and cruise power during an engine ground run. The Engine Maintenance Manual (EMM) fault isolation procedure refers to an '*unacceptable power lever split on the ground with engine speed, torque and fuel flow matched*'.

FDR data shows that, as the aircraft descended towards the runway during the time period from 20 seconds to approximately 9 seconds before impact, the engine torque for the No. 1 engine was recorded at values generally in the range 21 to 23% while that for the No. 2 engine was in the range 25 to 27%, values which were consistent with those recorded at similar stages on other approaches.

A negative torque value (-9%) on the No. 1 engine was recorded approximately 8 seconds prior to impact. The next recorded values for this parameter, following at intervals of one second, were +22%, +10%, +7% and +36%. Thereafter recorded torque values for No. 1 engine rose rapidly. In a similar timeframe, the No. 2 engine torque values were recorded at +8%, 0%, +3%, +5% and +25%. Thereafter recorded torque values for No. 2 engine also rose rapidly to values in excess of 90%. The recorded reduction of torque to a negative value for No. 1 engine coincided with the commencement of a left roll which reached a maximum recorded value of 40°. Thereafter, as the torques on both engines increased rapidly, the aircraft rolled to the right culminating in a maximum recorded value of 115° of bank prior to impact.

Relevant FDR parameters for the final 20 seconds of the flight are illustrated in **Figure No. 5a** (this is a reproduction of **Figure No. 5** to assist the reader).

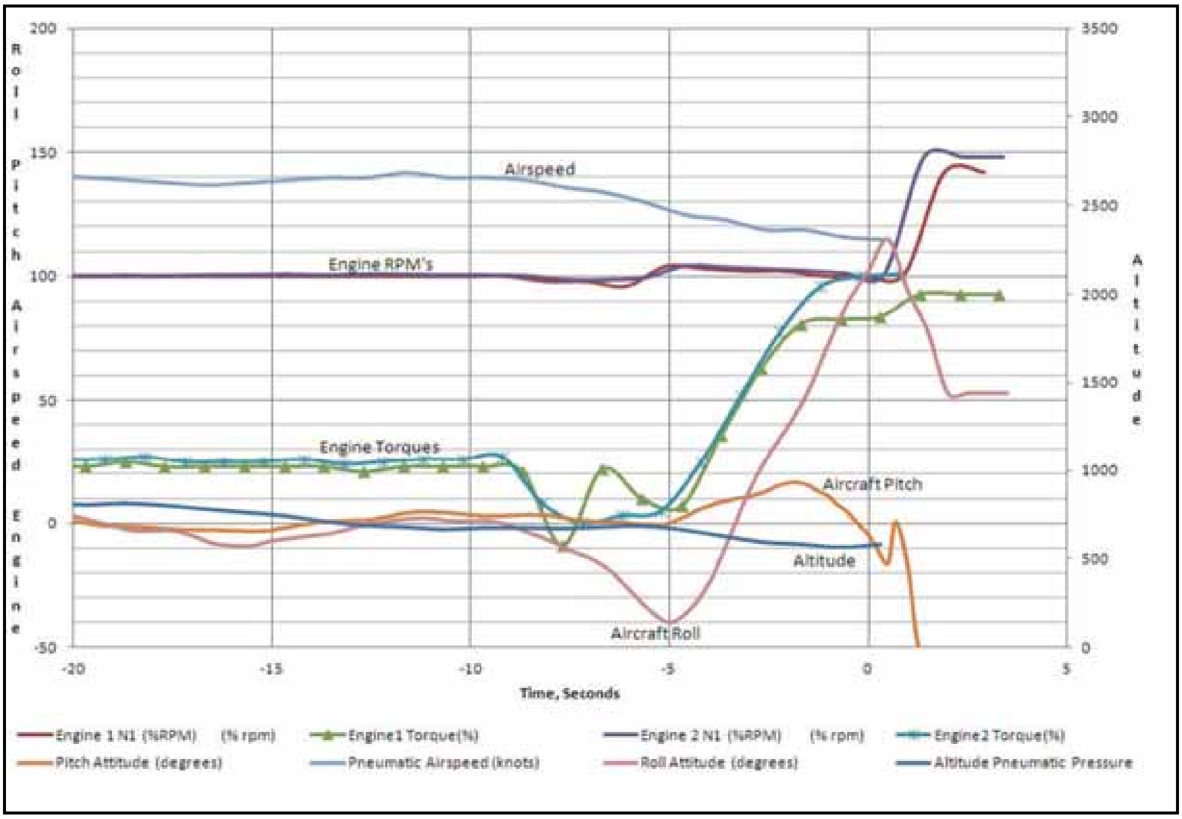


Figure No. 5a: FDR Data for final 20 seconds of recording

The Investigation, with the assistance of the NTSB and the manufacturers of the engines and the engine control components, undertook a detailed analysis of the recorded torque mismatch. The Investigation also carried out an analysis of the recorded engine parameters during the final seconds of the flight. This analysis is attached in **Appendix L**.

During laboratory examination of the engine control components under the oversight of the Investigation, an anomaly was found on the P_{T2}/T_{T2} sensor associated with the No. 2 engine. This sensor, which is located in the inlet to the first stage compressor, provides total pressure and total temperature information for the scheduling of the associated fuel control unit (FCU).

The bellows of the No. 2 engine P_{T2}/T_{T2} sensor when examined was found to be considerably shorter than required by the manufacturer's specification. Subsequently, a leak within the system was identified, which was due to a crack found in the inside coil of the sensor bulb. The exact cause of the crack initiation could not be determined and may have been related to several contributors, such as interface corrosion and in-service stresses. The crack appeared to have been present for some time as evidenced by corrosion found on the fracture surface.

Laboratory testing demonstrated that, as a consequence of this defect, the P_{T2}/T_{T2} sensor was outputting a temperature value up to 135°F below the actual total temperature to the No. 2 FCU.

This cold temperature signal resulted in incorrect scheduling of fuel flow to the No. 2 engine. This in turn had three effects on engine performance, all of which were in evidence throughout the FDR data. These were:

1. Slower engine speed response when the speed lever was advanced.
2. Faster engine torque response when the power lever was advanced.
3. Higher torque for a given power lever angle.

Appendix L details the analysis of the available recorded engine parameters which, together with the historical data for both engines, was used to calculate the fuel flow rates to the engines. The respective fuel flow rates were then used to calculate the power lever angles during this phase of flight. The data indicates that during the final approach up to a time approximately nine seconds before impact, both power levers were at angles in the range 50° to 52°. The power levers were then simultaneously moved below the Flight Idle position of 40° in the period from approximately eight seconds to six seconds before impact. Fuel flow calculations indicate that the power lever angles at this time were in the range 31° to 33°, i.e. below the Flight Idle position and in the Beta range of operation.

The AFM states that: *'Beta range (also known as Beta mode) is used only during ground operations and occurs when the power lever is positioned between Flight Idle and reverse'.*

Approximately six seconds prior to impact, the two power levers were rapidly advanced out of Beta range, which caused the engine speeds to increase and the torques to rise. Calculations show that just prior to impact, the power levers had been advanced to angles within the range 72° to 75°. The engine torques were both in excess of 80%, but the No. 2 engine torque significantly exceeded that of No. 1 engine, due to the higher fuel flow caused by the negative temperature bias due to the defective P_{T2}/T_{T2} sensor.

The analysis also indicates that after the No. 1 engine torque was recorded at a value of -9%, the Negative Torque Sensing (NTS) system on that engine became operative and acted to automatically increase the propeller blade angle towards the feather position. This is seen in the FDR data as the No. 1 engine torque increases to a value of +22% while the engine speed simultaneously drops towards a recorded value of 96%. The data does not indicate that the No. 2 engine entered a negative torque regime. Furthermore, there was no significant drop in No. 2 engine speed indicating that the NTS system did not activate on that side.

1.16.5 Cockpit Instrumentation

The Investigation examined FDR/CVR data, TAWS information and ATC Radar recordings. This examination showed that the airspeeds and altitudes flown were consistent with the Airspeed Indicators and barometric Altimeters functioning correctly.

The captain's and first officer's instrument panels, the left and right side of the cockpit respectively, were removed from the wreckage. The following cockpit instruments were sent to the AAIB in the UK for examination at approved facilities:

1. Captain's Attitude Indicator, BF Goodrich Model No. 510-37A.
2. First Officer's Attitude Indicator, Jet Electronics Model No. 510-24L.
3. Standby Attitude Indicator, Lifesaver P/N 4300-412.
4. Captain's Horizontal Situation Indicator (HSI), Collins Type 331A-3G, P/N 522-2638-007.
5. First Officer's HSI, Collins Type 331A-3G, P/N 522-2638-007.
6. No. 1 NAV Receiver, Collins Type VIR32, P/N 622-6137-201.
7. No. 2 NAV Receiver, Collins Type VIR32, P/N 622-6137-201.

The HSI Compass cards are signalled from remote gyro units, modified by flux detectors. In addition, slaving accessories are used to remove errors that could exist between the orientation of the earth's magnetic field sensed by the flux detectors and the magnetic heading presented on the HSI. It was later decided that these units would also be shipped to the UK for testing under the supervision of the AAIB. However, the avionics compartment in the nose of the aircraft sustained considerable damage during the impact sequence which resulted in a corresponding degree of damage to many of the avionic units. As a result, it was only possible to have one of the directional gyro units (No. 1 DG) tested. Thus, the following units were also sent to the UK for testing:

8. No. 1 Slaving Accessory 328A-3G, P/N 522-2644-011.
9. No. 2 Slaving Accessory 328A-3G, P/N 522-2644-011.
10. No. 1 Directional Gyro 332E-4, P/N 522-3241-000.

All flight instruments showed varying degrees of damage consistent with impact forces. Where testing revealed disconnection of a component due to impact, this defect was rectified to establish as far as could be ascertained, the pre-accident condition. Each unit was powered up and subsequently dismantled for detailed examination.

The Captain's Attitude Indicator erected correctly and displayed normal straight and level indication when the caging knob was pulled. The instrument was then gently moved through moderate angles of pitch and roll, during which the correct indications were displayed. After positioning the instrument to a nose-up pitch angle of around 45°, the display adopted the approximate correct pitch attitude but with a significant left roll. Upon examination, it was apparent that the gyroscope assembly was intermittently fouling the support chassis in the roll axis. Further inspection revealed a fracture of the mounting frame which would have interfered with the operation of the gimbal bearings. The fracture was likely to have been caused by impact forces either from the case directly or from inertial loads imparted by the gyroscope itself during impact sequence.

The First Officer's Attitude Indicator had sustained severe damage with crushing of the instrument case and the front face of the instrument had completely detached. As found, the instrument showed a roll angle of about 125°. Furthermore, the manner in which the chassis had collapsed suggests that the roll indication was in excess of 90° at the time of the accident. On disassembly, one of the gyroscope motor brushes was displaced from its slip-ring. This was attributed to the distortion that had occurred in the gyroscope chassis during the impact. The brush was eased back into position to enable further testing.

The motor spun up normally but distortion of the gyroscope chassis resulted in the gyroscope being held in position. The displayed roll angle of 125° is consistent with the roll at impact which provides some confidence that the instrument was functioning correctly at the time of the accident.

The Standby Attitude Indicator sustained substantial damage and when powered demonstrated an unstable indication which drifted over time. Internal inspection did not reveal any disconnections, fractures or obvious distortion. While the instrument failed to operate correctly, basic gyroscope motor operation was demonstrated. The unstable indication is considered likely to be due to gimbal bearing damage that occurred as a result of severe shocks to which the instrument was subjected during the impact sequence.

The Captain's HSI was examined and displayed a heading of 321°M, a selected course of 180°M with the heading bug at 243°M although it is possible that these had been altered by movement of their associated selector knobs. The deviation bar together with the flags and pointers all operated correctly when connected to a drive circuit. Subsequent testing showed that the compass card functioned correctly. The No. 1 Directional Gyroscope (DG) associated with the Captain's HSI was severely damaged and it was found that the inner and outer gimbal frames had fractured on impact. This had brought the gyroscope rotor into contact with the broken portions of the frame; light score marks observed on the rotor surface were the result of such contact and indicated that the rotor was spinning at impact.

The First Officer's HSI sustained considerable dents and distortion to the casing. The heading, course indicator and heading bug all indicated 165°M, the inbound course of RWY 17 ILS. The deviation bar together with the flags and pointers all operated correctly when connected to a drive circuit. Due to distortion of the instrument case, the compass card initially blew fuses when connected to the test equipment, but functioned correctly when the casing was cut away. In addition, a test was conducted which checked that the calibration of the deviation bar was within specification. Comparison of flown headings recorded on the FDR confirmed that the flux valves were sending correct information and that the HSI compass card was displaying correctly. It was found that the electro-mechanical components had remained resilient to the impact forces despite the damage to the instrument casing. It is probable that the instrument was operating normally at the time of the accident. The No. 2 DG was destroyed at impact.

Testing of the two Slaving Accessories was carried out at the Manufacturer's facility in the USA under supervision of the FAA. Both units provided an output that was displayed on the test-set indication (simulating a HSI) and moved smoothly, commensurate with the input.

Testing of the No. 1 NAV receiver showed that the VOR audio output was absent on all test frequencies applied by the test equipment. It was not determined whether this defect existed prior to the accident or developed as a result of it. All other NAV receiver functions tested serviceable.

The No. 2 NAV receiver was also tested. The tests were all satisfactory except for the Glideslope Sensitivity parameter. The test manual specified a maximum of 6.31 µV whereas the actual value was 26.3 µV. This would have had the effect of reducing the sensitivity to Glideslope transmissions meaning that the receiver, and thus the aircraft, would need to be closer to the transmitter than normal before the pilot was provided with the appropriate indication. However, it was not possible to define this reduced sensitivity in terms of distance from the transmitter. A soldered repair to a co-axial cable connector may have resulted in higher impedance which in turn could have caused the reduced sensitivity of the receiver.

1.16.6 Terrain Awareness Warning System (TAWS)

The FDR did not record aircraft position parameters (latitude and longitude). However, the aircraft was fitted with a Sandel ST3400 TAWS. Although not designed to be crashworthy, the TAWS remained sufficiently intact to allow full download of its memory by the OEM under the supervision of the Investigation. The unit system configuration menus showed that the TAWS unit's Terrain Revision was dated 18 May 2006 and the Airport Revision was dated 8 June 2006. The TAWS download provided position information which was cross referenced with the position information derived from the ground based radar system's recorded range/azimuth values. The download also contained Radio Altimeter callout flags which corresponded with the callouts heard on the CVR.

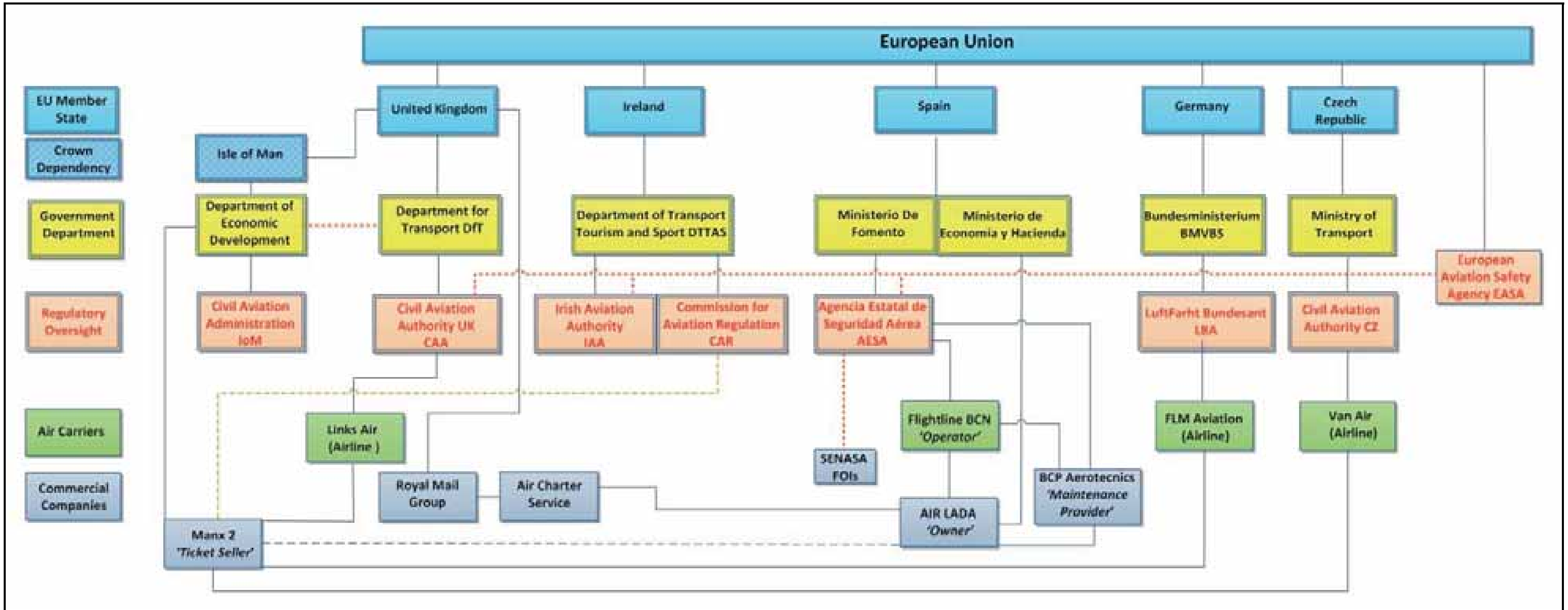
1.17 Organizational and Management Information

1.17.1 General

At the time of the accident, the aircraft was operating an international scheduled air service between EGAC and EICK. The Operator was a Spanish AOC holder and tickets for the flight were sold through the Ticket Seller, a ticketing agency based in the Isle of Man. The Ticket Seller acted as the agent for four individual operators that were AOC holders. Together they operated a series of commuter routes principally between the Isle of Man and the UK with a service from the UK to Ireland. Although the routes were flown by different operators, the aircraft used on these services traded under the Ticket Seller's brand name and livery.

In 2006, the Ticket Seller had made an arrangement with the Owner to use its aircraft under the AOC of a Spanish air carrier, Eurocontinental Air. This arrangement ceased in 2009 when the UK Department for Transport (DfT) suspended the Airline Operating Permit (AOP) for the operation following safety concerns. In 2010, EC-GPS and EC-ITP recommenced flying for the Ticket Seller and a new Permit **IASD/FTL/W2012-2011** was granted by the UK authorities for operations between the Isle of Man and the UK.

Flights operated by these aircraft in the UK, Ireland and the Isle of Man are referred to as the 'Operation'. **Graphic No. 2** shows the complex relationships between the various agencies and those undertakings associated with the Operation.



Graphic No. 2: Agencies and undertakings

1.17.2 Ticket Seller

The Ticket Seller was based at Ronaldsway Airport (EGNS) in the Isle of Man and commenced selling tickets in April 2006. The Ticket Seller did not hold an Operating Licence or an AOC, but had a series of arrangements (contractual and otherwise) with a number of AOC holders. The Ticket Seller described itself as a 'Marketing Group' which provided common services for the 'Group' such as a website, booking and check-in and the management of consumer obligations such as Denied Boarding Compensation. Pilots operating flights for the Ticket seller were required to wear a uniform that identified the Ticket Seller on such items as high-visibility tabards, ties and security pass lanyards.

The Ticket Seller informed the Investigation that when setting up the ticket selling operation it did not wish to have the regulatory complexity and crewing problems associated with holding an AOC. Accordingly aircraft were leased from EU AOC holders. This business model allowed specialisation, with the Ticket Seller concentrating on the commercial side of the operation and sub-contractors used for most other requirements; the operational requirements of crewing, maintenance, provision and operation of the aircraft being addressed by the AOC holders. The Ticket Seller also provided accommodation and a car for the use of the Operator's flight crews at Belfast.

At the time of the accident, the Ticket Seller had four arrangements in place:

1. Belfast City to Cork route operated by the Operator with Metro III aircraft, on which the accident flight occurred;
2. Isle of Man to Gloucester, and a PSO[35] route between Cardiff and Valley (Wales, UK) operated by a German AOC holder with Dornier 228 aircraft;
3. Isle of Man to Blackpool and Belfast City to Newcastle routes operated by a Czech AOC holder using Let 410 aircraft and;
4. Isle of Man to Leeds-Bradford route operated by a UK AOC holder using Jetstream 31 aircraft.

Flights between the UK and Ireland were operated as intra-community air services under Regulation (EC) No 1008/2008. The Ticket Seller applied for a Tour Operator's Licence and was issued Tour Operator's Licence No. T.O. 249 by the Commission for Aviation Regulation (CAR), Ireland. There was a bond requirement under the Tour Operator's Licence. As part of its application for licensing the Ticket Seller had described its business model to the satisfaction of the CAR. The name of the Operator was not identified on the associated application documentation nor was it required to be.

The Ticket Seller did not need an Operating Licence or an ATOL[36] when selling tickets on flights within the UK as none of the operators within the 'Marketing Group' operated aircraft in excess of 19 seats.

[35] **PSO**: Public Service Obligation, see Section 1.18.10.

[36] **ATOL**: Air Travel Organisers Licence – The UK compliance scheme for the Package Travel Directive 90/314/EEC.

This allowed the Ticket Seller to declare as their agent, that they met the requirements of ATOL Exemption 1 which exempts 'small' aircraft with 19 or fewer seats available for passengers.

The UK Civil Aviation Authority (CAA) stated that it periodically reviewed the Ticket Seller's website and engaged with the company when it identified problems. There were concerns that the Ticket Seller was allowing the impression to be created that it was a licensed airline in its own right. Subsequently, the Ticket Seller's website was amended to clearly state that it acted as agent for the four AOC holders within the 'Marketing Group'. A booking confirmation for flight NM7100 on the 9 February 2011 between EGAC and EICK, the day previous to the accident, was provided to the Investigation an extract of which is reproduced in **Graphic No. 3**:

Manx2 look forward to welcoming you aboard!
On behalf of Manx2, Van Air Europe As will be the main operator for flights from the Isle of Man to Blackpool, Belfast City, Galway, Newcastle and Leeds; also between Belfast City & Galway, and Galway to Cork. FLM Aviation will be the main operator for flights from the Isle of Man to Gloucestershire Airport and Cardiff to Anglesey. Flightline BCN will be the main operator for flights from Belfast City to Cork. Please see our terms and conditions for full details or enquire at check in.

Graphic No. 3: Extract from booking confirmation for flight NM7100 on 9 February 2011

The Ticket Seller stated, when interviewed by the Investigation, that it was surprised when the Permit for the operation (under the AOC of Eurocontinental Air) was suspended by the UK DfT. The Ticket Seller had been unaware of the number of safety occurrences related to the operation as it had not been included in the occurrence reporting list. The contract for the operation was then cancelled by the Ticket Seller.

The Operation later resumed under a different AOC holder (the Operator) with the Ticket Seller having requested inclusion in the occurrence report circulation in order, it stated, to monitor any safety issues. Whereas the Ticket Seller had visited the airlines to meet their quality teams and see their audit procedures, these were not formal audits.

The Ticket Seller stated that it relied on the local Regulatory Authority, Safety Assessment of Foreign Aircraft (SAFA) ramp checks and the DfT to ensure that the airlines met safety requirements. It issued forms to the Operator (titled 'Aircraft Inspection Report') to be completed by flight crews. This form provided a checklist for the inspection of the aircraft by the crew and an additional check of items associated with the operation including crew and aircraft licencing and certification.

This was in addition to the regulatory requirements as the Operator had already carried out quality checks on the operation of the aircraft in the Isle of Man.

The associated 'Aircraft Inspection Guidance Notes', dated 1 November 2010, state that the inspection should be carried out by a person nominated by the Ticket Seller's Operations Director and that: *'…the relevant operator or representative must be informed prior to the inspection that an audit is being conducted.'* and '*At this time, no* [Ticket Seller] *representative is authorised to conduct an in-flight operational inspection.*'

The Ticket Seller outlines in its Quality Manual its procedure to detail the course of action that should be taken in the event of an incident or accident. The procedure acknowledges that each operator maintains their own procedures and that crews should familiarise themselves with this procedure so that they will be aware of the action that will be taken by [the Ticket Seller] alongside their own operator's procedure:

1. *Operations need to speak with the crew of the aircraft concerned and establish what has happened as well as where, when and what damage has occurred. Make a note of what phone number the crew can be reached on.*

2. *Call [Ticket Seller Operations] and inform them of what has taken place. Also send a message to the 'Incident Distribution List' to let staff know that an incident has taken place and that more details will be made available when known.*

3. *Call [Company Advertising Agency] to let them know about what has happened so they are prepared for any press inquiries. All inquiries must be directed to Isle of Man Advertising and comments must not be made to the press or public about the incident. Reservations should be informed that any statements will be made by Isle of Man Advertising and passengers should be told a statement will be made when information becomes available.*

4. *Inform the relevant operator of the aircraft involved and give them details of the incident.*

5. *At the first available opportunity the aircraft needs to be moved out of the way and If possible at IOM it needs to be in the hangar.*

6. *As soon as it is possible an incident report will be needed from the crew with details of the incident that has taken place.*

The Ticket Seller stated that it had constructed the schedule to which each airline flew, each airline having an operations manager in the Ticket Seller's office in the Isle of Man. The crew called their operations manager if there was a problem with the aircraft in which case the Ticket Seller organised the passengers and chartered an aircraft if necessary. On the day of the accident, the Owner's Operations Manager received a message that EC-ITP was airborne from EGAC at 08.12 hrs.

The Ticket Seller further stated that, although it provided a list of preferred commercial alternates for the pilots, that the decision when to divert rested with the commander. The Quality Manual provided a list of preferred alternates for its routes together with useful information regarding handling agents and contact telephone numbers.

1.17.3 International Air Transport Association (IATA) Airline Codes

The Ticket Seller marketed and sold tickets for EGAC-EICK service using the flight prefix NM. The prefix NM was used by the Ticket Seller for all flights conducted on its routes by the different operators. This prefix was assigned by IATA in August 2007 to FLM Aviation, which was not operating the accident flight.

The Ticket Seller informed the Investigation that use of the prefix NM did not '*indicate the identity of the operating or contracting carrier*'.

IATA Resolution 762 allocates a unique airline designator to each operator holding a valid AOC and does not provide for prefix transfer or sharing except in the case of a code sharing agreement where airlines, each having their own unique designator, may agree to use the same IATA designator. The Ticket Seller informed the Investigation that the three airlines it provided tickets for had all agreed to use the same designator NM for marketing purposes.

1.17.4 Aircraft Ownership

EC-ITP was registered in Spain on 22 January 2004. Documentation provided to the Investigation showed that at the time of the accident the aircraft was owned by a Spanish bank, was leased to the Owner and subleased to the Operator. Two Fairchild SA 227 Metro III aircraft were involved in the Operation; EC-GPS being the primary aircraft with EC-ITP used as a backup when the primary aircraft was unavailable. Both aircraft were similarly leased and subleased. Two of the Owner's directors were pilots flying as part of the Operation. The Owner, whose office was based in Seville, Spain, did not and had never held an AOC.

In 2006, the aircraft commenced operating with the Owner providing the aircraft, crew, maintenance and insurance (ACMI) to the Ticket Seller under an ACMI contract. At that time this operation was conducted under the AOC of Eurocontinental Air, a company that was based in Valencia, Spain. Due to a series of safety incidents in UK airspace that resulted in the submission of Mandatory Occurrence Reports (MORs) by the UK Air Navigation Service Providers, the DfT suspended the Permit for the operation on 28 September 2009. Following discussions between the UK and Spanish Authorities, the Eurocontinental Air AOC was initially suspended by Spain on the 30 October 2009 and revoked on the 27 June 2011. Department for Transport Permits are issued according to Article 223 of the Air Navigation Order UK.

The Spanish Authorities required that the flight crew involved be retrained and language tested before resuming duties as flight crew. Two of these pilots resumed operating for the Owner, after the aircraft were transferred to the AOC of the Operator in 2010, and commenced a new scheduled service linking EGAC with EICK in addition to night cargo flights for the Royal Mail. The aircraft and flight crew were again provided under an ACMI arrangement, for a 12-month series of flights. An 'Aircraft Lease Agreement' was drawn up between the Ticket Seller and the Owner to commence on 7 September 2010. The terms of this document included the Ticket Seller paying the Operator for scheduled sectors flown; any other sectors flown were paid per flight hour. Airway charges were paid by the Owner and recharged to the Ticket Seller who also paid all fuel and landing charges.

The Owner undertook to operate the aircraft on the Operator's AOC, supplying the aircraft, flight crew, maintenance and insurance and preparing the crew rosters which were forwarded to the Operator. The Agreement contained a penalty for late or non-provision of an aircraft to operate the service. The occasions when the aircraft flew night cargo flights (with seats removed) within the UK under contract to the Royal Mail were not part of the Agreement but a separate commercial arrangement by the Owner with an intermediary company, Air Charter Service. These flights were operated under the flight prefix FLT, the ICAO designator of the Operator.

The aircraft commenced operations on 8 September 2010 in accordance with the 'Aircraft Lease Agreement'. The copy of this document provided to the Investigation was signed by the Ticket Seller alone. A representative of the Owner informed the Investigation that, although the Owner wished to have a signed contract in place, the Ticket Seller did not and that a member of the Owner's staff was approached by the Ticket Seller after the accident and asked to sign a contract, but declined as he did not have the authority to do so. The Ticket Seller however stated that their '*Ops Director (who left the business a year after the accident) informed the Chairman of* [the Ticket Seller] *that he signed and issued but had failed to ensure the return of a countersigned contract. The Owner performed and was paid throughout to terms of the contract and at no time did the Owner or any member of its staff request a copy of the contract from the Chairman/principal shareholder of the Ticket Seller.*'

In November 2010, the Owner issued a Crew Circular to all its flight crew, an extract from which is reproduced in **Graphic No. 4**.

AirLada Crew Circular - November 2010

Attention of all AirLada Crew

First of all I would like to express my thanks for your help and understanding with finances recently. Your patience whilst waiting to receive the monthly salary has been highly appreciated by me and the Company. As you are aware, we have had many problems getting ITP back into full, serviceable operation, resulting in protracted and difficult repairs, and involving far more unforeseen expenses than we had originally expected.

Graphic No. 4: Extract from Crew Circular

This Circular also detailed the appointment of a new Operations Manager employed by the Owner and located in the offices of the Ticket Seller. Reference was made to development of a new planning approach using online management software to handle all aircraft planning and crew scheduling. The Circular stated that the Owner's operational procedures were also being reviewed; as these were released and integrated into operations all crews were to acquaint themselves with these procedures and implement them accordingly.

At the time of the accident, EC-GPS was undergoing maintenance and thus the backup aircraft EC-ITP was used for the Operation. EC-GPS, similar to aircraft normally used by the Ticket Seller, carried the logo of the Ticket Seller on the fuselage and engine cowlings. EC-ITP was operated without titles on the fuselage, the only markings being the nationality and registration marks of Spain.

1.17.5 The Operator

The Operator was based in Barcelona, Spain and commenced operations in March 1993 under AOC E-AOC-34 issued by AESA. The Operator was also the holder of Operating Licence No A.45/04 issued on the 16 March 2006 by the *Ministerio de Fomento*, Spain. This was valid for 5 years from 5 April 2006, contingent on the Operator possessing a valid AOC. Its main business was flying cargo operations using a fleet of Fairchild SA 226 Metro II aircraft. An Embraer EMB-120RT was also listed on its AOC; this was owned by a different Spanish company and was used for business air charters.

Under an agreement, dated 25 November 2009, the Operator and the Owner agreed to the operation of two Metro III aircraft under the Operator's AOC. On 16 April 2010 and 15 November 2010 respectively, the Operator formally added EC-GPS and EC-ITP to its AOC. The operations and scheduled maintenance of both aircraft were conducted under the Operator's AOC while the commercial arrangements and flight scheduling were arranged by the Owner. According to the terms of this contract the Operator subleased EC-GPS and EC-ITP from the Owner and was responsible for the whole operation. This included training and checking the pilots for both aircraft, auditing the operation and performing supervisory flights. Under a separate contract between the Owner and the Operator on one part and the Maintenance Provider on the other, all maintenance costs were met by the Owner. These costs included support of the aircraft while based in the Isle of Man and the travel costs of maintenance personnel.

There was no contract between the Operator and the Ticket Seller and the Investigation found no evidence of any direct contact between these undertakings.

A number of operational documents were provided to the Investigation including 'Procedure – Crew Responsibilities and Duties', 'Procedure – Crew Administration' and 'Procedure – Briefings to Passengers'. Although these used the title of the Operator, the address and contacts were for the Owner's office in the Isle of Man.

The document 'Procedure – Briefings to Passengers' included:

> *'The Safety Brief that should be used is detailed below:*
> *Failt Erriu ladies and gentlemen and welcome on board this Manx2.com flight operated by (Operator name…)'*

The Arrival Briefing commenced:

> *'Ladies and Gentlemen welcome to ...., we hope you have enjoyed your flight with Manx2.'*

A (draft) document titled 'Operational Procedures Manual Belfast City Airport' with the Operator's logo and an address for the Owner's office in the Isle of Man contained only contacts for the Ticket Seller and included the following:

> *'All daily operational issues are handled in the first instance by* [Ticket Seller] *Operations, based in the* [Ticket Seller] *Headquarters in the Isle of Man. It is essential that crews stay in regular contact with operations, updating as required on flight schedule operations, and in particular should any problems occur.'*
>
> *'To ensure continuation of* [the Ticket Seller] *Quality Standards throughout every aspect of the company, each operator has appointed a Quality Manager. They will communicate the standards that are expected from* [Ticket Seller] *and in return and issues that may be encountered in achieving them.'*

This document was based on the Ticket Seller's Quality Manual with some additional information relating to operations at Belfast City Airport. The Operator's Quality Manager named in this document was one of the pilots supplied by the Owner. No evidence that he was appointed to this position by the Operator was provided to the Investigation. Both the Owner's Quality Manager and the Operations Director were based in the Isle of Man and, according to the Ticket Seller's Manual, were the first point of contact for Flight Crews.

Further information regarding the Operator including the relevant interviews of staff/postholders is contained in **Section 1.18.1**.

1.17.6 Aviation Safety Oversight

The International Civil Aviation Organization (ICAO) is a global forum for civil aviation and works to achieve its vision of safe, secure and sustainable development of civil aviation through the cooperation of its contracting States (this includes Ireland, Spain and the United Kingdom). It publishes international aviation Standards and Recommended Practices (SARPS) in the various Annexes to the Convention on International Civil Aviation. These standards are implemented into legislation by the Member States of ICAO. Within the European Union various regulations and directives are enacted centrally to give effect to SARPS, with EU directives being implemented in the different EU Member States through national legislation.

1.17.6.1 Aviation Safety Oversight - ICAO

ICAO Annex 6, Operation of Aircraft, Part I, International Commercial Air Transport - Aeroplanes defines the following:

> Operational Control: *The exercise of authority over the initiation, continuation, diversion or termination of a flight in the interest of the safety of the aircraft and the regularity and efficiency of the flight.*
>
> Operational Flight Plan: *The operator's plan for the safe conduct of the flight based on considerations of aeroplane performance, other operating limitations and relevant expected conditions on the route to be followed and at the aerodromes concerned.*

ICAO Annex 6 further states:

> *3.1 Compliance with laws, regulations and procedures*
>
> *3.1.1 An operator shall ensure that all employees when abroad know that they must comply with the laws, regulations and procedures of those States in which operations are conducted.*
>
> *3.1.2 An operator shall ensure that all pilots are familiar with the laws, regulations and procedures, pertinent to the performance of their duties, prescribed for the areas to be traversed, the aerodromes to be used and the air navigation facilities relating thereto.*
>
> *The operator shall ensure that other members of the flight crew are familiar with such of these laws, regulations and procedures as are pertinent to the performance of their respective duties in the operation of the aeroplane.*
>
> *3.1.3 An operator or a designated representative shall have responsibility for operational control.*
>
> *Note.— The rights and obligations of a State in respect to the operation of aeroplanes registered in that State are not affected by this provision.*
> *3.1.4 Responsibility for operational control shall be delegated only to the pilot-in-command and to a flight operations officer/flight dispatcher if an operator's approved method of control and supervision of flight operations requires the use of flight operations officer/flight dispatcher personnel.*
>
> *Note.— Guidance on the operational control organization and the role of the flight operations officer/flight dispatcher is contained in the Manual of Procedures for Operations Inspection, Certification and Continued Surveillance (Doc 8335).*

ICAO Document, Doc 8335, Manual of Procedures for Operations Inspection, Certification and Continued Surveillance includes procedures for oversight. The Foreword to this document states *inter alia*:

In accordance with Annex 6, Part I and Part III, Section II, there is a need for the State of the Operator to exercise a positive and continuing measure of control over any operator of that State offering, or wishing to offer, commercial air transport services. Since Annex 6, Parts I and III, presents specifications for broad objectives rather than methods of realizing these objectives, details not covered by Annex 6, Parts I and III, have been provided as well as indications of an acceptable means of compliance with the Annex provisions.

The method by which the State of the Operator exercises the necessary control of its operators is through the issuance of AOCs without which it is contrary to ICAO Standards to operate an international commercial air transport service. An AOC, once issued, should be subject to revocation or suspension if the operator is subsequently unable to meet the conditions specified. States need to establish systems and procedures for the initial certification and the continuing surveillance of the operations. Such a system should be firmly based upon aviation law.

This manual outlines the duties and responsibilities of both the State of the Operator and the operator and recognizes their interdependence in maintaining acceptable standards of operation and safe operating practices. The organization, administration and procedures required for inspection, certification and continuing safety oversight of operators are outlined, including the establishment of a safety oversight system within the Civil Aviation Authority (CAA).

This Manual provides the detailed procedures for continuing safety oversight of the operator by the State of the operator and procedures for the State in fulfilling its responsibilities under Annex 6.

1.17.6.2 Aviation Safety Oversight - European Union

Oversight of Commercial Air Transport within the European Union and its Member States is conducted at the following levels:

(i) European Union (EU)
(ii) European Aviation Safety Agency (EASA)
(iii) Member States

(i) European Union

Commercial Air Transport within the European Union Member States and the granting of AOCs is regulated according to:

1. Regulation (EC) 859/2008, which sets out common technical requirements and administrative procedures applicable to commercial transportation by aircraft, leading to the granting and continuance of an Air Operator Certificate.

2. Regulation (EC) No 216/2008, which details common rules in the field of civil aviation and establishes a European Aviation Safety Agency (EASA), referred to as 'the Agency'.

3. Regulation (EC) No 1008/2008, which details common rules for the operation of air services in the Community, regulates the licensing of Community air carriers, the right of Community air carriers to operate Community air services and the pricing of intra-Community air services, leads to the granting and continuance of an Operating Licence. This Regulation provides the framework for the internal EU commercial air transport aviation market.

4. Regulation (EC) No 2111/2005, which details the establishment of a Community list of air carriers subject to an operating ban within the Community and informs air transport passengers of the identity of the operating air carrier.

1. Regulation (EC) No 859/2008

This Regulation, also referred to as 'EU OPS', sets out *inter alia* the general rules for air operator certification and the responsibilities of an AOC holder, which include in Subpart C, OPS 1.175:

…
(b) An applicant for an AOC, or variation of an AOC, shall allow the Authority to examine all safety aspects of the proposed operation.
(c)…3. satisfy the Authority that he is able to conduct safe operations.
…
(g) The operator must satisfy the Authority that:
1. its organisation and management are suitable and properly matched to the scale and scope of the operation; and
2. procedures for the supervision of operations have been defined.

The rules for granting an AOC or a variation to an AOC are specified in OPS 1.180, 'Issue, variation and continued validity of an AOC', which include:

(a) An operator will not be granted an AOC, or a variation to an AOC, and that AOC will not remain valid unless:

1. Aeroplanes operated have a standard Certificate of Airworthiness …

2. The maintenance system has been approved by the Authority in accordance with Part M, Subpart G; and

3. He has satisfied the Authority that he has the ability to:
(i) Establish and maintain an adequate organisation;
(ii) Establish and maintain a quality system in accordance with OPS 1.035;
(iii) Comply with required training programmes;

(iv) Comply with maintenance requirements, consistent with the nature and extent of the operations specified, including the relevant items prescribed in OPS 1.175 (g) to (o); and
(v) Comply with OPS 1.175.

(b) Notwithstanding the provisions of OPS 1.185 (f), the operator must notify the Authority as soon as practicable of any changes to the information submitted in accordance with OPS 1.185 (a) below.

Regarding the management and organisation of an AOC holder, Regulation (EC) No 859/2008, comments that:

An operator must have a sound and effective management structure in order to ensure the safe conduct of air operations.

Nominated post holders must have managerial competency together with appropriate technical/operational qualifications in aviation.

This Regulation also states the applicable rules concerning commencement and continuation of instrument approaches in Section OPS 1.405, see **Appendix M**.

2. Regulation (EC) No 216/2008 (establishing '*the Agency*') states, *inter alia*:

'The effective functioning of a Community civil aviation safety scheme in the fields covered by this Regulation requires strengthened cooperation between the Commission, the Member States and the Agency to detect unsafe conditions and take remedial measures as appropriate.'

'Article 1. This Regulation shall apply to:
…(b) personnel and organisations involved in the operation of aircraft.'

Article 2.
1. The principal objective of this Regulation is to establish and maintain a high uniform level of civil aviation safety in Europe.'

Article 10, Oversight and enforcement states:

1.The Member States, the Commission and the Agency shall cooperate with a view to ensuring that any product, person or organisation subject to this Regulation complies with its provisions and with its implementing rules.

2. For the purposes of the implementation of paragraph 1, Member States shall, in addition to their oversight of certificates that they have issued, conduct investigations, including ramp inspections, and shall take any measure, including the grounding of aircraft, to prevent the continuation of an infringement.'

Regulation (EU) No 965/2012, which was not in force at the time of the accident, contains a set of implementing rules under Regulation (EC) No 216/2008.

3. Regulation (EC) No 1008/2008 states, *inter alia*:

'air carrier' means an undertaking with a valid operating licence or equivalent; (Article 2. Definitions)

'air operator certificate (AOC)' means a certificate delivered to an undertaking confirming that the operator has the professional ability and organisation to ensure the safety of operations specified in the certificate, as provided in the relevant provisions of Community or national law, as applicable; (Article 2. Definitions)

'competent licensing authority' means an authority of a Member State entitled to grant, refuse, revoke or suspend an operating licence in accordance with Chapter II;

'operating licence' means an authorisation granted by the competent licensing authority to an undertaking, permitting it to provide air services as stated in the operating licence; (Article 2. Definitions)

No undertaking established in the Community shall be permitted to carry by air passengers, mail and/or cargo for remuneration and/or hire unless it has been granted the appropriate operating licence. (Article 3. 1)

An undertaking shall be granted an operating licence by the competent licensing authority of a Member State provided that:

its principal place of business is located in that Member State;
it holds a valid AOC issued by a national authority of the same Member State whose competent licensing authority is responsible for granting, refusing, revoking or suspending the operating licence of the Community air carrier; (Article 4 (a) and (b))

The granting and validity of an operating licence shall at any time be dependent upon the possession of a valid AOC specifying the activities covered by the operating licence. (Article 6. 1)

Any modification in the AOC of a Community air carrier shall be reflected, where appropriate, in its operating licence. (Article 6. 2)

The competent licensing authority may at any time assess the financial performance of a Community air carrier to which it has granted an operating licence by requesting the relevant information. As part of such an assessment, the Community air carrier in question shall update the data referred to in point 3 of Annex I and provide it to the competent licensing authority upon request. (Article 8. 4)

A Community air carrier shall notify the competent licensing authority:

(a) in advance of any plans for the operation of a new air service to a continent or a world region not previously served, or any other substantial change in the scale of its activities, including, but not limited to, changes in the type or number of aircraft used; (Article 8. 5)

4. Regulation (EC) No 2111/2005 states:

Information on the identity of the operating air carrier
Upon reservation, the air carriage contractor shall inform the passenger of the identity of the operating air carrier or carriers, whatever the means used to make the reservation.

This Regulation also contains the following definitions:

'contract of carriage' means a contract for or including air transport services, including one where the carriage is composed of two or more flights operated by the same or different air carriers;

'air carriage contractor' means the carrier which concludes a contract of carriage with a passenger or, where the contract comprises a package, the tour operator. Any ticket seller shall also be deemed an air carriage contractor;

'ticket seller' means the seller of an air ticket who arranges a contract of carriage with a passenger, whether for a flight on its own or as part of a package, other than an air carrier or a tour operator;

'operating air carrier' means an air carrier that performs or intends to perform a flight under a contract of carriage with a passenger, or on behalf of another person, legal or natural, having a contract of carriage with that passenger…

Competent authority is defined in Regulation (EC) No 2006/2004, regarding the enforcement of consumer protection laws, as:

…(c) 'competent authority' means any public authority established either at national, regional or local level with specific responsibilities to enforce the laws that protect consumers' interests.

(ii) European Aviation Safety Agency (EASA)

EASA is a European Union (EU) agency whose mission is to promote the highest common standards of safety and environmental protection in civil aviation. This includes:

- Rulemaking;
- Inspections;
- Type-certification of aircraft, engines and parts;
- Approval of aircraft design organisations and maintenance organisations;
- Coordination of (SAFA)[37],
- Data collection, analysis and research.

[37] **SAFA**: Such Inspections are carried out under the auspices of the European SAFA Steering Expert Group (ESSG). If a SAFA inspection identifies significant irregularities, these can be raised with the airline and the oversight authority. Where irregularities have an immediate impact on safety, inspectors can demand corrective action before they allow an aircraft to depart.

Regulation (EC) No 216/2008 (establishing 'the Agency') states in Article 17, the Establishment and functions of the Agency, that:

1. *For the purpose of the implementation of this Regulation, a European Aviation Safety Agency shall be established.*

2. *For the purposes of ensuring the proper functioning and development of civil aviation safety, the Agency shall:*

   (a) undertake any task and formulate opinions on all matters covered by Article 1(1);

   (b) assist the Commission by preparing measures to be taken for the implementation of this Regulation. Where these comprise technical rules and in particular rules relating to construction, design and operational aspects, the Commission may not change their content without prior coordination with the Agency. The Agency shall also provide the Commission with the necessary technical, scientific and administrative support to carry out its tasks;

   (c) take the necessary measures within the powers conferred on it by this Regulation or other Community legislation;

   (d) conduct inspections and investigations as necessary to fulfil its tasks;

   (e) in its fields of competence, carry out, on behalf of Member States, functions and tasks ascribed to them by applicable international conventions, in particular the Chicago Convention.[38]

The Agency's Rulemaking Directorate contributes to the production of all EU legislation and implementation material related to the regulation of civil aviation safety and environmental compatibility. This legislation is published by the EU and includes regulations regarding airworthiness, air crew, air operations and flight standards, among others, in particular Regulation (EC) No 859/2008 regarding common technical requirements and administrative procedures applicable to commercial transportation by aeroplanes.

The Agency also monitors the application of the EU aviation safety regulations by the National Aviation Authorities (NAAs) of the EU Member States through standardisation inspections (**Section 1.18.9**). It does not monitor the activities of the individual airlines or operators within the Member States; this is carried out by the NAAs. EASA competence to conduct oversight within the EU became effective on 8 April 2012 and is being implemented by Member States in accordance with an agreed schedule.

[38] **Chicago Convention**: An international agreement among states initially signed in 1944, setting out certain principles and arrangements in order that international civil aviation may be developed in a safe and orderly manner and that international air transport services may be established on the basis of equality of opportunity and operated soundly and economically.

(iii) Member States

The Member States associated with the Operation were:

- Spain; the State of Registry and the Operator.
- Ireland where the accident occurred.
- United Kingdom where the flight originated.

In addition, the Ticket Seller was a company based in the Isle of Man and the Operation was also based there. The Isle of Man is a Crown Dependency, an internally self-governing dependent territory of the British Crown, which is not part of the United Kingdom or the European Union. The Isle of Man has its own parliament and Civil Aviation Administration (CAA-Isle of Man) whose website states:

> *'The CAA is responsible for ensuring aviation legislation in the Isle of Man meets International Civil Aviation Organisation (ICAO) Standards and Recommended Practices and other relevant European aviation standards.'*

The Isle of Man's relationship with the European Union is set out in Protocol 3 to the United Kingdom's Treaty of Accession 1972. Article 2 of Protocol 3 states:

> *'The rights enjoyed by Channel Islanders or Manxmen in the United Kingdom shall not be affected by the Act of Accession. However, such persons shall not benefit from the Community provisions relating to the free movement of persons and services*.'

Under Protocol 3, the Isle of Man is neither a Member State nor an associate member of the European Union; the Isle of Man's relationship with the EU being through the UK. EU Regulations apply only to Member States and not to a Crown Dependency. Consequently, Regulation (EC) No 1008/2008 did not apply. A flight to or from the Isle of Man and the UK by a non-UK AOC holder required a permit in accordance with Article 223 of the UK Air Navigation Order 2009 (SI 2009 No. 3015) for the UK and Article 138 of the Air Navigation Order 2005 (SI 2005 No. 1970) as applied to the Isle of Man. Permission for the Operator to operate services was granted by the (UK) Secretary of State for Transport under Permit No. IASD/FTL/W2010-2011. Two permits were issued by the UK Secretary of State, acting in two capacities; one in relation to the UK and the other in relation to the Isle of Man.

Records showed that permits were applied for by the Operations Manager of the Ticket Seller on behalf of the Operator with the Operator named as the airline. The AOPs were granted on 19 November 2010.

1.17.6.3 Oversight by Member States

The flight between Belfast and Cork, an intra-Community air service, was operated under the provisions of Regulation (EC) No 1008/2008. In adopting this Regulation the European Parliament and the Council of the European Union state:

'…(3) Recognising the potential link between the financial health of an air carrier and safety, more stringent monitoring of the financial situation of air carriers should be established.

(4) Given the growing importance of air carriers with operational bases in several member states and the need to ensure the efficient supervision of these air carriers, the same Member State should be responsible for the oversight of the air operator certificate and of the operating licence.'

Article 15 states:

1. Community air carriers shall be entitled to operate intra-Community air services.

2. Member States shall not subject the operation of intra-Community air services by a Community air carrier to any permit or authorisation. Member States shall not require Community air carriers to provide any documents or information which they have already supplied to the competent licensing authority, provided that the relevant information may be obtained from the competent licensing authority in due time.

As Spain was the State of Registry and the Operator, continuing oversight of the Operator and its operation fell under the remit of AESA, the Competent Authority of Spain.
Regulation (EC) No 216/2008, (Article 3) states:

'continuing oversight' shall mean the tasks to be conducted to verify that the conditions under which a certificate has been granted continue to be fulfilled at any time during its period of validity, as well as the taking of any safeguard measure;

Regulation (EC) No 216/2008, (Article 10, paragraph 2) places an obligation on Member States to conduct ramp inspections under the SAFA Program:

'For the purposes of the implementation of paragraph 1, Member States shall, in addition to their oversight of certificates that they have issued, conduct investigations, including ramp inspections, and shall take any measure, including the grounding of aircraft, to prevent the continuation of an infringement.'

Under the SAFA Programme, EU Member States and States, which have entered into the SAFA Working Arrangement, may inspect third country aircraft under a common, agreed procedure. SAFA reports are stored and analysed by EASA, and reported to the Air Safety Committee of the EU. Inspections under the SAFA Programme are carried out during a turnaround and as a SAFA inspection is not generally permitted to delay the departure, such inspections cannot carry out an in depth safety assessment of the aircraft or its operation.

In the 12 months prior to the accident, both EC-ITP and EC-GPS were subject to SAFA Inspections by NAAs of other Member States; namely Germany and Ireland. There were findings on both inspections.

During one inspection, a Category 3 finding was made where '*access to emergency exits were impeded by baggage or cargo*' and the aircraft was not allowed to depart until passenger bags were removed from the seats and placed in the hold. There was no SAFA inspection conducted on either aircraft by the UK CAA.

1.17.6.4 Oversight by Spain

AESA is the state authority which ensures that civil aviation standards are observed in all Spanish aeronautical activity. The initial AOC and the Operating Licence of the Operator were issued by the DGAC of *Ministerio de Fomento*. AESA assumed these responsibilities in October 2008 on appointment of its Executive with the Directorate of Air Safety issuing AOCs and the Civil Aviation Safety and User Protection Directorate issuing Operating Licences. AESA's safety oversight activities and responsibilities are shared between AESA headquarters and 8 regional offices. AESA informed the Investigation that in 2011, it employed 14 Flight Operations Inspectors (FOI) based at 4 locations in Spain. It delegated most air operations activities to SENASA[39], a specialised state company approved by law to conduct such activities.

AESA is a self-managing state agency with responsibility for and competences in:

- Aviation safety
- Certification
- Maintenance
- Licenses
- Operations
- Aircraft registration records
- Training
- Air navigation
- Air cargo

In accordance with these competencies it issues, amends or revokes authorisations to aviation undertakings in Spain and is responsible for oversight of these undertakings.

On the 16 April 2010, at the Operator's request, EC-GPS was included on the Operator's AOC. On the 29 November 2010, the Operator subsequently applied to include EC-ITP on its AOC and this too was granted. The AOC approval forms (for both aircraft) stated that low visibility operations for Take-off, and Approach and Landing were not approved. Accordingly, the approval permitted operation to CAT I limits only.

At the time of the accident, the Operator held AOC No. E-AOC-34, issued by AESA on 30 November 2010, and valid until 30 June 2011. The AOC allowed operation within a defined geographic area of Europe and North Africa.

[39] **SENASA**: *Servicios y Estudios para la Navegación Aérea y la Seguridad Aeronáutica*.

AESA informed the Investigation that these aircraft were transferred onto the AOC following an application by the Operator; this change in the AOC being termed a 'standard variation'.

AESA stated that an AOC variation is normally applied for along with a revision of the Operations Manual; depending on the scope of the variation an in-situ inspection and/or documentary inspection is needed during the evaluation. The technical evaluation of the variation of the Operator's AOC was carried out by the FOI assigned to the Operator who was occasionally assisted by another FOI. The assigned FOI had been a military pilot who served in the Spanish Air Force and later became a captain with a major Spanish airline. He had accumulated in excess of 20,000 flight hours in his career and met the requirements of ICAO Document 8335 for a Flight Operations Inspector.

Inspections were carried out by AESA/SENASA on the Operator as part of the Continuing Surveillance Plan for the purpose of maintaining the validity of the AOC. These were performed in May 2009 and May 2010 and inspections covering specific areas were carried out in March 2009 and October 2009. In the year prior to the accident, a total of 8 Audits and Inspections on the Operator's Flight Operations were conducted between 11 February 2010 and 14 January 2011; with 7 audits and Inspections on Maintenance and Airworthiness. In addition, 16 SANA[40] Inspections were carried out by AESA.

AESA said that its supervision of the Operator was included in the programmed and implemented audits, when evaluation was made on how the airline itself monitors and controls its operations. Also evaluated were records corresponding to such activities as crew training, flight time limitations and flight planning records.

AESA stated that during the first application for an AOC and in granting an Operating Licence there is an exchange of information between the operational and commercial Directorates of AESA. In an AOC variation process, the Operational Directorate of AESA does not conduct oversight regarding the financial resources of an operator and their links with the Operating Licence, as the Security and User Protection Directorate of AESA performs a quarterly economic supervision of their operators.

Regarding the Operator, AESA later stated to the Investigation that it had followed the economic records on a quarterly basis since December 2008. In addition, transferring the two Metro IIIs from a suspended AOC was acceptable to AESA as different procedures and postholders were in place in the new AOC holder (the Operator).

AESA said that the Operator's application provided no details regarding how the aircraft would be utilised and, at the time, it was seen as a charter operation. AESA stated that transferring such aircraft between operators was not unusual and that, in so far as it was aware, the only operator for both of those aircraft was the AOC holder.

[40] **SANA**: Safety Inspection of National Aircraft - national inspection programme in Spain.

AESA informed the Investigation that it had no knowledge of the Owner, which was a commercial company and therefore not within its regulatory remit, nor were they aware of the connection between the Ticket Seller and the Owner. In addition, AESA was unaware that two former Eurocontinental Air pilots had moved with the aircraft to the Operator.

AESA had issued letters to the Eurocontinental Air pilots, following incidents in UK airspace that resulted in the withdrawal of the UK AOP, stating that that they would have to undergo English proficiency language training. However, their pilot licences were not suspended but were limited to non-commercial air transport operations, and following training, the limitations were no longer considered applicable. AESA stated that there was no obligation for an operator to inform the Authority regarding remote operations. It further stated that, had it known that the Operation was remote and that such a small number of people was involved, it would have taken a greater interest.

AESA had previously, during the Eurocontinental Air operation, sent two inspectors to the Isle of Man to carry out an extended ramp inspection due to the problems that arose in that operation. However, it stated that, as it was unaware that the aircraft had resumed operations in that area under the AOC of the Operator, no inspectors had been sent.

AESA further informed the Investigation that '*in order to have better tools/procedures for proper oversight of a remote operation, EU regulation should require the operators to provide the certifying Authority with a formal declaration stating which are the organizations that ultimately decide the flight's schedule, routes, crew roster, etc.*'

1.17.7 Responsibilities of an Air Carrier

An air carrier undertakes specific responsibilities as determined by Regulation (EC) No 1008/2008 of 24 September 2008 on the common rules for the operation of air services in the Community. The following extract is relevant:

> *'…5. A Community air carrier shall notify the competent licensing authority:*
> *(a) in advance of any plans for the operation of a new air service to a continent or a world region not previously served, or any other substantial change in the scale of its activities, including, but not limited to, changes in the type or number of aircraft used.'*

The Regulation includes, *inter alia*, the following definitions:

> *'…3. 'undertaking' means any natural or legal person, whether profit-making or not, or any official body whether having its own legal personality or not;*
>
> *4. 'air service' means a flight or a series of flights carrying passengers, cargo and/or mail for remuneration and/or hire; …*

9. ‘effective control’ means a relationship constituted by rights, contracts or any other means which, either separately or jointly and having regard to the considerations of fact or law involved, confer the possibility of directly or indirectly exercising a decisive influence on an undertaking, in particular by:

(a) the right to use all or part of the assets of an undertaking;

(b) rights or contracts which confer a decisive influence on the composition, voting or decisions of the bodies of an undertaking or otherwise confer a decisive influence on the running of the business of the undertaking; …

11. ‘Community air carrier’ means an air carrier with a valid operating licence granted by a competent licensing authority in accordance with Chapter II; …

13. ‘intra-Community air service’ means an air service operated within the Community;

14. ‘traffic right’ means the right to operate an air service between two Community airports; …

16. ‘scheduled air service’ means a series of flights possessing all the following characteristics:

(a) on each flight seats and/or capacity to transport cargo and/or mail are available for individual purchase by the public (either directly from the air carrier or from its authorised agents);

(b) it is operated so as to serve traffic between the same two or more airports, either:
— according to a published timetable, or
— with flights so regular or frequent that they constitute a recognisably systematic series; …

21. ‘Member State(s) involved’ means the Member State(s) concerned and the Member State(s) where the air carrier(s) operating the air service is (are) licensed; …

25. ‘wet lease agreement’ means an agreement between air carriers pursuant to which the aircraft is operated under the AOC of the lessor;

Regulation (EU) No 965/2012 of 5 October 2012 (subsequent to the accident) laying down technical requirements and administrative procedures related to air operations pursuant to Regulation (EC) No 216/2008 defines:

‘operational control’[41] *means the responsibility for the initiation, continuation, termination or diversion of a flight in the interest of safety;*

[41] **Operational Control**: While Operational Control is central to both ICAO Annex 6 and EU-OPS, this is the first time that the Investigation found the term defined in EU Regulations.

Regarding operational control, Regulation (EC) No 859/2008, OPS 1.195 requires that an operator shall:

(a) Establish and maintain a method of exercising operational control approved by the Authority; and

(b) Exercise operational control over any flight operated under the terms of his AOC.

Section 2 of the Regulation, Operational Control and Supervision, states:

2.1 Supervision of the operation by the operator. A description of the system for supervision of the operation by the operator (see OPS 1.175(g)). This must show how the safety of flight operations and the qualifications of personnel are supervised. In particular, the procedures related to the following items must be described:

(a) Licence and qualification validity;
(b) Competence of operations personnel; and
(c) Control, analysis and storage of records, flight documents, additional information and data.

EU-OPS 1.415 states:

'Journey log. A commander shall ensure that the journey log is completed.

The requirements for a Journey Log, recording all crew duties etc. are detailed in EU-OPS 1.1055 and enable the reconstruction of a flight or series of flights from this record.'

In regard to the composition of flight crew EU-OPS 1.940 (a) 4 states:

'Procedures are established acceptable to the Authority, to prevent the crewing together of inexperienced flight crew members'

In regard to the selection of alternates, EU-OPS 1.295 states:

'…(*d) An operator must select two destination alternate aerodromes when:*

1. the appropriate weather reports or forecasts for the destination aerodrome, or any combination thereof, indicate that during a period commencing one hour before and ending one hour after the estimated time of arrival, the weather conditions will be below the applicable planning minima (see OPS 1.297(b)); or
2. no meteorological information is available…'

In regard to Flight and Duty Time Limitations and Rest Requirements, Subpart Q, EU-OPS 1.1090, 2.2 states, *inter alia*:

> *'Flights are planned to be completed within the allowable flight duty period taking into account the time necessary for pre-flight duties, the flight and turn-around times.'*

Regulation (EC) No 785/2004 on insurance requirements for air carriers and aircraft operators differentiates between an air carrier and an aircraft operator, which it defines as:

> *'Article 3 (c) 'aircraft operator' means the person or entity, not being an air carrier, who has continual effective disposal of the use or operation of the aircraft; the natural or legal person in whose name the aircraft is registered shall be presumed to be the operator, unless that person can prove that another person is the operator;'*

1.18 Additional Information

1.18.1 Operator Interviews

The Investigation visited the Operator after the accident and interviewed relevant postholders and staff members. The Investigation was informed that flights were tracked via a Eurocontrol[42] link.

1.18.1.1 General Manager (GM)

The GM (Accountable Manager)[43] stated that a contract for flights had been signed with the Owner to allow three aircraft to operate under the Operator's AOC, two of which were operational. The Operator then had seven aircraft operating under its AOC. He stated that the Operator had been inspected by FOIs from both AESA and SENASA. His point of contact with the Owner was the Commercial Manager who resided in Seville.

1.18.1.2 Quality Manager (QM) and Operations Quality

The QM (Postholder) stated that the Owner produced a draft roster for flight crew which the Operator, using a commercial flight planning program to monitor rosters rules, would then change as required to ensure that the flight time limitation rules were complied with.

Any roster change required by flight crew, after the roster was published, had to be approved at base. In the case of the accident flight no changes had been approved and the Operator was unaware that the Co-pilot had swopped onto the flight until after the accident.

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[42] **Eurocontrol**: The European intergovernmental air traffic management organisation.

[43] **Accountable Manager**: An operator must nominate an accountable manager, acceptable to the Authority, who has corporate authority to ensure that all operations and maintenance activities can be financed and carried out to the standard required by the Authority (EU-OPS 1.175).

The flight crew instruction regarding making a roster change request was in Spanish and no English translation was found. The QM said that the base for all the crew was Barcelona and that the Commander had asked for the flight plans to be sent to Belfast the evening before.

1.18.1.3 Maintenance Manager (MM)

The MM stated that he had been recruited into the company as a Postholder in 2010 to address '*some maintenance issues*'. He stated that the Operator had its own Part 145 approval and that there were 3 staff in the CAMO with a total of 10 staff in the maintenance organisation.

The MM was responsible for the maintenance of aircraft operating under the Operator's AOC of which three were the Owner's, three were the Operator's and one belonged to another Spanish company. He drew up the maintenance programme for all these aircraft and arranged maintenance as required. He stated that the Owner had a signed agreement with the Maintenance Provider which conducted maintenance on EC-GPS and EC-ITP in line with the maintenance programme, with invoices sent directly to the Owner.

1.18.1.4 Accident Prevention and Flight Safety Manager (FSM)

The FSM stated that he was appointed to the position in January 2010, in accordance with EU-OPS 1.037, but no training was provided for this post. He was a commander on the SA 226 (Metro II) with 2,500 hours, and also fulfilled the position of a Flight Dispatcher. He maintained the Operator's occurrence reporting system and conducted occurrence analysis via an Excel spread sheet.

1.18.1.5 Training Manager (TM)

The TM (Postholder) joined the Operator as a co-pilot in 2009 on the Embraer 120 and was appointed as a commander on that fleet in 2010. At the end of December 2010, he was appointed TM and was approved as an instructor for both Crew Resource Management (CRM) and Dangerous Goods. His responsibilities also included the scheduling of training for flight crews. He stated that the procedures for command upgrade were laid down in OM Part D. These included ground school, company procedures (1 day), CRM (1 day) and aircraft procedure and Operational Proficiency Check (OPC).

According to the TM, the Class Rating Examiner (CRE) would decide on the number of training sectors that a command candidate would receive which could vary between 10 and 20 sectors with an instructor.

1.18.1.6 Chief Instructor (CI)

The CI said that he was initially employed by the Operator in 2006, subsequently left but returned to the Operator again in 2008. He was the sole CRE having been appointed in 2010; the other Class Rating Instructor (CRI) resigned in December 2010. The CI stated that all pilots were considered to be the Operator's pilots but the pilots who flew the Metro III were paid by the Owner; he himself was paid by the Operator.

Regarding selection of candidates for command, he stated that captains would discuss co-pilots and recommend some for command. The command course consisted of CRM training (**Section 1.18.5**), refresher training regarding procedures, an OPC in the LH seat with an instructor followed by 10 sectors flight training (this could be with a RH seat qualified captain). This was followed by a Line Check. The result could be fail, or a pass, with/without restrictions. Once passed there were no operational restrictions. He did not know the lowest number of hours required before consideration for command but the minimum age was 25. Although he agreed that there should be a different CRI and CRE this was not possible in the Commander's case, as the other CRI resigned in December 2010, but he felt that he had enough criteria to objectively evaluate him. He agreed that the command training of the Commander was very disrupted but did not know why this was so. He thought it was possibly because they were tight in numbers and the Commander, who was flying from Belfast, had to travel to Barcelona for training.

The CI had conducted the training of both the Commander and Co-pilot but did not participate in any of the Operation's line flights. He stated that the Commander was enthusiastic with good CRM and crew interaction and that the Co-pilot '*was okay for his hours*'.

Regarding aircraft handling, he stated that it was not standard operational procedure for the PNF to operate the power levers during an approach and that full flaps were taken in the Metro III when the field was in sight. Although they trained for monitored approaches in the Embraer 120, they did not do so on the Metro II/III fleet. Regarding the stall characteristics of the Metro III, he had only conducted approaches to stalls while instructing. He stated that he had actually stalled the aircraft and that the aircraft had to be straight [without bank or yaw]; otherwise there was a wing drop which could be to either side and had nothing to do with engine rotation.

1.18.1.7 Rostered co-pilot

This co-pilot was originally rostered to operate the accident flight and had previously flown with the Commander on the 6, 7 and 8 February 1011. He requested to go to Spain to attend an English Language Proficiency (ELP) test in Barcelona. This is a commercial pilot licencing requirement under JAR-FCL. This request was made through the Operations Manager of the aircraft Owner, who was '*the person responsible*', and was approved. Accordingly, he had flown to Spain on the 9 February 2011. He stated that flight plans were normally sent up the evening before and that alternate weather for EIWF and EIKY was normally obtained by phone and later by a VHF call en-route.

1.18.2 Composition of Flight Crew

Regulation (EC) No 859/2008 (EU-OPS) 1.940 addresses composition of flight crew and states, *inter alia*:

'(a) An operator shall ensure that:

1. *the composition of the flight crew and the number of flight crew members at designated crew stations are both in compliance with, and no less than the minimum specified in the Aeroplane Flight Manual (AFM);*
2. *the flight crew includes additional flight crew members when required by the type of operation, and is not reduced below the number specified in the Operations Manual;*
3. *all flight crew members hold an applicable and valid licence acceptable to the Authority and are suitably qualified and competent to conduct the duties assigned to them;*
4. *procedures are established, acceptable to the Authority, to prevent the crewing together of inexperienced flight crew members.*
5. *one pilot amongst the flight crew, qualified as a pilot-in-command in accordance with the requirements governing Flight Crew Licenses, is designated as the commander who may delegate the conduct of the flight to another suitably qualified pilot; …'*

The Operator's OM Part A, General/Basic, Section 4, Composition of the Crew, contained no reference to any procedure '*to prevent the crewing together of inexperienced flight crew members*' and the Investigation found no evidence that the Operator had considered this matter.

1.18.3 Operator's Command Training Procedures

EU-OPS 1.955 addresses Nomination as Commander. Procedures regarding the Operator's 'Appointment of Commander' are contained in the Operator's OM, Part D, Rev 8 (**Appendix N**). The command candidate was required to be over 25 years old and to hold a CPL with appropriate Class and Instrument Ratings. The Operator flew the aircraft using two pilots although the Metro fleet was certified for single pilot operation.

The OM required that 4 hours ground school instruction was provided which included instruction on Company Procedures and the authority, functions and responsibilities of the Captain (Section 1.4 of the OM, Part A). In addition, CRM training was provided.

With no simulator available, all normal, abnormal and emergency procedures that did not involve alteration of the aircraft's profile were carried out in the aircraft on the ground. Any procedures that involved alteration of the flight profile were required to be carried out in-flight.

The OM Part D 2.1.5.B (c) requires 2 hours of actual flight training time on the Metro fleet, as there is no access to a simulator. During the flight a verification of competency was required to be carried out according to JAR FCL 1.240 and 1.295. The flight training on this 2-hour flight includes a simulated engine failure after V_2, a simulated engine failure on approach and during a go-around and included a minimum of 4 touchdowns and landings and a circling manoeuvre.

Line Training under supervision required a minimum of 10 sectors as line training in command under supervision. A Line Check was then required with sectors flown as PF and PNF; this included an assessment of CRM. Having satisfactorily completed the Line Check, the new commander was qualified to operate the routes and airports used by the company without restriction.

1.18.4 Operator's Monitored Approach Procedure

According to the Operator's SOPs, as specified in OM Part A, Section 8.5.2, in meteorological conditions with visibility less than 1,200 m it is compulsory to carry out an ILS CAT I '*approach monitored by the commander*'. A commander may also decide, if he thinks it advisable, to make this type of approach in any other circumstance. OM Part A, Section 8.5 B.2, states:

> '*The approach Monitored by the Commander consists of an approach based on division of functions, in which the Commander acts as PNF, at least from the intermediate approach, until once the visual reference required is established, he gives the regulatory command before going on to act as PF to carry out the landing.*
>
> *If the commander does not establish the visual reference required to proceed with the landing, the co-pilot will carry out the aborted approach manoeuvre on the DA/DH after having received the required order from the commander. If the co-pilot does not receive any order on the DA/DH (which is to be understood as incapacitation of the commander), he will immediately initiate an aborted approach manoeuvre, giving the required notification. The co-pilot will stay at instruments during the manoeuvre and will remain there until the runway has been left. This type of approach has the following characteristics: - It is not necessary for the two pilots to change their monitoring responsibilities. Only the commander changes from instrumental to visual as the DA/DH is being approached. The co-pilot is on instruments throughout the entire procedure.*
>
> *This requires that the Commander begins to look out before the aircraft reaches the DA/DH and before taking the decision to land and this enables the Commander to basically concentrate on observing the exterior, and so he finds it easier to have visual contact. On the basis of the assessment of the visual references that he has obtained, the Commander takes the decision to land or to abort on reaching the DA/DH. Make sure that the instruments are monitored all the time by the two pilots from the OM to the DA/HS + 100 Ft, and by one pilot throughout the entire approach until the touchdown.*'

The Operator's OM Part B, (Operational aspects relating to Fairchild SA 227-BC), Normal Procedures, (i) Instrument approach, does not contain specific information pertaining to the SA 227. Section (i) refers to general instrument procedures contained in OM Part A (General). The text does not specify if monitored approach procedures are applicable to the SA 227.

Having executed a missed approach, the Operator's Procedures contained no restriction on the number of approaches that could be conducted before having to divert. A significant number of commercial transport accidents have occurred when a third approach has been attempted. This has led to many operators prohibiting flight crews making a third approach, unless there has been a significant improvement in the weather conditions. Notwithstanding this, the Operator's OM contained no limit on the number of approaches that could be made. Subsequent to the accident, the Operator made changes to its policy in this regard as detailed in its Operational Letter No. 4/11:

> '*in case of a missed approach from minimum values due to weather causes, proceed to the alternative*'.

1.18.5 Crew Resource Management (CRM)

CRM is an essential element in the safe and effective operation of commercial aircraft. The use of CRM is designed to make optimum use of available resources thereby improving safety. Effective CRM training develops a wide range of skills as a crewmember including enhanced crew co-ordination, decision-making, effective communications, teamwork, good situational awareness and conflict resolution. Flight and Cabin Crews are trained and assessed on their knowledge and use of CRM principles.

During command upgrade, EU-OPS 1.955 requires that '*elements of Crew Resource Management*' are included in the command course. The Operator's syllabus was detailed in OM Part D – Training, 2.1.5.4 and states

> '*This training will take place over 2 days with a minimum of 10 hours of lectures*'.

The Investigation was informed that the CRM training conducted in January 2011 and attended by the Commander and Co-pilot lasted between 2 and 2 ½ hours on the general topic of 'situational awareness'.

1.18.6 Operator's Audit on Commencement of the Operation

The Operator conducted an audit (No. Extra 1-2010) two weeks after the commencement of the Operation to '*verify that the operation started in Ireland with the Metro SA227 Fleet complies with all the requirements described in OPS 1 as well as with the* [the Operator's] *proceedings described in its Operation Manual…*'. The audit report (dated 2 June 2010) examined the aircraft (EC-GPS), the on-board documentation, handling, flight (experience required), operational aspects and the pilots. The following comments in the report are relevant:

'3. Handling and [Ticket Seller]

The operation is provided for [the Ticket Seller], *which supplies all kinds of facilities in the operation. A work space for the crew is available, with a desk and computer.* [The Ticket Seller] *provides the passenger manifest, the updated weather forecast and the information to carry out the loadsheet. At the completion of the flight, they send all the required documents to operations and they comply with the requirements.*

4. Flight

The meteorology of the Isle of Man in particular, with strong winds and low minimum temperatures, and of England in general, necessitates a different approach to the operation. Both the commander and the co-pilot must be experienced and have a good level of English. Our company should guarantee this. Pilots who are currently operating do not have any problem in this sense.

5. Operational aspects

They must change the normal checklist and adapt it to our company, carry out the pre-flight inspection, sign it and apply the anti-icing system before entering clouds. It is important to study the SOP's well, as well as clearly specifying in its list who is responsible for what and when, which are 'read and do' and which are 'do and read', as well as which are memorized and which are not.

6. Pilots

From a theoretical point of view, everyone must deepen their knowledge about the airplane, as well as the use of OPS 1 and airplane performances.'

The Investigation found no further audit reports on the Operation by the Operator.

1.18.7 Flight and Duty Time Limitations

Flight and Duty Time Limitations & Rest (FTL) requirements for all EU operators are contained in EU-OPS, Subpart Q, OPS 1.1090 to 1.1135. The structure of these requirements is set down in OPS 1.1090 – Objective and Scope, paragraph 2:

'*An operator shall ensure that for all its flights;*
The flight and duty time limitations and rest scheme is in accordance with both:

a) The provisions of this Subpart; and

b) Any additional provisions that are applied by the Authority in accordance with the provisions of this Subpart for the purpose of maintaining safety. Flights are planned to be completed within the allowable flight duty period taking into account the time necessary for pre-flight duties, the flight and turn-around times. Duty rosters will be prepared and published sufficiently in advance to provide the opportunity for crew members to plan adequate rest.'

The Regulation imposes responsibilities on: a) Operators; b) Crew Members and c) Civil Aviation Authorities (Competent Authority). A Competent Authority may grant variations to the requirements in Subpart Q in accordance with the applicable laws and procedures within Member States and in consultation with interested parties, provided such variation or variations produce an equivalent level of safety.

Under the provisions of OPS 1.1110, 1.4.1, the Authority may grant reduced rest arrangements, subject to certain conditions. Such arrangements, as in the case of any other variations to the Regulation, are required to be subject to demonstration by the operator to the authority, '*using operational expertise and taking into account other relevant factors such as scientific knowledge*', and, if approved, are detailed in the Operator's OM, Part A, Section 7 (Appendix 1 to OPS 1.1045). Although the Operator's OM included the reference from Subpart Q, regarding the provision for AESA to grant exemptions or variations, no variation or extension of any provision of Subpart Q was found in this Manual.

Whereas the Operator's OM provided for extensions of the Flight Duty Periods (FDPs), in accordance with the provisions of Subpart Q, the Investigation found no provision for the reduction of a rest period. Notwithstanding this, Spanish national regulations make provision in *Real Decreto* (RD) 1952/2009 (Article 5) for 'partial rest on the ground'. However, using this provision to extend a flight duty period requires that the subsequent rest period must take account of the entire preceding flight duty period under EU OPS. The Operator's OM, Section 7 included all aspects of EU-OPS Subpart Q; Annex IV to this Section contains the provisions of RD 1952/2009 under '*Circular Operativa*' (Operating Circular) CO 16B.

Regarding flight crew duties and FTLs between the times of 02.00 hrs and 05.59 hrs, the definition and provisions for the use of WOCL[44] were included in the Operator's OM, Part A, Section 7.

The Investigation was informed by the Operator that the 'Home base' (OPS 1.1095, 1.7) for crews employed on the Operation was Barcelona. Flight and Duty Time Limitations & Rest Requirements calculations in **Appendix B** have been completed on this basis.

OPS 1.1120 states that:

> *'…1.3 An operator shall ensure that:*
> *1.3.1. The Commander submits a report to the operator whenever a FDP is increased by his/her discretion or when a rest period is reduced in actual operation and*
> *1.3.2. Where the increase of a FDP or reduction of a rest period exceeds one hour, a copy of the report, to which the operator must add his comments, is sent to the Authority no later than 28 days after the event.*

The Investigation did not find any such reports from the Operator in the course of the Investigation.

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[44] **WOCL**: Window of Circadian Low, the period between 02.00 and 05.59 hrs. See EU-OPS 1.1095, 1.15.

1.18.8 ICAO Universal Safety Oversight Audit Programme (USOAP)

USOAP was launched in 1999 in response to widespread concerns regarding the adequacy of aviation safety oversight worldwide. This audit programme focused on a state's capability to provide safety oversight by assessing whether critical elements of a safety oversight system had been implemented effectively. Also examined was the level of implementation of safety relevant ICAO SARPs. ICAO carried out USOAP audits on all ICAO member states, with states required to host audits at least once every 6 years.

The State of Spain was audited by ICAO between 6 July 2010 and 16 July 2010. However, the Final USOAP Audit Report of Operational Safety Surveillance of the Civil Aviation System in Spain is not publicly available although many of those of other countries are. This Report was considered by the Investigation; however the Spanish DGAC[45] declined to allow the Investigation to use relevant extracts of the recommendations made by the ICAO audit team in this Final Report.

1.18.9 State Standardisation Inspections by EASA

EASA conducts Standardisation Inspections in order to monitor the application by the NAAs of EU Regulations. Regulation (EC) No 736/2006[46] establishes the working methods for conducting Standardisation Inspections of Member States. Following the issuance of an inspection report, there is a follow-up phase lasting up to 16 weeks for a remedial action plan and the associated timeframe to be agreed. EASA may, at any time, either on its own initiative or upon request from the European Commission, conduct follow-up inspections of NAAs and undertakings to assess satisfactory completion of corrective actions.

Prior to the formation of EASA, the JAA carried out a Standardisation Inspection of Spain in April 2003 and a recurrent Inspection was carried out in April 2007. The first Standardisation Inspection by EASA was carried out in April 2009.

EASA informed the Investigation that between 20 September 2010 and 24 September 2010 it carried out a Combined Standardisation Inspection of Spain. This Inspection assessed compliance with regulations applicable to Initial Airworthiness (IAW), Continuing Airworthiness (CAW), Flight Crew Licensing (FCL) and Air Operations (OPS). The Final Report was issued on 17 December 2010 and a number of findings were raised. The areas of concern identified included:

- Initial certification (issuance of AOCs).
- Continued oversight of AOC holders.
- Resolution of Safety Concerns.

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[45] **DGAC**: *Dirección General de Aviación Civil* (Spain).
[46] **Regulation (EC) No 736/2006**: is replaced by Regulation (EU) No 628/2013 which applies from 1 January 2014.

As a result a 'Corrective Action Plan' was prepared by Spain and implemented. EASA commented that it is unlikely that such action would have shown a major impact on the system at the time of, or prior to the accident.

1.18.10 EU Air Safety Committee (ASC)

The ASC was established under Article 12 of Council Regulation (EEC) No 3922/91. It is comprised of representatives of EU Member States, chaired by a representative of the European Commission and is mandated to enhance aviation safety in all its aspects as defined under Articles 8, 9 and 11 of the Regulation. While the EU Commission provides a regulatory framework for aviation operations within the EU, the ASC monitors the performance of the system and can recommend legislative changes.

The ASC meets regularly and advises the EU on regulations regarding aviation safety. EASA briefs the ASC on ICAO USOAP Reports, EASA Standardisation Reports and the results of the analysis of SAFA inspections. ASC reports are published as regulations. The ASC has *inter alia* the following functions:

- Assisting the European Commission with the adoption of harmonised implementation measures in order to enhance the effectiveness of the EC SAFA programme such as the approval of SAFA procedures;
- Assisting the European Commission with decisions related to corrective measures taken in respect of specific operators or operators of a specific third country (Community List).

At a scheduled meeting of the ASC on the 14 March 2011, AESA briefed the Commission '*that they decided to limit the AOC of* [the Operator] *to prevent operation of the Fairchild Metro 3s, and that they had initiated the process to suspend the AOC.*' The Commission sought to clarify whether AESA's surveillance activity had provided the evidence to show that the Operator (air carrier) was capable of adequately supervising its remote operations.

Commission Implementing Regulation (EU) No 390 of 2011, establishing the Community list of air carriers which are subject to an operating ban within the Community, contains the following relevant information:

> *'…(19) Following the analysis of SAFA inspection data by EASA and the identification of an increased number of Spanish air carriers with results from SAFA inspections of greater than a major finding per inspection, the Commission launched formal consultations with the competent authorities of Spain (AESA) and held a meeting on 14 March 2011.*
>
> *(20) The particular situation of Flightline, an air carrier certified in Spain was discussed at the meeting. The air carrier attended and made a presentation on actions taken to address identified safety deficiencies noted during SAFA inspections. In addition the air carrier detailed the actions taken following the accident to aircraft of type Fairchild Metro 3, registration EC-ITP.*

Flightline explained that they had entered into a business arrangement with the company Air Lada, not a certified air carrier, to operate two Fairchild Metro 3 aircraft, registrations EC-GPS and EC-ITP, using pilots provided by Air Lada. The Commission pointed out to Flightline that the same aircraft had been previously operating within the AOC of Eurocontinental, another air carrier certified in Spain, and that as a result of SAFA inspections and significant safety incidents with the operation of these aircraft, AESA had suspended Eurocontinental Air's AOC.

(21) Flightline stated they had conducted all the required conversion training of the pilots and had carried out quality checks of the operation of the aircraft in the Isle of Man. The Commission requested further details concerning the air carrier's corrective action plan and copies of the internal audit reports of the Fairchild Metro 3 operation.

Following receipt of the information on 22 March, the Commission invited the air carrier Flightline to make presentations to the Air Safety Committee.

(22) At the meeting on 14 March 2011 AESA briefed the Commission that they decided to limit the AOC of Flightline to prevent operation of the Fairchild Metro 3s, and that they had initiated the process to suspend the AOC.

(23) The Commission invited AESA to provide further clarification on enforcement action concerning four other air carriers certified in Spain which had been identified by EASA as having poor SAFA results. AESA subsequently informed the Commission on 28 March 2011 that, following recent audits of Air Taxi and Charter International, and Zorex, significant safety discrepancies had been noted and, therefore, the procedure to suspend the AOCs of both air carriers had been initiated.

In terms of the air carrier Jetnova, AESA awaited the response of the air carrier to specific findings made by AESA and if found to be inadequate will initiate the suspension procedure. With respect to the air carriers Aeronova, Tag Aviation and Alba Star, AESA was continuing its oversight but considered specific regulatory action was not required at this stage. The air carrier Flightline was heard by the Air Safety Committee on 5 April 2011. They briefed that they had introduced revised procedures to enhance the operational control of Flightline flights, particularly those operating away from their main base, had amended their Operations Manual to include guidance on the use of alternate aerodromes, had amended their training programme to reinforce pilot knowledge of operating procedures, and had revised their pilot selection procedures.

(24) Spain informed the Air Safety Committee that following discrepancies found during inspections of Flightline, AESA had initiated on 14 March 2011 a procedure to suspend the AOC of Flightline and had introduced precautionary measures to address the immediate safety concern. AESA confirmed that Flightline had subsequently taken action to address the immediate safety concern and also provided a Corrective Action Plan which was being evaluated by AESA.

(25) In light of the actions undertaken by the competent authorities of Spain in resolving the identified safety deficiencies of Flightline and other Spanish air carriers it is assessed that, at this time, no further action is necessary.

However, the Commission underlined that if such actions are ineffective in improving the performance of air carriers certified in Spain, action would be necessary to ensure that identified safety risks have been adequately controlled. In the meantime, the Commission, in co-operation with EASA, will continue to monitor the safety performance of Spanish air carriers.'

The subsequent Commission Implementing Regulation (EU) No 1197/2011, establishing the Community list of air carriers which are subject to an operating ban within the Community, includes the following relevant information:

'At a meeting on 19 October 2011, AESA briefed the Commission on the actions taken to date to address the identified safety issues with Spanish air carriers in a sustainable manner. In particular, AESA informed the Commission that the air carrier Flightline, following corrective actions by the company, had its AOC renewed, but limited to exclude the aircraft of type Metro III.'

The Metro III was the type used on the UK-Ireland passenger services; the operation of the other aircraft on its AOC was unaffected.

1.18.11 Submission from the Operator to Air Safety Committee

The presentation was made by the Operator to the Air Safety Committee on 5 April 2011. The presentation included a description of the Operator, inspections and SAFAs performed on the Operator, a description of the relationship between the Operator and the Owner, an analysis of the accident [to EC-ITP] (including measures taken to prevent such an event from re-occurring) and actions taken for improving safety.

The Operator set out changes in its operational procedures regarding Flight Dispatch and Control. These procedures were included in Revision 11 of their OM and submitted to AESA for approval. Revisions to procedures were made in the following areas:

1. New flight control procedures.
2. Operational Letter No. 4/11 circulated to all crew.
3. Operational Procedures and SOP courses for all crew.
4. An additional 6 hours included in all training and conversion programmes.
5. All pilots on the AOC to have a contract with [the Operator].
6. All business relations with [the Owner] to be terminated.
7. Audit and verification of the new procedures.

Operational Letter No. 4/11 set out detailed changes in the following areas:

- Operational Control
- Instructions for Flight Preparation
- Take-off and Landing Performance
- Start and Continuation of Approach

Relevant extracts of the Operator's presentation and Operational Letter No. 4/11 are reproduced in **Appendix O**.

1.18.12 Public Service Obligation (PSO)

In 2010, the EU imposed a PSO in respect of scheduled air services between Cardiff Airport and Anglesey (RAF Valley), at the request of the United Kingdom (2010/C 185/09). This was in accordance with the provisions of Regulation (EC) No 1008/2008 on common rules for the operation of air services in the Community, Article 17.8 of which states:

> *'…8. The Member State concerned may compensate an air carrier, which has been selected under paragraph 7, for adhering to the standards required by a public service obligation imposed under Article 16. Such compensation may not exceed the amount required to cover the net costs incurred in discharging each public service obligation, taking account of revenue relating thereto kept by the air carrier and a reasonable profit.'*

The PSO invitation to tender stated that Welsh Ministers sought to '*procure the services of an airline operator to provide a scheduled air service between Cardiff Airport and RAF Valley on Anglesey*'. This process was concluded by an Air Service Compensation Agreement (C-33/2010/11) between the Welsh Ministers and jointly, the Ticket Seller & FLM Aviation, referred to in the Agreement as '*Service Providers*'. This states, *inter alia* that:

> *'3.1 It is a condition of this agreement and the compensation provided by the Welsh Ministers that the Service Providers shall, and the Service Providers hereby covenant with the Welsh Ministers that they shall, operate the Designated Service in accordance with: …3.1.6 any published timetable for the Designated Service; …'*

The Investigation was informed by the *Luftfahrt-Bundesamt* (LBA), the regulatory authority responsible for the issue of operating licenses in Germany, that AOC No. D-275 and operating licence of FLM Aviation were revoked with effect from 1 November 2012 due to financial/economical reasons as the operator was no longer able to fulfil the requirements of Regulation (EC) 1008/2008, Article 5. Accordingly, FLM Aviation ceased operations. Subsequently, the Ticket Seller continued to sell tickets on this PSO route with FLM Aviation being replaced by an Air Carrier operating under an AOC issued by the UK CAA.

The Ticket Seller informed the Investigation in late 2012 that its assets were being sold to a new company as part of a management buy-out of certain parts of its business. The new company commenced operation on 2 January 2013 and continued to sell tickets on the PSO route.

1.18.13 Air Traffic Control Clearances

ICAO procedures for Air Traffic Management (ATM) services are contained in ICAO Doc 4444 (PANS-ATM). Procedures for issuing ATC clearances are contained in Section 4.5.1, which states *inter alia* that:

'The issuance of air traffic control clearances by air traffic control units constitutes authority for an aircraft to proceed only in so far as known air traffic is concerned. ATC clearances do not constitute authority to violate any applicable regulations for promoting the safety of flight operations or for any other purpose; neither do clearances relieve a pilot-in-command of any responsibility whatsoever in connection with a possible violation of applicable rules and regulations.'

1.18.14 Changes to the ICAO Flight Plan Format

In 2008, ICAO approved Amendment 1 to Doc 4444, which proposed changes to the Flight Plan System to meet the needs of aircraft with advanced capabilities and the evolving requirements of automated ATM systems. Among these changes was the inclusion of an indicator in Item 10 of the Flight Plan, Equipment and Capabilities which comprises the following elements:

a) presence of relevant serviceable equipment on board the aircraft,
b) equipment and capabilities commensurate with flight crew qualifications, and
c) where applicable, authorisation from the appropriate authority.

The date for implementation of this Amendment was 15 November 2012; however this amendment is subject to further review.

1.18.15 Infringements of Flight Time Limitations

Regulation (EC) No 216/2008, states in Article 68, Penalties, that:

'Member States shall lay down penalties for infringement of this Regulation and its implementing rules. The penalties shall be effective, proportionate and dissuasive'.

AESA informed the Investigation that since the accident, Spain has launched a number of punitive processes of which five have been resolved and another five are in process with proposed sanction amounts between €5,000 and €12,000.

1.18.16 Examiner Oversight Programme

Subsequent to the accident, Regulation (EU) No 1178/2011 was adopted on 3 November 2011 and entered into force on 8 April 2012. FCL.1005 of the Regulation titled 'Limitation of privileges in case of vested interests' states:

'Examiners shall not conduct:

(a) skill tests or assessments of competence of applicants for the issue of a licence, rating or certificate:

(1) to whom they have provided flight instruction for the licence, rating or certificate for which the skill test or assessment of competence is being taken; or

(2) when they have been responsible for the recommendation for the skill test, in accordance with FCL.030(b);

(b) skill tests, proficiency checks or assessments of competence whenever they feel that their objectivity may be affected.'

1.19 Useful or Effective Investigation Techniques

1.19.1 NTSB Aerodynamic Study

Because of the limited number of FDR recorded parameters available the Investigation requested the NTSB to conduct a detailed analysis of the aircraft dynamics in the final moments of the accident flight. This study, which was hampered by the small number of recorded parameters and non-availability of aircraft type aerodynamic data for the regime corresponding to the power reduction and asymmetric thrust effects, indicated that, in general, the simulation could reproduce aircraft dynamics that were consistent with the recorded data, runway impact marks and wreckage analysis.

1.19.2 Human Factors

ICAO Circular 240-AN/144 confirms the importance of conducting a study of the human factors involved in an accident and states, *inter alia*:

'The Investigation of Human Factors in aircraft accidents and incidents should be an integral part of the entire investigation and its resulting report. Humans do not act alone; they are but one element of a complex system. Often, the human is the last barrier that stops the sequence of events from causing an accident. However, when events combine and interact together to cause a catastrophe, the investigation authority must ensure that all elements of the complex system are investigated to understand why the accident happened. A systematic search of the 'Why' is not intended to pinpoint a single cause, nor is it intended to assign blame or liability, nor even to excuse human error. Searching for the 'Why' helps identify the underlying deficiencies that might cause other incidents or another accident to happen.'

2. ANALYSIS

2.1 General

Over many years, the aviation transport industry has developed a wide range of checks and balances to ensure the safety of passengers using commercial air transport. On 10 February 2011, events occurred that resulted in the loss of a public transport aircraft with fatalities and serious injuries to its occupants. The analysis of this occurrence examines the immediate factors together with the wider systemic issues that contributed to the accident.

From an initial examination of the accident flight itself the analysis considers the operational issues involved; these include crew training, the planning and the conduct of the flight. Arising from issues identified, deeper systemic factors are examined. These involve the nature of the remote operation, the oversight and control exercised by the Operator and the Competent Authority and the effectiveness of oversight. Furthermore, relevant aspects of the regulatory framework within which the Operation was conducted are considered.

2.2 Overview of the Accident

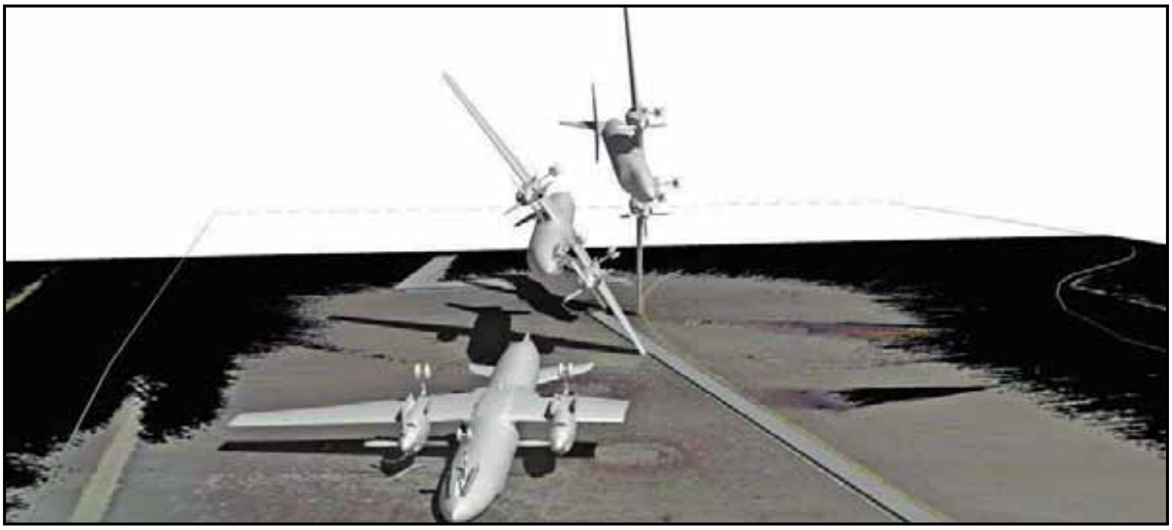
The aircraft carried out two ILS approaches, both of which were continued beyond the OM equivalent point with conditions below required minima. On both of these approaches, descent was continued below DH, followed by a missed approach. The aircraft then entered a holding pattern following which a third ILS approach was made with conditions below required minima. This approach was continued below DH and a missed approach was initiated. Approaching the runway threshold, the aircraft rolled to the left, followed by a rapid roll to the right during which the right wingtip contacted the runway surface. The aircraft continued to roll and impacted the runway in an inverted position. The aircraft departed the runway surface to the right and came to rest in soft ground.

2.3 Passenger Interviews

The passengers interviewed reported conditions of low cloud and fog during the final approach. Statements made by four of the passengers confirmed the aircraft rolling to the right immediately prior to impact. Two of the passengers observed the right wing tip strike the runway; one recalled the right bank occurring following an increase in engine power.

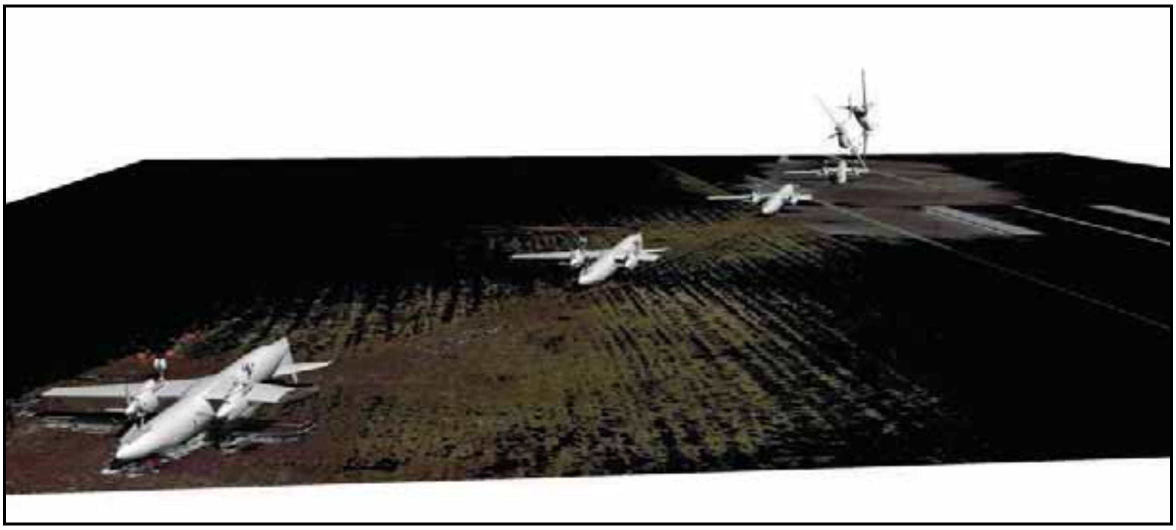
2.4 Wreckage and Impact Analysis

Impact evidence showed that the aircraft first contacted the runway surface with the right wingtip. At that moment the aircraft was at a roll angle of 97 degrees to the right, following which it continued to roll right, impacting the runway surface in an inverted position (**Graphic No. 5**).



Graphic No. 5: Reconstruction of initial impact sequence

Three of the right propeller blades detached as contact was made with the runway surface and were found at various distances from the main wreckage. The aircraft left the paved area and decelerated rapidly in the soft ground (**Graphic No. 6**). At this point the roof of the forward fuselage ruptured allowing a substantial quantity of soil to enter the cabin.



Graphic No. 6: Reconstruction of ground path to final resting place

2.5 Loss of Control

Following a third approach, a missed approach was initiated, at which point a loss of control occurred. The Investigation examined the flight path of the aircraft during its final manoeuvring and approach. The evidence from the FDR, TAWS and ATC Radar indicates that the final approach was flown at approximately 140 kts, an airspeed consistent with the proper control of the aircraft since the zero bank stall speed calculated for the aircraft in that configuration was 88 kts.

Although the stall warning horn activated during the final seconds of the flight, various combinations of airspeed decay and load factors, coupled with the aerodynamic disturbance associated with a prohibited in-flight manoeuvre, were the likely causes of its activation.

The Investigation examined the following scenarios that may have contributed to the loss of control:

- a flight control problem
- a primary instrument failure on the aircraft
- unreliable signals from the ILS ground based equipment
- incorrect display of ILS signals
- incapacitation of one or both of the Flight Crew
- powerplant anomaly (the engines, propellers or the engine control components).

2.5.1 Flight Controls

The flight control runs and surfaces were examined at the accident site. This examination was carried out by the Investigation following rescue efforts by the AFS and prior to movement or cutting of the wreckage for recovery purposes. This inspection revealed no pre-existing defects in the control runs or the control surface assemblies. The cutting of the control run cables and control assemblies by the AFS, for the purposes of gaining access to the Flight Crew, was taken into account in determining the control run continuity. Consequently, the Investigation is satisfied that the flight control system was not a factor in the accident.

2.5.2 Flight Instruments

Analysis of FDR/CVR data, TAWS information and ATC Radar data show the aircraft flight path was consistent with correct functioning of the flight instruments. Although the Primary Attitude Indicators were both damaged as a result of impact forces, examination and testing indicated that both instruments were probably functioning normally at the time of impact. The Standby Attitude Indicator displayed an unstable indication under test. This damage was considered likely to have been caused as a result of severe shocks during impact. In any event, the Standby Attitude Indicator was not a primary instrument, and would only be used by the Flight Crew in the event that one of the Primary Attitude Indicators became unserviceable. There was no evidence of this being the case, as there is no reference to any instrument malfunction on the CVR recording by the Flight Crew.

Consequently, the Investigation is satisfied that the primary instrumentation was functioning correctly and was not a factor in the accident.

2.5.3 Instrument Landing System

All navigation aids at EICK were subject to continuous automatic monitoring. The LLZ, GP and DME on RWY 17 were equipped with dual monitors and audio alarms to ensure the integrity of the radiated signal and to initiate a shutdown if limits were exceeded. The monitoring log files show that all parameters were normal prior to, and following the accident. No warnings or failure indications were evident during the final approach of EC-ITP. Apart from a brief engineering intervention on the ILS switch over panel at 08.48 hrs, the ILS, LLZ, GP and DME were operating normally and within prescribed limits. A Flight Inspection Procedure carried out on the day following the accident revealed no anomalies with the radiated signals.

The withdrawal from use of the RWY 35 OM, MM and 'OB' Locator as per NOTAM was not a factor as these aids were replaced by the provision of DME thereby providing distance information to the runway during an approach.

The Investigation is therefore satisfied that ILS Radiated Signals were functioning correctly at the time of the accident. In addition the approach lighting systems was also found to be operating correctly. Accordingly, the ILS System was not a factor in the accident.

2.5.4 Reception and Display of ILS Signals

The No. 1 NAV Receiver passed all tests with the exception of the VOR audio output which would not have affected the Flight Crew's ability to track the received ILS signals.

The No. 2 NAV Receiver tested satisfactorily apart from the Glideslope Sensitivity parameter. This parameter defines the point at which the instrument captures the glideslope signal, revealing the CDI (Course Deviation Indicator) pointer on the HSI. The CVR recorded the Flight Crew setting the correct ILS frequency when commencing the final approach. The CVR also recorded both the PNF and PF commenting on the successful acquisition of the LOC and GS. In addition, TAWS and Radar data show that, on each approach, the aircraft tracked the ILS glide path and localiser with accuracy consistent with a hand flown approach.

Testing of the Captain's HSI showed that the instrument was most probably operating normally at the time of the accident. The HSI heading of 321°M is most probably accounted for by damage arising from the nose impact with the runway surface generating spurious DG inputs to the HSI. In addition, no comments were made by either Flight Crew member regarding abnormal indications in the cockpit during the final approach.

Testing of the Co-pilot's HSI concluded that the internal electro-mechanical components had remained resilient to the impact forces despite the damage to the instrument casing. The heading bug, course indicator and heading were all indicating 165°M, which was the heading of the runway on which the aircraft was attempting to land. In conclusion, the Investigation is satisfied that the HSIs and the reception and display of ILS signals did not contribute to the loss of control.

2.5.5 Incapacitation of the Flight Crew

The possibility of subtle or sudden incapacitation of the Flight Crew was examined. The CVR confirmed that all conversation between the Commander and Co-pilot was interactive with no indication that either Flight Crew member was subject to subtle or sudden incapacitation. Therefore the Investigation has discounted this possibility.

2.5.6 Powerplant

Examination of the propellers showed that, at the moment of impact, the blades of both propellers were at pitch angles of approximately 40 degrees, which was appropriate for a power setting commensurate with a go-around. No pre-accident defects were found with any of the propeller blades and all available evidence indicates that the propellers were functioning correctly at the moment of impact.

Prior to commencement of the go-around, FDR data shows a negative torque value of -9% on the No. 1 engine. At that time, the CVR recording contains a short, coarse cyclic sound consistent with a brief operation in Beta mode. In addition, the Beta mode latch on No. 2 power lever was found in the raised position, held against spring pressure by impact damage to the power lever. When the power lever was straightened with minimal pressure, the Beta latch mechanism returned to the normal position. The Beta latches are normally operated as a pair, and therefore the Investigation is of the opinion that the Beta latches were probably being held in the raised position at the moment of impact. Analysis of FDR engine torque and RPM data indicates that both power levers were simultaneously moved below the Flight Idle position of 40 degrees, in the period from approximately 8 seconds to 6 seconds before impact. Calculations derived from the torque and RPM data indicate that the power lever angles at this time were in the range 31 degrees to 33 degrees, i.e. below the Flight Idle position. Calculations also show that shortly before impact, the power levers had been advanced to angles within the range 72 degrees to 75 degrees, representing a high power setting.

Examination of the L and R Beta annunciator light bulb filaments, which would be illuminated if in Beta mode, indicated that the lights were not illuminated at the moment of impact consequently the propellers were not in Beta mode at the moment of impact.

The evidence from the CVR, Beta mode latch and FDR engine parameters is consistent with a simultaneous retardation of both power levers below the Flight Idle stops. Operating one or more power levers below Flight Idle in-flight produces high drag conditions which may result in excessive airspeed deceleration and may induce an uncontrollable roll rate due to asymmetric thrust and drag.

The anomaly found with the No. 2 engine P_{T2}/T_{T2} sensor caused a mismatch in fuel scheduling between the two engines, which resulted in three effects:

(1) Slower engine speed response when the speed lever was advanced.
(2) Faster engine torque response when the power lever was advanced.
(3) Higher torque for a given power lever angle.

FDR data shows that the engine speeds were at approximately 100% throughout the approach phase (HIGH) and that the speed levers were not moved during this time. Thus effect (1) was not relevant during this phase. The FDR data also shows that the engine torques were closely matched during the application of power during the go-around. Consequently, effect (2) was quite limited in this particular case.

Effect (3) is evident at several times in the recorded data. During the period from -20 to -10 seconds (**Figure 5, 5a**), engine No. 2 torque was generally approximately 4% higher than that for No. 1 engine. During the time when the data indicates the power levers were brought below the Flight Idle stop (Beta range), the FDR recorded a minimum torque value of -9 % for No. 1 engine, while the minimum recorded torque value for No. 2 engine was 0%.

Evidence suggests that No. 1 powerplant entered a negative torque regime while No. 2 did not do so. This in turn triggered the Negative Torque Sensing (NTS) system on the No. 1 engine, which would have automatically acted to increase the propeller blade angle toward the feathered position. The probable reason that No. 1 engine entered a negative torque regime while No. 2 engine did not do so, when both power levers were retarded below Flight Idle, is the mismatch in fuel scheduling between the engines which was due to the negative temperature bias of the No. 2 engine P_{T2}/T_{T2} sensor with the shortened bellows.

These rapid and asymmetric torque and drag variations coincided with the initial stages of loss of control i.e. a rapid roll to the left to an angle of 40 degrees. Upon application of go-around power, the aircraft commenced a rapid roll to the right during which the right wingtip came in contact with the runway.

While an anomaly was identified with the P_{T2}/T_{T2} sensor on the No. 2 engine, which resulted in a torque split between the two engines, it is noted that this condition existed for more than 106 hours of aircraft operation and that two go-arounds had already been conducted prior to the accident. It is the opinion of the Investigation that this anomaly did not materially affect the normal operation of the aircraft; however when the aircraft entered a regime prohibited by the AFM, this anomaly became significant.

2.5.7 Loss of Control Summary

The Technical Log identified that the Co-pilot was PF for the flight. The CVR and ATC recordings also indicate that the Co-pilot was PF during the flight. Furthermore, injuries sustained by the Co-pilot to his right hand are consistent with him handling the aircraft at the time of impact. As no autopilot or flight director was fitted, the PF was under a high workload throughout the flight. This was especially so as three approaches were made in poor weather to below minima with two go-arounds. Normally the PF handles both flight and engine controls in a coordinated manner to achieve the required flight path; the PNF carries out other tasks including monitoring the aircraft's flight path, radio communications and keeping the flight log.

The CVR indicates that the Commander (PNF) took control of the power levers during the final approach, this action being acknowledged by the PF. This was significant, as both power levers were subsequently retarded below Flight Idle – an action which would have been unexpected by the PF.

The recorded data shows that the No. 1 engine reached a minimum torque value of -9% in Beta range, while No. 2 engine reached a minimum value of 0%. This thrust asymmetry was coincident with the aircraft commencing a roll to the left (maximum recorded value 40 degrees of bank). It is possible that the PF may have made a control wheel input to the right in response to the unanticipated left roll. However, without the FDR parameters of control wheel or control surface position the Investigation cannot determine if such input was made. The subsequent application of power to commence the go-around, at approximately 100 feet, coincided with the commencement of a rapid roll to the right and loss of control. This roll continued through the vertical, the right wingtip struck the runway and the aircraft inverted.

Three principal factors contributed to the loss of control:

- Uncoordinated operation of the power levers and the flight controls, which were being operated by different Flight Crew members.

- The retardation of the power levers below Flight Idle, an action prohibited in flight, and the subsequent application of power are likely to have induced an uncontrollable roll rate due to asymmetric thrust and drag.

- A torque split between the powerplants, caused by a defective P_{T2}/T_{T2} sensor, became significant when the power levers were retarded below Flight Idle and the No. 1 powerplant entered a negative torque regime. Subsequently, when the power levers were rapidly advanced during the attempted go-around, this probably further contributed to the roll behaviour as recorded on the FDR.

2.6 Operational Issues

2.6.1 Crew Training and Qualifications

The Commander held a CPL, with type and instrument ratings, and a valid medical certificate. He had significant experience on type when he joined the Operator in December 2009. He was given a number of sectors in Command under Supervision on initial line flying, but continued to fly as a co-pilot afterwards until 2 February 2011. He made his first flight in command on 6 February 2011, four days prior to the accident. In addition, the command training programme was disrupted without proper continuity of training, making that training less effective.

The Co-pilot had recently joined the Operator and had previous experience on the SA 227 but little operational experience with the Operator. It is also relevant to note that all of his operational experience was in Spain, where different meteorological conditions prevail to those of the UK and Ireland. His exposure to the Operator's SOPs was limited with little time to adjust to the new procedures.

The Co-pilot also held a CPL with type and instrument ratings and valid medical certificate however his line training with the Operator had not been completed. As such, the Co-pilot should only have been flying with a training captain until he had satisfactorily passed a Line Check.

The Operator did not employ any form of restriction to newly qualified flight crew, but paired crews as required. With this practice it was possible for newly qualified commanders and co-pilots to operate together.

2.6.2 Flight Crew Roster

Inspection of the Operator's records shows that the Flight Crew's actual duties were at variance with those planned in the roster. On the day of the accident, the Operator was under the impression that a different co-pilot was operating the duty. The duty change was brought about by the originally rostered co-pilot requesting a duty change through the Operations Manager of the aircraft Owner, '*the person responsible*' as that co-pilot stated to the Investigation.

The Co-pilot was then tasked to operate flights on the 9-10 February 2011. This change was not made known to the Operator, although the preparation of rosters and availability of adequately rested flight crew was wholly the responsibility of the Operator.

2.6.3 Flight Crew Duty Times

The Investigation examined the duties and rest periods of the Flight Crew in the period leading up to the accident. Due to the difficulties found in determining their duties, the operation of both aircraft and the associated records were examined in order to determine the actual duties performed by each pilot. Consequently, the duties of all seven pilots involved in the Operation were examined (**Appendix B**). The Investigation found deviations from the rostered duties and significant transgressions of the Flight & Duty Time Limitations and Rest Regulation (FTL).[47] The following analysis examines the work patterns of the Commander and Co-pilot for the four days prior to and the day of the accident.

[47] **FTL**: Flight Time Limitations, Regulation (EC) No 859/2008, Subpart Q.

2.6.3.1 Commander

The Commander had completed two line check sectors on the 4-5 February 2011, following which he positioned to Belfast prior to commencing his first duties as Commander. He operated from 6 February and each day thereafter until the accident flight on 10 February.

Flight duty is calculated from 45 minutes prior to the first departure on each day. There is no provision for post flight duties; duty time terminates at engine shutdown.

On 6 February, the Commander operated a series of flights EGAC-EGNS-EGAC-EICK-EGAC, commencing duty at 12.05 hrs and terminating at 18.55 hrs.

On 7 February he operated two return flights, EGAC-EICK, commencing duty at 07.05 hrs and terminating at 18.45 hrs.

On 8 February he operated 5 sectors and then positioned back to EGAA. He commenced duty at 07.15 hrs and, on completion of the two return flights to EICK, operated a positioning flight to EGNS with EC-GPS as this aircraft was scheduled for routine maintenance. This flight arrived at EGNS at 19.50 hrs, and while there is no record of the Commander's return to Belfast, it seems probable that he positioned on the other Metro III aircraft, EC-ITP which operated EGNS-EGAA and was operated by captain 'C' and co-pilot 'E', departing at 20.20 hrs, and arriving at 21.00 hrs.

The allowable maximum duty time for this duty (taking account of partial rest on the ground under the provisions of CO 16B) increased from 11 hours 30 minutes to 14 hours 17 minutes. The Commander's duty time was 13 hours 45 minutes, requiring a minimum rest period equal to this duty. Accordingly, the earliest time he should have commenced the next duty was 10.45 hrs on 9 February. The actual rest he achieved was 9 hours 15 minutes. The co-pilot for the series of flights (until arrival at EGNS) was co-pilot 'D', who returned to Barcelona on 9 February.

On 9 February, the Commander commenced duty at 06.15 hrs, 4 hours 15 minutes prior to completion of minimum rest. He operated from EGAA to EGAC and again operated two return flights between EGAC and EICK, finishing at 18.40 hrs, a duty time of 12 hours 25 minutes. The allowable maximum duty time for this duty (again taking account of CO 16B) was 14 hours 15 minutes. The minimum rest required between the termination of duty on 9 February and commencement of duty on 10 February was 12 hours 25 minutes (the length of the preceding duty), resulting in an earliest duty commencement time of 07.05 hrs.

On 10 February (the day of the accident) he commenced duty at 05.55 hrs, 1 hour 10 minutes earlier than allowed under EU-OPS 1.1110, 1.2 and operated EGAA-EGAC-EICK.

Table No. 1 provides a summary of Duty Times and Rest Periods for the Commander:

Date:	6 Feb 2011 (h:mm)	7 Feb 2011 (h:mm)	8 Feb 2011 (h:mm)	9 Feb 2011 (h:mm)	10 Feb 2011 (Accident)
No. of Sectors:	4	4	5	5	2
WOCL:	No	No	No	No	
Max Basic FDP:	12:00	12:00	11:30	11:30	
DPT: (1)	0	5:30	5:35	5:40	
DPT extension:	0	2:45	2:47	2:50	
Max allowable FDP:	12:00	14:45	14:17	14:20	
Actual FDP:	**6:50**	**11:40**	**13:45**	**12:25**	
Min rest required (2):	10:00	11:40	13:45	12:25	
Rest achieved:	**12:10**	**12:30**	**9:15**	**11:15**	
FTL Exceedance:				**Duty commenced 4 hours 30 minutes prior to completion of minimum rest.**	**Duty commenced 1 hour 10 minutes prior to completion of minimum rest.**

Table No. 1: Summary of Duty Times & Rest Periods (Commander)

Note 1: DPT: *Descanso Parcial en Tierra*, partial rest on the ground.

Note 2: Minimum rest (at home base) shall be at least as long as the preceding duty period or 12 hours, whichever is the greater (OPS 1.1110); Minimum rest (away from home base) shall be the length of the preceding duty or 10 hours whichever is the greater (OPS 1.1110). The Operator informed the Investigation that the 'home base' for the Flight Crew was Barcelona, Spain (LEBL).

In summary, on the day prior to, and on the day of the accident, the Commander was not fully rested in accordance with the provisions of EU-OPS, Subpart Q and the Operator's OM, Part A, Section 7.

2.6.3.2 Co-pilot

The Co-pilot operated from 7 February and each day until the accident flight on 10 February, on a mix of night mail (cargo) and day (passenger) flights. On 7 February he operated EGAC-EGAA-EGPH-EGAA-EGAC, commencing duty at 19.00 hrs and terminating at 07.30 hrs on 8 February, a total duty time of 12 hours 30 minutes. As this flight duty (a) involved the operation of 4 sectors and (b) had entered the period 02.00-05.59 hrs, defined as the Window of Circadian Low (WOCL),[48] the allowable maximum duty time was reduced from a basic 13 hours by the following:

(a) 30 minutes for each sector from the third sector onwards and
(b) 50% of the encroachment into the WOCL.

This reduced the allowable maximum duty time by 3 hours, to a total of 10 hours. While the Operator's OM, Part A, Section 7, provides for an extension of 1 hour, no such extension is available under OPS 1.1105, 2.4 when the FDP encroaches on the WOCL by more than 2 hours, in which case '*extensions are limited up to two sectors*'. Consequently, no duty time extension is allowable in this case.

As a result, the operation on the night of 7-8 February involving 4 sectors exceeded the allowable maximum duty time by 2 hours 30 minutes. As the third sector was completed before the WOCL commenced, the operation of this sector did not breach the provisions of EU-OPS Subpart Q. However, the final sector (EGAA-EGAC) should not have been commenced. The aircraft had arrived at EGAA at 01.30 hrs and was on the ground throughout the WOCL period.

The sector from EGAA to EGAC (07.00-07.30 hrs) commenced at a time when the maximum allowable time for this duty had already been exceeded due to the WOCL limitations. The Operator's OM (Section 7.1.b.i, Para 4) states that where the flight duty exceeds 2 hours of the WOCL period '*extensions are limited to two sectors*'. This made operation of the last sector a breach of regulation.

On 9 February, the Co-pilot flew with the Commander for the first time. The Co-pilot commenced duty at 06.15 hrs. He operated from EGAA to EGAC and again operated two return flights between EGAC and EICK, finishing at 18.40 hrs, a duty time of 12 hours 25 minutes. The allowable maximum duty time (taking account of partial rest on the ground under the provisions of CO 16B) was 14 hours 15 minutes. The minimum rest required between the termination of duty on 9 February and commencement of duty on 10 February was 12 hours 25 minutes (the length of the preceding duty), resulting in an earliest duty commencement time of 07.05 hrs.

On 10 February (the day of the accident) the Co-pilot operated EGAA-EGAC-EICK, commencing at 05.55 hrs. This commenced 1 hour 10 minutes earlier than allowable, based on a minimum rest requirement resulting from the duty performed on 9 February.

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[48] EU-OPS 1.1095, 1.15.

Table No. 2 provides a summary of Duty Times and Rest Periods for the Co-pilot:

Date:	**7-8 Feb 2011 (h:mm)**	**9 Feb 2011 (h:mm)**	**10 Feb 2011 (Accident)**
No. of Sectors:	4	5	2
WOCL:	Yes (50%)	No	
Max Basic FDP:	10:00	11:30	
DPT: (1)	Nil	5:40	
DPT extension:	Nil	2:50	
Max allowable FDP:	10:00	14:20	
Actual FDP:	**12:30**	**12:25**	
Min rest required (2)	12:30	12:25	
Rest achieved:	**12:30**	**11:15**	
FTL Exceedance:	**(a) Exceeded allowable FDP by 2 hours 30 minutes** **(b) Final sector should not have been commenced.**		**Duty commenced 1 hour 10 minutes prior to completion of minimum rest.**

Table No. 2: Summary of Duty Times & Rest Periods (Co-pilot)

Note 1: DPT: *Descanso Parcial en Tierra*, partial rest on the ground.

Note 2: Minimum rest (at home base) shall be at least as long as the preceding duty period or 12 hours, whichever is the greater (OPS 1.1110); Minimum rest (away from home base) shall be the length of the preceding duty or 10 hours whichever is the greater (OPS 1.1110). The Operator informed the Investigation that the 'home base' for the Flight Crew was Barcelona, Spain (LEBL).

In summary, the Co-pilot, two days prior to the accident, exceeded flight and duty time limitations by 2 hours 30 minutes and operated a final sector in breach of regulations. On the day of the accident, he was not sufficiently rested according to the provisions of EU-OPS Subpart Q.

2.6.3.3 FTL Summary

In the four days prior to the accident and on the day of the accident, the Investigation identified a total of five breaches of Flight & Duty Time Limitations and Rest Requirements (FTL) regarding the duties operated by the Flight Crew. The duties operated resulted in both Flight Crew members having inadequate rest prior to commencing duty on the day of the accident. In addition, in examining the duties conducted by the seven pilots involved in the operation, the Investigation identified other breaches of FTL - one of which was a gross exceedance of FTLs involving a duty of 20 hours and 10 minutes.

The Investigation is therefore of the opinion that the Operation was conducted without due regard to FTL requirements. As both Flight Crew members did not achieve adequate rest prior to the commencement of duty, and considering the workload involved in manually flying the aircraft in limiting condition, tiredness and fatigue may have been a factor in the accident.

Member States shall lay down penalties for infringement of Regulation (EC) No 216/2008 and its implementing rules. Regarding infringements of FTL, the penalties imposed by States shall be effective, proportionate and dissuasive. Other than Spain, the Investigation is unaware of any Member State that has introduced penalties under this Regulation and accordingly issues a Safety Recommendation to the EU to review this matter.

Safety Recommendation No. 1
It is recommended that the Director-General for Mobility and Transport, European Commission should review the obligations of Member States to implement penalties, in accordance with the Standardisation Regulation (EU) No 628/2013, as a result of transgressions including Flight Time Limitations as provided for in Regulation (EC) No 216/2008. (**IRLD2014001**)

2.6.4 Meteorological Situation

Generally that morning, all airports in Ireland had slack winds with poor visibility or low lying fog, with the exception of EIKY which had good conditions.

At the time of the accident the weather at EICK was poor with foggy conditions and a low cloud base. Similar, but not quite so poor weather conditions had prevailed for the previous two days, including the previous day when the Flight Crew had flown into EICK in the morning and again in the afternoon when Low Visibility Procedures were in force. The weather forecast issued that morning at 05.00 hrs accurately forecast conditions at EICK and forecast an improvement later that morning between 09.00 and 11.00 hrs, as occurred. Of other nearby airports that morning, the actual weather conditions at the alternate airport EIWF were below limits as was the case with EINN. The weather at EIDW was poor but operational. EIKY was free of fog and fully operational. The Investigation is satisfied that the meteorological conditions were correctly forecast and that TAFs accurately forecast the weather encountered.

2.6.5 Flight Planning

At the flight planning stage, flight crew should make an adequate assessment of the destination and alternate weather to satisfy themselves that the proposed flight may be undertaken in safety.

The meteorological briefing pack provided the previous evening to the Flight Crew by the Operator via a third party supplier was out of date. Records show that the Flight Crew obtained up to date meteorological information for EGAA, EGAC, EICK and EIDW. The RVR trends in the METAR for EICK were circled in pen indicating that the Flight Crew had considered them. Although the 'TEMPO 0300' on the METAR at 06.00 hrs was underlined, there were no marks made on the TAF report that forecast a visibility of 300 m in fog which indicated that conditions were likely to be below required minima at the scheduled time of arrival. The Commander may have intended to obtain more up to date weather information later at EGAC during the turnaround.

There is no evidence that the Flight Crew made contact with EIWF to obtain the actual weather conditions there, or that any weather information was obtained for EIKY at the flight planning stage, where a precision approach was available. The evidence indicates that the Flight Crew were unaware of the forecast and actual weather conditions for their nominated alternate airport EIWF and both EINN and EIKY.

As weather conditions at their destination EICK were below limits, regulations required that the flight plan should nominate two alternate aerodromes with suitable weather conditions. Since only one alternate (EIWF) was nominated on the flight plan received the previous evening, the Flight Crew should have requested another flight plan and re-filed with ATC but this was not done.

A commander has options available should the weather at the planned destination be below limits. If it appears likely that the weather will improve, the flight may be delayed for a period and the weather re-assessed. Alternatively, the flight may be completed to an alternate aerodrome close to the destination where the weather is above limits and where the passengers can be conveyed by surface transport. Either way, the safety of the flight is not compromised. The commander must take responsibility for the disposition of the aircraft, and if the flight cannot be completed safely and within regulations, the commander must communicate this fact to the operator. Making such judgements in real time is not an easy task, especially for a newly appointed commander.

In the flight operations office at EGAA, the Commander should have been fully aware of the poor weather conditions at EICK and the probability that an approach could not be made under those conditions. If time constraints were an issue at the flight planning stage in EGAA, there was also an option to obtain an updated weather brief at EGAC following the short positioning flight.

In general, pilots obtain the latest weather prior to departing on the next sector, especially when the weather is poor at the destination. There is no record of the Flight Crew having done so at EGAC and it is possible that they were distracted from this task considering that passenger boarding was delayed due to the Flight Crew having to work on passenger seating in the cabin. Alternatively it is possible that the Flight Crew were unaware how poor the actual weather conditions were at EICK. In any case, when the flight departed EGAC en-route to EICK the Flight Crew was inadequately prepared regarding meteorological information.

2.6.6 Conduct of the Flight

The CVR recordings, which contained the final 28 minutes and 59 seconds of the flight, provided an insight into the operation and conduct of the flight. The CVR recording commenced as the aircraft entered the holding pattern at ROVAL. The atmosphere on the flight deck, although outwardly light-hearted, was symptomatic of increasing stress levels as the situation developed. Inter-crew communications revealed a flat cockpit authority gradient, with little formal command in evidence. Although cockpit checks were accomplished, these checks were not accomplished in a formal manner, through challenge and response. There was limited formal evaluation of the weather conditions or discussion of available options.

Generally in such weather conditions, one of the functions of the PNF is to provide an update of the METARs of nearby airports. There was no evidence of this. It is apparent that the crew were content to continue to hold and wait for an improvement in the weather, which was an option considering that they had adequate fuel. While the aircraft was continuing to hold, Cork ATC enquired as to the alternate aerodrome. This was given as EIWF and weather was sought by ATC at the request of the Flight Crew. As EIWF was below limits the Flight Crew now declared their second alternate as EINN and again enquired regarding its weather. EINN conditions were also below limits.

At the prompting of ATC the weather conditions at EIKY, which were good, and its proximity to EICK were provided to the Flight Crew, thus providing the flight with an operational alternate. It is clear therefore that the Flight Crew had no overall picture of the actual weather situation and were reacting to the operational inputs of ATC, rather than proactively managing the flight.

There was a mention on the CVR of a diversion to EIKY, but this was interrupted by an enquiry regarding the current weather conditions at EICK, made by an inbound commercial flight. In poor weather conditions, this type of enquiry is a normal request for flight crews to make, as it allows a crew to plan ahead and indicates if a diversion is likely. In this case, the enquiry showed that a slight improvement in the IRVRs was occurring. This was significant, in that the Flight Crew decided to attempt a third approach and the option of diverting to EIKY was not referred to again.

The Flight Crew had already completed two approaches, one to RWY 17 and one to RWY 35. In both cases, weather conditions precluded continuing the approach beyond the outer marker or equivalent position due to the conditions being below limits. The reason for this prohibition is that, if the conditions are below minima and an approach is continued, it is unlikely that there will be sufficient visual cues at DH to continue to a safe landing.

The Investigation is concerned that the Operator's OM contained no limit on the number of approaches that could be made. This is particularly so since the aircraft did not have an autopilot or a flight director and had to be hand flown throughout the flight. Furthermore, during an IMC approach the flight path had to be controlled by sole reference to the primary flight instruments using ILS raw data. This would have increased the workload and stress, particularly on the PF while making an approach and the PNF who would have to monitor the flight path during all phases of flight and complete all other duties.

The Operator's OM contained no limit on the number of approaches that could be made so the decision to conduct a third approach was entirely at the discretion of the Commander. Many operators have in place restrictions on the number of approaches that can be made, in that a third approach can not be made unless there is a significant improvement in the conditions. As EU-OPS contains no restrictions regarding the number of approaches that can be conducted, the Investigation issues a Safety Recommendation to EASA that it reviews this issue.

Safety Recommendation No. 2
The European Aviation Safety Agency should provide guidance to Operators concerning successive instrument approaches to an aerodrome in IMC or night VMC where a landing cannot be made due to weather reasons and incorporate such guidance in Commission Regulation (EU) No 965/2012 accordingly. (**IRLD2014002**)

2.6.7 Command Decision Making

The safety of the aircraft and its passengers and crew are the prime responsibility of the commander, even if the role of actually flying the aircraft has been delegated to the co-pilot. From an operational point of view however, the issues are more complex. To promote a first officer to the rank of commander, an operator must have adequate procedures in place. These procedures must ensure that a candidate selected for promotion is suitably experienced in the duties of a co-pilot and has the ability to progress through a rigorous command training programme which should provide the candidate with the tools and capabilities to make appropriate and safe decisions in the command role.

One of the tools a commander can use is to employ the principles of CRM. The Commander completed CRM training annually during his commercial flying career, but with potential command imminent, an in-depth understanding of these principles was paramount. In January 2011, the FSM gave ground instruction to flight crews on aspects of CRM. CRM instruction as part of the command process was required to be of 10 hours duration over a period of 2 days but the Commander received approximately 2½ hours, which was not adequate either in its duration or its content.

The use of CRM principles would have helped the Commander to manage the situation, not least on arrival at EICK with the weather below minima. By identifying the problem and the possible options that were still available, the Commander would have demonstrated more effective leadership, created a better cockpit authority gradient and enabled pro-active and constructive participation on the part of the Co-pilot.

Records show that the Commander received a basic level of experience acting in command under supervision. This training lacked continuity and was carried out on familiar routes that were local to the Operator's base, and in weather conditions that were far more benign than those on the day of the accident.

The command process must first familiarise a candidate with operation of the aircraft from the left seat; this process takes a number of sectors to ensure that the candidate is thoroughly familiar with and proficient in the task of handling the aircraft in normal and non-normal situations, for example during engine failure or fire.

An important part of command training is the ability of the candidate to learn to make balanced decisions to achieve a safe flight. This can be facilitated by structured ground based training, followed by first-hand experience during line training under supervision. The role of the Training Captain is to ensure that the candidate makes considered and safe decisions, while operating on routes that the candidate will be likely to operate on in command. Every opportunity should be taken to require the candidate to use good judgement and ensure that decisions made are prudent and adequately address any risk encountered prior to, or during a flight.

The new Commander may have felt under pressure to complete his flight duties punctually and in accordance with the flight schedule. To delay, re-route or even cancel a flight takes confidence on the part of a commander, especially considering the resources of a small operator, but the consideration of decisions such as these should have been part of the command training process.

Regulations stipulate that an approach may not be continued beyond the outer marker (or equivalent position) if the RVR/visibility conditions are below the required minima. If an aircraft has passed the equivalent position and visibility subsequently deteriorates, then an approach may be continued to DH, but without visual contact a go-around must then be carried out. On an ILS approach, a go-around carried out at DH will result in the aircraft going slightly below the DH. This is factored into the minima as the aircraft will be pitching up and commencing a climb at this point. These minima give the flight crew a reasonable probability of acquiring adequate visual reference at DH.

From an operational point of view, on initially receiving the latest weather conditions at EICK (which were below minima), the Flight Crew had the options to enter a hold and assess the situation or divert. However, they elected to conduct an approach to RWY 17 without delay while the weather conditions at the time precluded a continuation of the approach beyond the outer marker (or equivalent point). This approach was made contrary to Regulations. In addition, the descent was continued to a recorded height[49] of 101 ft, significantly below the DH of 200 ft, prior to a go-around being executed.

A decision was then made to conduct an approach to RWY 35. The deciding factor for this decision, according to the ATC transcript, was that the early morning sun was shining towards the aircraft during the first approach and that an approach on the reciprocal runway would place them in a better position to obtain visual reference at minima. Due to the level of approach lighting installed on the RWY 35, the minimum RVR for an ILS approach is higher than that for RWY 17, with a minimum IRVR of 750 m required as the aircraft passes 4.9 NM on the approach. Again the weather conditions were such that an approach beyond that position was precluded and this approach was also made contrary to Regulations. The descent was continued to a recorded height of 91 ft, significantly below the DH of 200 ft, prior to a go-around being executed.

The Flight Crew then decided to enter a hold to see if an improvement in the weather conditions would occur. This also allowed them to check the weather conditions at alternate airports and to possibly make a decision on a diversion in good time, while allowing briefing for the diversion and approach and landing. It is likely that a slight improvement in conditions reported to another inbound aircraft was evidently sufficient to convince the Flight Crew to carry out a third approach. Consequently the consideration to divert to EIKY was not followed through.

Prior to the aircraft passing the Outer Marker equivalent position, the RVRs passed by ATC reduced below minima. Nevertheless, the approach was again continued contrary to Regulations.

In summary, the Investigation is of the opinion that the command decisions made were not in accordance with good practice and contributed to a situation that resulted in the loss of the aircraft.

2.6.8 Training and Experience

From the records available the Commander had spent almost his entire professional flying career as a co-pilot. It was reported that, in all respects, he was a diligent and hard-working individual, dedicated to his job and the Investigation found no adverse comments in his training records. Similarly, the Co-pilot who had only recently joined the Operation, had completed his initial proficiency check with the Operator with no adverse comment on his performance, and was also reported to be a competent and dedicated pilot.

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[49] **Recorded height**: measured by the radio altimeter/TAWS system.

On the day of the accident, the Commander flew with the Co-pilot who had only joined the operation a few weeks before and who had not completed his initial line check (subsequent to the proficiency check) with the Operator. Newly appointed commanders may find first flights in command challenging, as decisions regarding the flight are now solely theirs, yet they do not possess experience that is gained with time. To this end, operators are required to ensure that newly promoted commanders are only scheduled to fly with experienced co-pilots, who although not having executive authority for the flight, possess route experience and provide support to the new commanders. The Operator had no restriction in its OM regarding this requirement, contrary to EU-OPS.

Ideally command training during the upgrade of a co-pilot to commander requires:

- Familiarisation with operation of the aircraft from the left seat with an OPC to verify that such skills had been achieved.
- An adequate number of training sectors operating as Pilot-in-Command under Supervision, carrying passengers on representative routes.
- A number of check sectors, by an independent examiner, to observe the command candidate actively making balanced and safe command decisions.

Command training requirements are set out in EU-OPS 1.955 and the Operator's OM Part D, 2.1.5 Rev 8. According to the Operator's procedures a candidate must satisfy certain criteria prior to consideration for promotion to commander; the Commander satisfied the necessary criteria to commence a command upgrade course.

The references to JAR OPS in the OM were out of date as JAR OPS was replaced by EU-OPS. However, the requirements are similar. The Operator's 'Command Training Programme' was broadly in line with these requirements but the training of the Flight Crew involved in this accident was not.

The Commander's OPC, required 2 hours duration with 4 landings, whereas only 40 minutes and 2 landings were recorded. Although there were no handling issues identified during the OPC, the effectiveness of such a brief check flight to verify proficiency is questionable. Accordingly, the OPC conducted by the Operator was inadequate.

Although the Commander's logbook showed that he underwent command line training in December 2009, the training records provided to the Investigation did not record this training. In any case, as this occurred over a year prior to his promotion it was not current and therefore not relevant. A total of 10 command training sectors were conducted in December 2010. These included the OPC check referred to above and two line check sectors. While the two line check sectors were in accordance with the Operator's OM, only 7 out of 10 line training sectors under supervision were completed. As the 10 line sectors under supervision were designated training, the only sectors that could be considered as 'command checks' were the two line check sectors immediately prior to the Commander being promoted. The Investigation considers that this period of check was insufficient to assess the candidate's abilities in the command role.

Furthermore, the training immediately prior to his promotion was conducted on flights from the Barcelona base to two other points, Reus and Seville, in weather conditions atypical of those encountered in the Operation. Moreover, as this training was conducted only on cargo flights, the Commander was not exposed to the demands and considerations that are encountered during passenger operations.

The OM Part D states: '*having completed, with satisfactory results, the line check the pilot will be qualified to operate the routes and airports used by the company*'. The Commander had flown as co-pilot on these operations but the command process is intended to allow the candidate to gain command experience, both training and checking, in this environment and this was not accomplished.

The Investigation is of the opinion that the nature, content and duration of his command training was inadequate; and furthermore, that the command checks carried out prior to his promotion to Captain were also inadequate. Although the Commander may have demonstrated adequate handling skills in the left seat of the SA227, he was poorly equipped to make the necessary command decisions. The fact that the Commander initially dispatched and then conducted the flight in the manner found during the Investigation clearly indicates that he was inadequately trained and checked in the command role. He was ill prepared for the situation he found himself in on the day of the accident and did not possess the necessary tools to exercise good judgment or to make correct operational decisions in challenging circumstances.

The Investigation considers that the command training as conducted by the AOC holder and its oversight was of inadequate standard and was not in accordance with the provisions of EU-OPS. While recognising that the command training completed by the Commander was not as prescribed in the OM Part D, the Investigation is concerned that the minimum requirements as set out in EU-OPS 1.955 'Nomination as Commander' may themselves be insufficient, particularly in the case of air carriers with limited resources where the minimum legal requirement may be treated as the standard. The Investigation therefore makes a Safety Recommendation in regard to this issue:

Safety Recommendation No. 3
It is recommended that the European Aviation Safety Agency should review Council Regulation (EEC) No 3922/91 as amended by Commission Regulation (EC) No 859/2008, to ensure that it contains a comprehensive syllabus for appointment to commander and that an appropriate level of command training and checking is carried out. (**IRLD2014003**)

The Investigation is also concerned that the Commander was trained and checked by the same TRE with no independent evaluation conducted. The Investigation is of the opinion that this is contrary to good practice and that a fairer and independent appraisal of a candidate's abilities would be served by such checks being conducted by a TRE who had no direct role in the candidate's training.

The Investigation notes that the provisions of Regulation (EU) No 1178/2011, which had not entered into force at the time of the accident, satisfy concerns regarding the independent evaluation of flight checks and the fair and adequate appraisal of a candidate's performance. Therefore, no Safety Recommendation is required.

2.7 Maintenance Issues

2.7.1 General

The Operator contracted all maintenance for EC-ITP and EC-GPS to the Maintenance Provider, a Part 145 approved organisation based in Barcelona. The Operator remained responsible under its Part M Subpart G approval for determining all maintenance required to be accomplished.

2.7.2 Aircraft Configuration Changes

Both aircraft were reconfigured by removal of all passenger seats to facilitate mail/cargo flights. These configuration changes, which modified the aircraft, constituted aircraft maintenance which should be performed by appropriately authorised personnel and released to service by an appropriately approved Part 145 maintenance organisation. The requirement to reconfigure the aircraft, necessitating maintenance certification, should have been identified by the Part M Subpart G organisation and arrangements made by them to have it performed by the Maintenance Provider under the terms of the maintenance contract.

Part 145 provides for the limited authorisation of flight crew to perform minor maintenance or simple checks. However, the reconfiguration of these aircraft, as described above, did not meet the criteria for maintenance which flight crew could be authorised to perform as set out in Part 145 AMC.145.30 (j) 4, paragraph 2. The reconfiguration of the aircraft, which was being performed by unauthorised flight crew, was not being recorded or certified in the aircraft Technical Log. Furthermore, there was no evidence that approved data or clear work instructions were issued or utilised in support of this activity as is required by Part 145.

The Investigation found that only 18 passenger seats were installed and that the aircraft was being operated in a non-standard seating configuration on the day of the accident.

2.7.3 Recording and Control of Aircraft Defects

The accident aircraft, which was manufactured in 1992, had been with the Operator for three months prior to the accident. Over this time there were no pilot reports, defects, or maintenance entries made in the Technical Log. Additionally, not all pre-flight inspections were recorded for this period of operation. A review of the Technical Log for the sister aircraft EC-GPS was also performed from 17 April 2010 to 8 February 2011. Over this time, only two entries were made in the Technical Log for this aircraft, both relating to an ignition problem with the No. 1 engine which meant that the engine could not be started.

It is most unusual that an aircraft of this age and service did not incur any defects over the period of the operation. Typical defects that could be expected to occur would relate to seats, emergency equipment, cabin furnishings, lighting or cockpit indicator lights, wear to wheels and brake components, replenishment of engine oils and hydraulic system fluids.

Depending on the nature of the defect, it may have been possible to defer its rectification in the Technical Log in accordance with the provisions of the approved Minimum Equipment List (MEL) and release the aircraft to service for a limited period. However, the release would still have to have been performed by appropriately authorised personnel, which may include the flight crew if so authorised. There is no evidence that the Flight Crew were authorised to defer defects in accordance with the MEL.

Regarding the torque anomaly, the Investigation notes that power lever split checks were carried out on engine ground runs in October 2010. This was prior to the aircraft's return to service following the repairs and maintenance which arose after a heavy landing event in November 2009. During this maintenance period, the No. 1 engine, which was a loaner engine, was replaced with a different loaner engine, S/N P-70204. The No. 2 engine, S/N P-70189, was removed and re-installed on EC-ITP during the maintenance.

The documentation provided to the Investigation shows that the engine ground runs were recorded using Form 503 which is part of the Phase Inspection Manual. The power lever split checks in Form 503 differ from those laid down in the AMM 71-00-30 'Engine Ground Run (Adjustments)' and AMM 71-00-35 'Engine Ground Run (Worksheet)'. The main difference is that Form 503 does not include a power lever split check at Flight Idle whereas such a check is documented in AMM 71-00-30 and 71-00-35.

The AMM states that the ground run procedures set out in 71-00-30 are used to *'verify the integrity of installed/replaced items.'* Form 503 states that *'this checklist is intended only as a guide'* and that complete check procedures are in the AMM 71-00-00.

The Investigation considers that, since the No. 1 engine was new to the aircraft and the No. 2 engine was removed and re-installed on the aircraft during the maintenance period, the use of Form 503 as a checklist for the ground runs was not appropriate and that the more comprehensive procedures set out in AMM 71-00-30 should have been carried out. This would have included an additional power lever split check at Flight Idle.

FDR data showed that the torque being delivered by No. 2 engine exceeded that being delivered by No. 1 engine by values up to 5%, including when the torque outputs were at low values at and below Flight Idle. Also, the torque response for No. 2 engine was faster than that for No. 1 engine during engine acceleration (**Appendix L**). The AMM calls for a power lever split (at the pedestal) no greater than 0.05 inch at Flight Idle. The EMM considers an 'unacceptable power lever split' worthy of further investigation, without defining what is unacceptable.

However, although FDR data shows that the power levers were manually adjusted in normal flight to compensate for the engine torque differential, no such anomaly was recorded in the Technical Log of EC-ITP and there is no evidence that it was brought to the attention of maintenance personnel for investigation or rectification. In the absence of such a report it would be difficult for the defect, as existed with the P_{T2}/T_{T2} sensor, to be identified during scheduled maintenance.

Visual checks of the P_{T2}/T_{T2} sensors for condition and security were required at each Service Check. These checks were certified as having been carried out on the final Service Check in the week before the accident. Given the nature of the defect to the sensor on the No. 2 engine, the Investigation considers that the defect could only have been found on a detailed inspection in a workshop.

2.7.4 Aircraft Defects – Impact on Operations

Any defect arising during the operation of the aircraft would have the immediate effect of grounding the aircraft until appropriately authorised staff arrived to rectify the defect and release the aircraft to service. Alternatively, appropriate maintenance support would have needed to travel on the aircraft to avoid such a consequence of a defect arising. This potential scenario should have been assessed and provided for by the Part M Subpart G organisation as part of their obligations in managing the continuing airworthiness of the aircraft under the auspices of Part M.

The operational impact of recording a defect in the Technical Log without proper maintenance support in place to affect a proper certified return to service of the aircraft could have had a bearing on the flight crews' apparent reluctance to record such defects and to continue in service. In any event, the aircraft continued in operation with an unrecorded and unaddressed engine defect and with aircraft reconfigurations improperly performed and uncertified.

A properly functioning Part M Subpart G organisation should have identified the need to have appropriate maintenance support in place with the aircraft, i.e. an established line station, and have made provisions for this. It should also have identified that the aircraft reconfigurations were not being properly performed or certified. Also it should have identified and questioned the minimal number of defect entries in the Technical Log for two aircraft of this vintage, one of which was over a ten month period of operation.

In failing to address such issues the Operator was not meeting its obligations as an operator engaged in commercial air transport to comply with the provisions of Part M.

2.7.5 Part 145 Line Maintenance Support Responsibilities

The maintenance contract required the Maintenance Provider to perform line maintenance for the Operator at Barcelona Airport, Reus Airport, Girona-Costa Brava Airport and Sabadell Airport, and at *'any other airport that the Operator requests, with the written approval of the Maintainer'*.

Part 145 permits maintenance of an aircraft at any location subject to the need for such maintenance arising either from the unserviceability of the aircraft or from the necessity of supporting occasional line maintenance. However, in the case of scheduled minor maintenance, such maintenance should be performed at an identified line maintenance location capable of supporting such minor maintenance and such a location should be described in the maintenance organisation's MOE. Consistent with this requirement, the Maintenance Provider's MOE, Section L2.8 procedures stipulate that if maintenance is to be performed at a location for more than one week, a line maintenance base should be established.

As stated previously, the requirement to reconfigure the aircraft, necessitating maintenance certification, should have been identified by the Part M Subpart G organisation (the Operator) and arrangements made by them to have it performed by the Maintenance Provider under the terms of the maintenance contract. This would have necessitated the establishment of a line maintenance base at the airport where this maintenance was being performed. It would also have entailed the positioning of appropriate material, equipment, certifying staff, and airworthiness data at an acceptable facility for the work to be undertaken at the location in question. In addition, it would have been required to be listed as a line maintenance location in the Maintenance Provider's MOE. There is no evidence that such a line maintenance base was established by the Maintenance Provider for the remote UK/Ireland Operation.

The Investigation found non-compliances relating to the content, performance and recording of the aircraft pre-flight inspection, the content and layout of the Operator's Technical Log and the CAME, (**Appendix C**).

2.7.6 Maintenance Review Findings

Competent Authorities assess the effect of discrepancies with Part M and Part 145 requirements and classify them as findings using the following criteria:

- a *Level 1 finding* is any significant non-compliance with Part M or Part 145 requirements which lowers the safety standard and hazards seriously the flight safety.

- a *Level 2 finding* is any non-compliance with the Part M or Part 145 requirements which could lower the safety standard and possibly hazard the flight safety.

With reference to the tables in **Appendix C**, **Table 1** provides detailed information on the relevant Part M requirements together with details of areas of the requirements that are deemed not compliant or not subject to review. **Table 2** consolidates the areas of the Operator's non-compliance with the requirements of Part M based on the evidence available and lists them as findings.

These non-compliances are summarised as follows:

- The maintenance requirements for the remote Operation were not properly established or provided for by the Operator under its Part M Subpart G responsibilities.
- The aircraft passenger seat arrangement was not configured in accordance with the Operator's OM Part B Section 1.1(b) requirements.
- Aircraft reconfigurations were being carried out by unauthorised personnel and were not being properly performed, certified or recorded. This was not addressed by the Operator under its Part M Subpart G responsibilities.
- A technical defect existed on the aircraft at the time of the accident that was not recorded, rectified or deferred appropriately.
- The Operator, in conjunction with its contracted Maintenance Provider, did not establish a line maintenance facility in the Isle of Man, UK or Ireland to support scheduled line maintenance.

These non-compliances would represent a hazard to flight safety and therefore be classified as Level 1. As a consequence, the operation of the aircraft should not have taken place with this level of non-compliance with Regulations.

2.8 Oversight

2.8.1 General

The audit conducted by the Operator on the 2 June 2010[50] stated that experienced crews were required to conduct the Operation. Yet eight months later the Flight Crew on the accident flight consisted of a newly promoted Commander, who had received inadequate training, and a new Co-pilot who had not completed his initial line check. This pairing of flight crew was contrary to the provisions of EU-OPS 1.940, which required procedures to be established in the Operator's OM to prevent the crewing together of inexperienced flight crew members.

Within the EU Member States, flights are subject to an ascending level of supervision or oversight. At the operational level the operator (air carrier) nominates a commander who supervises the flight. The commander is supervised by the operator through the exercise of its operational control. The operator itself is supervised by the competent regulatory authority of the state, which issues the operator's AOC and supervises its activities. In turn, EASA audits the competent regulatory authorities and ICAO conducts audits of Member States.

The EU, in Regulation (EC) No 1008/2008, Article 15.1, stipulates that Community air carriers are entitled to operate air services between Member States and that this must be done without further permit or authorisation.

[50] **Section 1.18.6**: Operator's Audit on Commencement of the Operation.

Thus the EU created an internal open skies framework through this Regulation by allowing the air services of one Member State to have free access to other Member States without further licencing or supervision. This Regulation also provides for oversight of the operating licence issued to an air carrier but issues neither procedures nor guidance on how this is to be conducted.

2.8.2 Oversight by Operator

The accident flight between EGAC and EICK was conducted by the Operator, an intra-Community air services provider, in accordance with Regulation (EC) No 1008/2008. The Operator possessed a valid AOC and operating licence issued by Spain. Since the Operator possessed both an AOC and operating licence, it complied with the definition of an 'air carrier'. As such it was entitled under this Regulation to operate intra-Community air services, as was the case for the accident flight.

As the holder of an AOC, the Operator was required to exercise operational control over the flights it operated under the terms of its AOC. This is accomplished through Regulation (EC) No 859/2008 which requires a sound and effective management structure with nominated post holders that were competent in their positions. The Operator was a small organisation with the required organisational structure (accountable manager, post holders and a person responsible for the Operator's accident prevention and flight safety program[51]) to exercise operational control of all its operations. The addition of the Metro III aircraft to the Operator's AOC involved a substantial expansion of the nature and scope of the operation. This expansion was the responsibility of the Accountable Manager who had corporate authority to ensure that all operations and maintenance activities were financed and carried out to the standard required by the Competent Authority. In this regard, a number of issues such as finances, employment of crews, operational control etc., were identified by the Investigation.

At the time of the accident the Operator believed and its records indicated that a different co-pilot was involved in the accident. In practice, crew rosters were prepared by the operations manager of the Owner in the Isle of Man. As an AOC holder, production of the rosters, monitoring FTLs and crewing of the aircraft was the responsibility of the Operator. A change of duties occurred during the week of the accident whereby the original co-pilot was stood down and the Co-pilot, who had not completed his initial line check, was paired for duty with the newly appointed Commander. This change of duties took place without the knowledge of the Operator, whose responsibility it was to approve such changes.

Following completion of flights each day, the operational flight plans and all documentation associated with the series of flights were placed in a flight envelope. These envelopes were only returned to Barcelona after 7 to 10 days, consequently the Operator's ability to oversee the Operation in any realistic timescale was impaired.

[51] EU-OPS 1.0175 & 1.037.

While the historical records of crew duties and FTLs were managed by the Operator following return of the records, it is clear that the day-to-day crewing arrangements were being organised locally in the Isle of Man under the control of the Owner. Consequently, supervision of crew rosters by the AOC holder was not satisfactory.

The Operator's procedure for crew members to request a change of duties was promulgated to crews in Spanish and no evidence of an English version was found. The Co-pilot's recent CV contained no indication that he had any competency in Spanish and all inter-crew conversations recorded on the CVR were conducted in English. It is therefore unclear if the Co-pilot was aware of the Operator's procedure and this illustrates the difficulties of a native English speaking crewmember becoming conversant with procedures drafted only in Spanish.

The Investigation found difficulty in establishing the duties completed by the different crew members and secured all Metro II and Metro III crew rosters for January, February and March 2011. The documentation showed that two sets of rosters were prepared, one by the Operator for its crews operating its own Metro II aircraft on cargo operations from Barcelona, and a second set prepared by the Owner for its Metro III operations with EC-GPS and EC-ITP.

The Operator informed the Investigation that rosters were initially prepared by the Owner and sent to the Operator for acceptance, who forwarded it to a flight planning program that monitored flight time limitations. Considering that records provided by the Operator showed that a flight crew commenced duty on 8 February 2011, at 05.15 hrs in Seville and later operated night mail sectors in the UK, finishing the following day at 01.25 hrs, the Operator's monitoring of flight duty times was of dubious quality. In addition, the rest provided to the Flight Crew of EC-ITP on each of the three days preceding the accident was not in accordance with the approved flight time limitations thus bearing out the statement by the partner of the Co-pilot that '*he did not have very much rest*'.

Further factors in this regard are inaccuracies in the Technical Log of EC-ITP during the period 8 and 9 February 2011. Records supplied by the Operator, the aircraft's Technical Log and other flight documentation were in disagreement regarding the identity of the flight crew. The Investigation is satisfied, that contrary to entries made in the Technical Log of EC-ITP, the Co-pilot did not operate night mail sectors on 8-9 Feb 2011. However, this also indicates a gross exceedance of FTLs by other flight crew, which was not recorded in the aircraft documentation.

The Operational Flight Plans and weather briefing information were prepared by a Spanish service provider and sent by electronic means for the crews to print in the dispatch office in EGAA prior to departure. The Investigation was informed that the Commander had requested this information the previous evening when up to date weather information would not have been available. Accordingly the flight plan for the accident flight was produced with only one alternate.

On the morning of the accident the weather situation at EICK required two destination alternate aerodromes to be nominated with conditions above required minima and a new flight plan was required. However, as this was not done it is clear that the operational flight plans and weather reports were not properly scrutinised by the Operator. Consequently, the Operator failed to exercise operational control over this flight and did not have an appropriate system/contract in place to do so.

The ATC flight plans for the Operation, which are a key element of operational control, were filed by a FBO based in Denmark. The Operator evidently contracted out these obligations, further questioning its operational control and supervision of the flight.

As no line maintenance was available to the crews either at EGAA or EGAC, any defects with the aircraft were to be notified to the Operator in Barcelona who would arrange to have engineers flown from Barcelona to rectify any defect at a cost to the Owner.

The Operator provided the Investigation with certificates of training that had been provided to two commanders on the Operation regarding the task of removing and re-installing seats for cargo operations (neither of whom were involved in the accident). However, they were not authorised to carry out this task.

The above issues illustrate the level of operational control exercised by the Operator. Considering the foregoing, it is apparent that the remote Operation was not properly integrated into the core operation of the Operator. Thus the Operator did not ensure the safety of the Operation, as provided for in the relevant provisions of Community regulations and national law, by having a sound and effective management structure and procedures in place in order to properly oversee and ensure the safe conduct of its air operations.

Furthermore, as the Operator, which was the air carrier, did not schedule the Operation's passenger flights or organise its UK mail flights, it did not have effective control or disposal of the aircraft. An 'aircraft operator' as defined in Regulation (EC) No 785/2004 is *'…the person or entity, not being an air carrier, who has continual effective disposal of the use or operation of the aircraft; the natural or legal person in whose name the aircraft is registered shall be presumed to be the operator, unless that person can prove that another person is the operator,'*

The Operation was based in the Isle of Man, a Crown Dependency that is not part of the UK or the EU, where there were a number of operations managers including those of the Owner and the Ticket Seller. In the case of the Operation, the Owner scheduled the aircraft's flights in accordance with the Ticket Seller's schedule; the contact details provided for the Operation's flight crew were for the Ticket Seller and Owner. The Owner also organised the aircraft's Royal Mail flights and other charter flights. Therefore, under Regulation (EC) No 785/2004 the 'aircraft operator' was in fact the Owner who had effective disposal of the use or operation of the aircraft.

Accordingly, the duties and responsibilities of the AOC holder, under whose authorisation the aircraft was operating, were not carried out in accordance with EU-OPS. This situation, where a commercial air service was being operated within the EU and the air carrier was not the 'aircraft operator', was in contravention of Regulation (EC) No 1008/2008.

Subsequent to the accident, the Operator in its Operational Letter No. 4/11, set out changes to its operational control procedures including 'Flight Dispatch and Control'. The changes as set out in this letter addressed deficiencies in its operation. Regarding Start and Continuation of Approach, the Operator stated that '*in case of a missed approach from minimum values due to weather causes, proceed to the alternative'.* The Investigation is concerned that requiring a diversion after a single approach is not in the interests of efficiency or safety since it could pressurise flight crew into completing an inappropriate landing when it would be wiser to hold and allow the weather to improve. Consequently, the Investigation issues a Safety Recommendation to the Operator to review its procedures in this regard.

Safety Recommendation No. 4
It is recommended that Flightline S.L. should review its current operational policy of an immediate diversion following a missed approach due to weather. (**IRLD2014004**)

2.8.3 Operator's Flight Safety Management

The balance between productivity versus safety is a well understood concept in aviation. It is also more recently accepted that the establishment of a Safety Management System (SMS) assists in achieving a correct balance in this regard. The establishment of an SMS would have assisted in providing balance between operational requirements and mitigation of operational risk and should have identified that the oversight of the Operator's remote operation was less than satisfactory.

The Operator had nominated a Flight Safety Manager (FSM) who, in addition to other duties, was tasked with the responsibility of monitoring the safety of the operation. No training in the role of air safety or accident prevention was given to this individual and completion of a recognised accident investigation short course would have been highly beneficial. This left the FSM with the unenviable task of trying to balance the protection and production of the operation without any training and little resources. Accordingly, he did not have adequate competencies associated with his position.

Irrespective of the enthusiasm of an individual for the position, a flight safety manager should be trained and equipped with the expertise to manage their position. The Investigation accordingly issues a Safety Recommendation to the Operator in this regard.

Safety Recommendation No. 5
It is recommended that Flightline S.L. should implement suitable and appropriate training for personnel responsible for flight safety and accident prevention. (**IRLD2014005**)

2.8.4 Operational Documentation

The Owner provided the aircraft, crew, maintenance and insurance and independently organised cargo/mail flights. It was not an air carrier, not having an AOC or operating licence, but had the use and disposal of the aircraft. Although it had subleased the aircraft to the Operator, the Owner employed the crew and maintained an office with an operations manager at EGNS in the Ticket Seller's office. The operational information provided to the crew on the Operation, though using the Operator's title, contained only contacts for either the Owner's or the Ticket Seller's offices at the Isle of Man, to which all operational reports and administrative queries were to be sent. In addition, the Owner had two operational staff based in the Isle of Man who were located in the premises of the Ticket Seller. While the operational flight plans and weather briefing information were prepared by a service provider in Spain, mission reports from each aircraft were required to be sent to Operations in the Isle of Man, which was also the first point of contact for operational issues.

The application for an AOP was made to the DfT by the Ticket Seller on behalf of the Operator. In the case of the Ticket Seller's application to the Irish CAR for a Tour Operator's Licence, the name of the Operator was not identified in any documentation nor was it required to be as the Operation was to be conducted under the aegis of Regulation (EC) No 1008/2008.

All contacts provided in the document entitled 'Operational Procedures Manual' (a draft document prepared for flight crew by the Owner in relation to the Operation from Belfast City Airport) were for the Ticket Seller's Operations Manager. This document stated that the Ticket Seller provided its own branded tie and hi-visibility safety vest for each new crew member which had to be worn as required, stating that it raised brand awareness. The operational documentation provided stated that flight crew were to contact the Ticket Seller in the event of schedule disruption or other operational events. While the Ticket Seller would be informed of any delays etc. this was normally via the Owner's operational staff who were the first point of contact for the flight crew or handling agents.

All flights conducted by operators for the Ticket Seller collectively used the NM prefix, which had been allocated by IATA to FLM Aviation. Additionally, the aircraft normally used in the operation (EC-GPS) carried the logos of the Ticket Seller on the fuselage and engine cowlings. Passenger Safety Instructions which carried details of the Operator were prepared by the Ticket Seller and supplied to the Owner for use in the aircraft. These were referred to in both the passenger pre-departure and arrival briefings by flight crew.

The UK CAA stated that there were concerns that the Ticket Seller was allowing the impression to be created that it was a licensed airline in its own right. The CAA addressed these concerns by requesting the Ticket Seller to amend its website. The Investigation notes that the term 'airline' was not defined or addressed in EU regulations.

The Investigation is of the opinion that the Ticket Seller, an 'air carriage contractor' as defined in Regulation (EC) No 2111/2005, Article 2 (c), was portraying itself as an airline. The Investigation further considers that in the eyes of the travelling public, an airline is synonymous with an air carrier, an entity which is required to hold a valid operating licence. Such an operating licence can only be held by the holder of a valid AOC.

The Ticket Seller was nominated as a joint 'Service Provider' in the PSO Air Service Compensation Agreement granted according to Regulation (EC) No 1008/2008. The Investigation notes that this Regulation states that: '*the Member State concerned may compensate an air carrier…*' and contains no provision for any undertaking other than an air carrier to be granted such compensation. Unlike the Belfast-Cork service, the Ticket Seller and the air carrier on the PSO route had direct links in place. Furthermore, that air operation was under the regulatory oversight of the UK CAA.

The combination of an 'aircraft operator' (the Owner) which was not an air carrier, and an undertaking (the Ticket Seller) appearing to a passenger to be an airline, was facilitated by the Operator in providing an air service through the use of its AOC. Furthermore, as there was no contract between the Operator and the Ticket Seller (the unsigned agreement being between the Owner and the Ticket Seller), the Operator was isolated from the activities associated with the Operation and became just a service provider. The operational oversight of this arrangement would be difficult to administer, with each undertaking carrying out various tasks, but with no overall effective oversight of the Operation being carried out by the AOC holder.

The Investigation established that there was no signed contract in place between the Ticket Seller and the Owner, however the Owner performed and was paid for flights under the terms of an unsigned contract document.

When the Owner and its aircraft (through the AOC of Eurocontinental Air) had previously been involved in the Operation, this was terminated due to safety transgressions which resulted in the withdrawal of its operating permit by the UK DfT. The Investigation notes that a conflict of evidence exists regarding the fact that the contract drawn up between the Ticket Seller and the Owner was not signed by both parties.

The limited finances of the Owner as demonstrated by the letter of November 2010, may have been a general cause for concern among flight crew should the arrangement be terminated particularly in view of the lack of a signed contract. Accordingly, this may have added pressure on flight crew to complete flights without disruption to the schedule.

It is clear that many of the operational responsibilities of the Operator as AOC holder including operational control were being exercised by the Owner and the Ticket Seller. Accordingly, the Operator did not maintain an appropriate level of operational control, as identified in ICAO Annex 6 (Section 1.17.6.1) and required by Regulation (EC) No 859/2008 OPS 1.175, 1.180 and 1.195.

It is the view of the Investigation that the role of a ticket seller who engages in providing passenger air services is not clear. While the role and responsibilities of an air carrier are well defined, the involvement of ticket sellers in this activity requires that their role and responsibilities should be clearly defined. The Investigation therefore makes a Safety Recommendation to the European Commission in this regard.

Safety Recommendation No. 6
It is recommended that the Director-General for Mobility and Transport, European Commission should review the role of the ticket seller when engaged in providing air passenger services and restrict ticket sellers from exercising operational control of air carriers providing such services, thus ensuring that a high and uniform level of safety is achieved for the travelling public. (**IRLD2014006**)

2.8.5 Oversight by the Competent Authority

2.8.5.1 General

The intra-community air service between EGAC and EICK, airports in the UK and Ireland, was operated according to Regulation (EC) No 1008/2008 by the Operator, an undertaking established in the Community. According to the Regulation, regulatory and continuing oversight of the Operator and its operation rested with the state of the AOC holder. In this case, Spain issued the AOC and operating licence and was also the State of Registry of the aircraft. As AESA is the Competent Authority in Spain that exercises oversight of the AOC, it was therefore responsible for oversight of the Operator.

The functions of a competent authority include the initial issue of an AOC to an undertaking, the renewal or modification or variation in the AOC and on-going monitoring of '*continuing oversight*'[52] of the operator through regular inspections, in order to exercise a positive and continuing measure of control over the operator. Under Regulation (EC) 859/2008, OPS 1.180 (*Issue, variation and continued validity of an AOC*) an air operator (AOC holder) must satisfy the Authority that it has the ability to establish and maintain an adequate organisation, establish and maintain a quality system in accordance with OPS 1.035. In addition, it must comply with required training programmes and maintenance requirements, consistent with the nature and extent of the operations specified, including the relevant items prescribed in OPS 1.175 (g) to (o); and comply with OPS 1.175.

In order to obtain its original AOC, the Operator satisfied AESA that its organisation and management were suitable, properly matched to the scale and scope of the operation and that its procedures for the supervision of operations were defined. AESA informed the Investigation that during this evaluation, the operational resources and financial aspects of the Operator were examined and that they were satisfactory.

[52] Regulation (EC) No 1008/2008.

However in 2010, when the variation in the AOC was requested to add EC-GPS (and later EC-ITP) to the AOC, AESA stated that it did not feel it was within its remit to look for additional organisational and financial information to ensure that the Operator was adequately resourced to operate two additional aircraft. Regulation (EC) No 1008/2008 recognises the potential link between the financial health of an air carrier and safety and that adequate resources, both manpower and financial, are needed to safely operate as an air carrier. The fact that these were not provided is evident in the multiple breaches of FTL Regulations found during this Investigation. The Investigation is of the opinion that EASA should revise the process by which AOC variations are granted. This revision should ensure that the scope of any new proposed operation is within the competence of the air carrier making the application for a variation.

Safety Recommendation No. 7
It is recommended that the European Aviation Safety Agency should review the process by which AOC variations are granted to ensure that the scope of any new operation is within the competence of the air carrier. (**IRLD2014007**)

2.8.5.2 Operating Licence

The AOC and the Operating Licence were issued by two separate directorates within AESA. As detailed in Regulation (EC) No 1008/2008, the Operating Licence and AOC fulfil two different functions. The Operating Licence authorises an undertaking to provide air services while the AOC confirms that the operator has the professional ability and organisation to ensure the safety of operations.

The Operating Licence A.45/04 was issued to the Operator in 2006. EC-GPS and EC-ITP were added to the AOC of the Operator during 2010. Article 6.2 of Regulation (EC) No 1008/2008 required that this change should have been reflected, where appropriate, in a modification of the Operating Licence. AESA was of the opinion that a change to the Operating Licence was not warranted in that there was no fundamental change to the characteristics of the operation such as fleets and world region served.

The Investigation considers that a new scheduled passenger service using Metros IIIs being operated remote from the Operator’s base was a fundamental change. The Operating Licence issued in 2006 remained in place without amendment.

Regulation (EC) No 1008/2008 requires oversight of the Operating Licence:

> *(4) Given the growing importance of air carriers with operational bases in several member states and the need to ensure the efficient supervision of these air carriers, the same Member State should be responsible for the oversight of the air operator certificate and of the operating licence’.*

There was no evidence of any such oversight being conducted by Spain of the Operation. However, the Regulation makes no provision nor provides procedures of how oversight of an operating licence should be conducted, in particular where operations are carried out from a base outside the Member State itself.

2.8.5.3 Air Operator Certificate (AOC)

The Air Operator Certificate, AOC E-AOC-34 issued to the Operator on 30 November 2010, was valid until 30 June 2011. Among the issues identified in **Section 2.6.3** regarding flight crew duty times, the Investigation has concerns that the Operator's lack of a sound and effective management structure, as typified by the oversight issues regarding breaches of flight time limitations and rest requirements, was not identified by AESA. In addition, non-conformances in the maintenance arrangements of the aircraft and the conduct of a remote operation between other Member States were also not identified. This is particularly so as the previous operation of the Owner's aircraft, on the same route structure but under the AOC of a different operator, proved to be unsafe and ultimately lead to the revocation of that AOC following intervention of the UK Authorities.

AESA informed the Investigation that it was unaware of the remote Operation of the Metro III aircraft following their addition to the Operator's AOC during 2010. On-going monitoring of continuing oversight of an operator is conducted through regular inspections. At the time of the accident, AESA employed 14 FOIs and delegated most air operations activities to SENASA. The Operator was the subject of inspection on a monthly basis. Eight audits and inspections on the Operator's Flight Operations were conducted between 11 February 2010 and 14 January 2011, in addition to seven audits and inspections on Maintenance and Airworthiness. Nevertheless, these audits did not identify that an aircraft was operating from a remote base and that it was inadequately resourced. In addition, they did not identify the incorrect format of the Operator's Technical Log (**Section 1.6.5 Maintenance**)[53].

The Investigation is satisfied that the particular FOI assigned to the Operator, considering his experience, was suitably qualified for the duties and tasks undertaken.

However, the Investigation is concerned that the lack of adequate oversight and control of the Operation by the regulatory authority of the state of the Operator did not identify the Operator's shortcomings, thereby contributing to the cause of the accident. Accordingly the Investigation issues a Safety Recommendation to AESA that it reviews its continuing oversight of AOC holders, in particular regarding identification and conduct of remote operations in Member States.

Safety Recommendation No. 8
It is recommended that *Agencia Estatal de Seguridad Aérea* should review its policy with regard to continuing oversight of air carriers, in particular those conducting remote operations. (**IRLD2014008**)

[53] **AMC M.A. 306 (A)**: Operators Technical Log System Regulation 2042/2003.

2.8.6 Oversight by Other Authorities

As the accident flight was being operated under Regulation (EC) No 1008/2008, as an intra-Community air service (Article 15.1) by an operator holding an AOC issued by Spain, the only Member State with oversight responsibility was Spain (Article 15.2). Accordingly, the regulatory authorities in both Ireland and the United Kingdom had no oversight function, nor is such permitted under the Regulation.

The IAA and UK CAA, pursuant to the Regulation, relied on the oversight of Spain to ensure compliance in regulatory matters, both prior to commencing the Operation and for its duration. The evidence shows that such oversight was of limited scope and low effectiveness.

Although the Irish Commission for Aviation Regulation (CAR) issued a Tour Operator's Licence for the route, this permit did not entail any regulatory oversight or scrutiny by that body as its purpose was to ensure that suitable financial bonding and provisions were in place to protect passengers who had bought tickets.

All the passenger flights in the Operation were operated on routes where tickets were sold principally by the Ticket Seller, as had been the case with Eurocontinental Air, while cargo flights were operated by the Owner within the UK between Belfast and a number of airports in Scotland. The Investigation is concerned that there was no evidence of oversight of the Operation by the Competent Authority. As both of these air carriers held AOCs issued by Spain, the only means by which any assessment of the safety of the Operation could be conducted by either the UK or Ireland was through the SAFA programme. Under this programme, States carry out SAFA inspections of foreign registered aircraft under a detailed schedule established by the Commission. No SAFA inspections were carried out on the aircraft at a UK airport following the resumption of operations by the Owner. Although the Operating Permit of the previous operator had been suspended by the UK authorities, the Owner's aircraft subsequently resumed operations under a new Spanish AOC holder (the Operator). The UK CAA stated to the Investigation that their concerns were with the Operational Safety Performance of the previous operator rather than with the Operator.

The Investigation notes that there were safety findings on the two SAFA inspections conducted by Member States on the Owner's aircraft; an inspection in Ireland which required corrective action before flight and another conducted by Germany which had a lesser finding. These inspections did not identify substantial operational deficiencies. SAFA inspections are limited to on-the-spot ramp assessments, typically carried out during a turnaround at a foreign airport. With increased aircraft utilisation and shorter turnarounds SAFA inspections, though working from a comprehensive checklist, are limited in what can be achieved in the protection of the aviation safety system. SAFA inspections are tools limited by design; although defects not being reported in the technical log can be raised during an inspection, oversight is otherwise exclusively the responsibility of the Member State of the air carrier.

SAFA inspections therefore cannot substitute for the continuing safety oversight responsibility of a National Aviation Authority (NAA).

The Investigation is therefore concerned that where the ability of a Member State to conduct effective oversight is limited, through resource issues, remote operation or otherwise, the safety of aircraft passengers is compromised. Accordingly, the Investigation issues a Safety Recommendation to the EU to review this matter.

Safety Recommendation No. 9
It is recommended that the Director-General for Mobility and Transport, European Commission should review Regulation (EC) No 216/2008 in the context of Implementing Regulation (EU) No 628/2013 in order to improve safety oversight including the efficacy and scope of SAFA Inspections and to provide for the extension of oversight responsibilities, particularly in cases where effective oversight may be limited due to resource issues, remote operation or otherwise. (**IRLD2014009**)

2.8.7 Oversight by EASA

EASA contributes to the production of all EU legislation and implementation material related to the regulation of civil aviation safety and environmental compatibility. It does so within its sphere of competence and does not have regulatory competence or oversight within a state. This competence is provided under Regulation (EU) No 965/2012 subject to derogation of implementation up to 28 October 2014. On that date EASA takes full responsibility for ensuring the proper functioning and development of civil aviation safety in the EU[54].

This Investigation notes that the findings of the EASA Combined Standardisation Inspection of Spain on 17 December 2010 are reflected in the oversight deficiencies found by this Investigation.

2.8.8 Oversight by the European Union

The EU, in Regulation (EC) No 1008/2008, which created an internal open skies framework by allowing the air services of one Member State to have free access to other Member States without further licencing or supervision, also recognised the link between the financial health of an air carrier and safety.

This Regulation provides for a broader level of oversight than is provided for in ICAO Annex 6 by the requirement for a Community air carrier to hold an operating licence in addition to an AOC. The operating licence concept ensures the financial health of an operator on the initial granting of the licence and the Regulation requires annual financial reports. In addition, an authority may at any time access the financial performance of an air carrier.

[54] Regulation (EC) No 216/2008, Chapter III.

The Investigation notes that the flight crew of the Operator, employed by the Owner, were unpaid for a period before the accident. Therefore the financial health of the Owner was questionable, particularly in the absence of a signed contract with the Ticket Seller. While it is clear that the Community air carrier was not the *de-facto* aircraft operator, it was the holder of a valid AOC and an Operating Licence issued by Spain. Although exercising operational control of the Operation between them, neither the Owner nor the Ticket Seller held any regulatory accountability regarding aviation safety, as neither the Owner, a company registered in Spain, nor the Ticket Seller, a company registered in the Isle of Man, held either an operating licence or an AOC. The Investigation considers this network of relationships anomalous. Furthermore, the Ticket Seller, which provided flights that operated under the provisions of Regulation (EC) No 1008/2008, was not based within the EU. This structure, incorporating Ticket Seller, Owner and Operator provided a platform which reduced the impact of aviation standards and regulations.

This accident demonstrates that the standard, referred to in Regulation (EC) No 216/2008, has yet to be achieved:

> *'The effective functioning of a Community civil aviation safety scheme in the fields covered by this Regulation requires strengthened cooperation between the Commission, the Member States and the Agency to detect unsafe conditions and take remedial measures as appropriate'.*

The Investigation notes the action taken by the ASC shortly after the accident where AESA informed the Commission that they had decided to limit the AOC of the Operator to prevent operation of the Fairchild Metro IIIs and that they had initiated the process to suspend the AOC. Following a review, the AOC was not suspended but operation of the Metro IIIs was excluded.

These actions by the ASC in the period following the accident indicate the effectiveness of the Committee as part of the EU aviation safety net. The Investigation is of the view that consideration should be given by the EU to widening the scope of the ASC to include the oversight of Operating Licences issued by Member States, including the processes and procedures by which such oversight is carried out by Member States in accordance with Regulation (EC) 1008/2008. Accordingly, a Safety Recommendation is issued in this regard.

Safety Recommendation No. 10
It is recommended that the Director-General for Mobility and Transport, European Commission should review the scope of the Air Safety Committee, and consider including oversight of Operating Licences issued by Member States and the processes by which such oversight is carried out. (**IRLD2014010**)

2.8.9 International Dimension

As signatories of the Chicago Convention, Ireland, Spain and the UK are required to be compliant through their national legislation with the SARPS of ICAO. Each of these States has been inspected under the ICAO USOAP programme (in the case of the UK this also included an inspection of the Isle of Man as a typical Crown Dependency) and the final report is made public provided that the State has agreed to the publication of that information.

The USOAP reports regarding both Ireland and the UK (including the Isle of Man) are publicly available but that of Spain is not, as is that State's entitlement. The Investigation requested permission from Spain to include relevant USOAP findings in this Report but this was denied by the DGAC of Spain, as is its right.

The EU, though not a State, has recognised the Convention and SARPS in its various regulations in the field of civil aviation in the Community. EU Regulations do not apply in the Isle of Man which sets its own legislation, although it may adopt UK CAA regulations (some of which are derived from EU regulations) through its own Civil Aviation Administration. The Investigation notes that the Operation was being conducted under Regulation (EC) No 1008/2008. Notwithstanding this fact, the Ticket Seller who was based in the Isle of Man where this Regulation did not apply, was a party to a PSO issued under this Regulation.

2.9 Air Traffic Control

The Investigation notes from ATC and CVR recordings that ATC personnel at EICK actively assisted the Flight Crew following requests for weather information and were pro-active in identifying an operational alternate for the Flight Crew. ATC monitored the flights final approach on Radar. Following the accident and loss of communications with the aircraft, ATC immediately activated the crash alarm.

The decision to conduct several approaches in the conditions that prevailed was solely at the discretion of the Commander. The remit of ATC does not preclude an aircraft from making an approach and does not relieve a pilot-in-command from responsibility regarding compliance with regulations.

2.10 ICAO Flight Plan Format

Aircraft intending to enter or operate in controlled airspace must first file a flight plan with ATC. This flight plan contains pertinent information regarding the proposed flight, and indicates *inter alia*, its operational capability.

However, an ATC flight plan does not contain information regarding the precision approach capability of the aircraft and its flight crew. In the case of the accident flight, ATC did not know nor were they required to know if the aircraft/flight crew were approved to conduct approaches to CAT II minima.

The Investigation considers that it would be useful for ATC to have such information available. As a result ATC would be in a better position to provide optimal assistance to flight crew during an approach. Such information could be provided in advance through the ATC flight plan filed for the flight. In the event of a change in the status to the capability status of the aircraft/flight crew the ATC plan could be amended in the normal way by the operator. ICAO informed the Investigation that 'Flight and flow – Information for a Collaborative Environment (FF-ICE)' will replace the ICAO Model Flight Plan Form. Consequently, the Investigation makes a Safety Recommendation to ICAO:

Safety Recommendation No. 11
It is recommended that the International Civil Aviation Organization should consider the inclusion of information regarding the flight-specific approach capability of aircraft/flight crew within the proposed 'Flight and flow – Information for a Collaborative Environment (FF-ICE)'. (**IRLD2014011**)

2.11 Weight and Balance

Due to the non-standard seating arrangement, the use of weight and balance procedures as outlined in the AFM could not be used. The Operator used its own approved Weight and Balance Sheets for the Metro III aircraft. The two aircraft used in the Operation had different MTOWs. However, it was likely that both aircraft used the same Weight & Balance Sheets, as the MTOW listed for EC-ITP (a Metro III heavy) on the Weight & Balance Sheets found in the wreckage was incorrect.

The Investigation found that the aircraft's weight and balance was within limits at the time of the accident.

2.12 Flight Data Recorder

To facilitate the extraction of data from the FDR, EU-OPS requires an operator to maintain information termed the 'data frame layout' for the unit. The Operator was unable to supply this information to the Investigation and thus analysis of the FDR data was significantly delayed.

Audits conducted on the Operator did not identify the absence of this data frame layout information. Furthermore, the State of the Operator had not enacted national regulations to require operators to keep such information and the Competent Authority had not established mechanisms to verify operator compliance.

2.13 Rescue and Fire Fighting

The AFS Fire and Rescue service responded promptly and located the accident site despite the poor visibility. The survivors were rescued in difficult circumstances. As the aircraft was inverted and crushed, the normal and emergency exits were unusable. Emergency break-in areas marked on the fuselage were also unusable due to inverted position of the aircraft.

The AFS gained entry to the passenger compartment by opening the aft cargo door which had jammed, and removing the partition between the baggage area and the cabin. The AFS crews worked to free the occupants by working forwards through the cabin, cutting out seats to gain further access.

The recovery operation became increasingly difficult because of reduced survival space due to crushing of the fuselage and the large amount of soil that had entered during the aircraft's inverted transition across soft ground. It was necessary to cut an opening in the forward fuselage ahead of the wing in order to gain access to casualties in the forward cabin. Access to the cockpit compartment and Flight Crew could only be gained by cutting through the floor structural members beneath the cockpit floor.

The prompt and effective emergency response by the AFS supported by the Local Authority Emergency Services was instrumental in stabilising the casualties' injuries and thus preventing the further loss of life. The area Major Emergency Plan was activated and appropriately downgraded when the scale of accident and the number of casualties was known.

2.14 Survivability

The initial impact of the fuselage was inverted and exerted negative loads on the occupants, lap straps and seat structure. The forward fuselage experienced a crushing load as the aircraft impacted inverted on the runway surface. The survival space at that moment was probably less than that observed in the resting wreckage due to deformation of the fuselage under impact load.

The flight crew compartment was crushed to the extent that survival was not possible. The four passengers who were fatally injured occupied seats towards the front of the passenger cabin, where significant crushing of the airframe occurred. The four passengers who suffered serious injuries were seated around the centre of the cabin, while the two passengers seated at the rear suffered relatively minor injuries. The accident was therefore survivable depending on the location of the occupants in the aircraft.

Injuries to the occupants were consistent with small survival space. Due to the large quantity of soil that had entered the fuselage, there was a potential suffocation risk to those occupants trapped towards the front of the cabin but this did not occur. Emergency evacuation from the aircraft was not possible due to the deformation of the fuselage and the quantity of soil in the cabin rendered the normal and emergency exits unusable. Most passengers were unable to undo their lap straps due to the inverted position of the seats placing undue load on the lap straps coupled with the confined survival space that remained. Furthermore, injury, shock, disorientation and darkness meant that the occupants required immediate rescue, which was effectively achieved by the AFS. In many cases the AFS had to cut lap straps to free the occupant.

Passenger seats are designed to provide protection for the occupants in the event of an accident with lap straps providing restraint against deceleration. No pre-accident defects were identified with the passenger seats, seat floor rails, lap straps or lap strap attachment fittings.

2.15 Allocation of Seats

Due to the non-allocation of seats at check-in the Investigation was unable to determine with certainty where all passengers were seated. The practice of air carriers not providing allocated seats may present significant challenges to future safety investigations.

2.16 Examination of Human Factors

At the pre-flight planning stage, the Flight Crew was probably aware that the RVR trend (measured at 06.00 hrs) was upwards at that time. This may have provided sufficient reassurance regarding the weather conditions at EICK. However, a closer scrutiny of the METAR and TAF should have generated concerns that conditions might not be suitable for an approach, with 300 m visibility forecast.

It would be natural for a newly-appointed Commander to want to complete his series of flight duties in an efficient and punctual way and perhaps this consideration was foremost in his mind when he elected to depart from EGAC. Records show he had made many previous flights to EICK as a co-pilot and that no diversions occurred on any of these flights. In any case, a departure was made without the Flight Crew having adequate information and a clear understanding of the overall weather conditions. Furthermore, an approach was immediately carried out on arrival at EICK despite the current conditions being below minima.

After a second unsuccessful approach, the Commander made a prudent decision to enter a holding pattern to see if the weather would improve. The CVR recording, which begins with the aircraft in the hold, provides insight into the conduct of the flight, the decisions made, the cockpit gradient, the working atmosphere and the Flight Crew's working relationship.

At all times Flight Crew exchanges with ATC were professional in nature and appreciative of the assistance that ATC was providing. However, within the cockpit, the CVR revealed an increasing level of stress with attempts at levity despite the seriousness of the situation. Throughout the 29 minutes of the CVR recording, there was no formal appraisal of the options available *vis-á-vis* fuel/time constraints, although the Commander was evidently aware that EIKY was a short distance away. The cockpit gradient was flat; at no point did the Commander take charge or objectively assess the situation. Neither was there a structured consideration of any plan other than to land at the destination. Considering the standard of his command training and his limited command experience, this is not necessarily a reflection on the Commander but probably more symptomatic of the inadequate training provided.

The input and assistance that could be provided by the Co-pilot was limited due to the continual demands of flying the aircraft manually on raw-data instruments.

Decisions appear to have been made on a reactive basis, as a result of the unfolding events, rather than pro-actively as part of an overall plan. A better alternative, which presented itself when the weather conditions at EIKY were passed by ATC, was briefly considered but a slight improvement in the RVRs convinced the Flight Crew to attempt a third approach without delay. Attempting a third approach was not prohibited by the Operator, but the aviation industry has found that attempting a third approach without a considerable improvement in the landing conditions greatly increases the risks associated with that approach.

Consideration must be given as to why a third approach was commenced when a suitable alternate with good weather and an ILS approach was available. It is also important to view this decision in context. Commencing the day with inadequate rest placed both Flight Crew members at a disadvantage and the first and second approaches contributed to the increasing tiredness and fatigue of the Flight Crew. Scientific research and accident investigations have demonstrated the negative affect of fatigue on human performance. This includes reduced alertness, impaired decision making, slowed reaction times and general performance deficiencies including lower situational awareness. Currently, there are no tools that can conclusively determine the degree to which the pilots were fatigued or to what extent fatigue impinged on performance on the day. Nevertheless the Investigation considers that the performance of the Flight Crew was likely to have been impaired through tiredness and fatigue, thus making balanced and safe decision making more difficult, though the extent that this contributed to the loss of control of the aircraft cannot be conclusively determined.

While in the hold, the option to divert was considered by the Commander but he was reluctant to do so. With the RVRs improving, the Commander probably felt that another approach had a better chance of success, despite the still poor conditions. Even if this third approach was unsuccessful the option to divert would still be there as fuel was not an issue. In attempting a third approach there was considerable pressure to achieve a landing. The operation of the power levers by the PNF on the final approach was probably an attempt by the Commander to reduce the workload on the PF, as the PF could then concentrate on control of the flight path and positioning the aircraft accurately. When the aircraft reached DH the Commander told the PF to 'continue'. This placed the PF in a difficult position, as the point at which to commence a go-around now became unclear. Ultimately, with the aircraft at a very low height the PF began to level the aircraft, probably anticipating a go-around call.

Without direct control of the power levers the PF was unable to directly affect a go-around. At this point the power levers were retarded into the Beta range, an action that was not possible without first lifting the Beta latches. While lifting of the Beta latches required intent and may have been due to the PNF anticipating landing, it cannot be stated definitively whether the retardation of the power levers into the Beta range was intentional or not.

Although the stall warning horn sounded shortly afterwards, this was not commented on by the Flight Crew whose full attention was probably devoted to trying to assimilate why and what the aircraft was doing, to the extent that they may not have even been aware of the sound.

The question arises as to why minima were repeatedly breached by such an inexperienced crew, particularly while flying an aircraft equipped to fly precision approaches with such basic instrumentation and equipment. The Investigation notes that the CVR did not record any discussion regarding the continuation of the three approaches without having the required minimum RVRs or descent in IMC below DH.

It is possible that such a discussion occurred prior to the recording commencing since when the aircraft reached DH the Commander said 'continue,' this was not queried by the Co-pilot who acknowledged the instruction and continued to descend. The CVR recorded that the Commander's approach briefing included the DH and RADALT minima being set and photographic evidence confirms that this was done correctly.

As no discussion was recorded regarding minimum RVR values, it is possible that the Fight Crew were unaware of the applicable RVR limitations or alternatively, they may have been aware but intended to land at EICK irrespective of the required minima. The only observation regarding RVR limitations recorded by the CVR was, following notification that the RVRs had reduced to 500 metres (less than the required minimum for continuing an approach), a casual remark by the Co-pilot that he would prefer the previous RVRs to which the Commander replied that it was 50 feet (sic) less. The Investigation considers this remark more likely a reference to the actual reduction in visibility rather than the RVR minimum value, which was coincidentally the same.

It is probable that human factors such as the desire of a newly promoted commander not to divert influenced the decisions to make these approaches. If he did not land the question could be subsequently asked as to why he had departed for EICK in such weather conditions. If he decided to divert, he faced increasing uncertainty as he would incur additional problems associated with a diversion. These include dealing with the disruption caused to passengers and organising their onward transportation. Since he had never landed at EIKY previously and had omitted to bring the notes that could have provided him with additional information, the ground support that could be expected at EIKY was unknown. Furthermore, the flight would incur additional costs and explanations would have to be given later to the Ticket Seller and Owner. In any case, the evidence from the CVR, which recorded no discussion of any RVR restriction or minima breach during its 29 minutes, appears to confirm that minima restrictions were not a consideration.

2.17 Summary

Systemic deficiencies at the operational, organisational and regulatory levels were identified by the Investigation as being contributory to the accident. Such deficiencies provided the conditions for poor operational decisions to be made on the day of the accident which resulted in the loss of the aircraft with fatalities and serious injuries.

2.17.1 Loss of Control

The immediate cause of the accident was a loss of control of the aircraft at a low height, from which recovery was not possible. The approach was continued despite not having the required minima and the aircraft descended below the decision height without adequate visual reference. Loss of control was initiated by the retardation of the power levers below Flight Idle, a manoeuvre prohibited in flight as such a manoeuvre may result in excessive airspeed deceleration and may induce an uncontrollable roll rate due to asymmetric thrust and drag.

At the time the power levers were operated below Flight Idle, the FDR shows a decrease in airspeed and rapid rolling, probably as a result of asymmetric thrust which may have been exacerbated by the latent fault identified in the P_{T2}/T_{T2} sensor of the No. 2 engine. The Investigation was unable to determine the contribution of flight control inputs during the event as these were not recorded parameters.

2.17.2 Operational Issues

It is recognised that tiredness and fatigue can adversely affect the performance of an individual to such an extent that the decision making and evaluation of a situation is compromised. Both Flight Crew commenced duty without the prescribed rest and it is likely that the Commander and Co-pilot were suffering from tiredness and fatigue at the time of the accident.

The aircraft Commander was inadequately trained in the command role. Poor evaluation of the weather conditions, lack of CRM and inappropriate decision making are largely attributable to the inadequate command training given to the Commander. In addition, the Co-pilot who had only recently joined the Operation, had not been line checked, yet was paired with the newly appointed Commander. This inappropriate pairing resulted in a flat cockpit authority gradient with little formal command in evidence.

The Co-pilot's duty change was made without the knowledge of the Operator although preparation and oversight of flight duty times was solely its responsibility. While the Operator stated it did not pair the Flight Crew together, there was no procedure in its OM to prevent this occurring, contrary to the provisions of EU-OPS. Such a crew pairing is not conducive to flight safety and came about due to the Operator not exercising appropriate control over its crew rosters and its lack of operational control and effective oversight.

Flight Time Limitations transgressions and the inadequate training provided to both Flight Crew members illustrate that this lack of oversight was not confined to the remote Operation.

2.17.3 Organisational Issues

The granting of an Air Operator Certificate requires that an operator satisfies the Competent Authority that it is able to conduct safe operations; that its organisation and management are matched to the scale and scope of the operation; and that procedures for the supervision of operations are defined.

The introduction of the intra-Community scheduled passenger air service was a significant departure from the Operator's core activity of cargo flights. Sufficient scrutiny of this proposed remote operation by the Operator should have identified and managed the additional resources and challenges while mitigating any risks identified. The lack of a contract or contact between the Operator and the Ticket Seller illustrates that this did not take place.

The Ticket Seller, which was not based within the European Union, accrued revenue from scheduled intra-Community air services. The Investigation found no evidence of a direct link between it and the Operator, the holder of the Operating Licence providing the air services. Furthermore, on flights operated under a Public Service Obligation (PSO) route the Ticket Seller was awarded the tender jointly with a Community air carrier, although Article 17 of Regulation (EC) No 1008/2008 states that a Member State *'may compensate an air carrier…'*.

2.17.4 Regulatory Oversight

In its oversight responsibility the Competent Authority conducted operational and engineering audits on a regular basis. The Investigation considers that the findings of these audits were superficial. Specifically, they did not identify the remote Operation or its inadequate resources.

Furthermore, the State audit carried out by ICAO and the Standardisation Audit by EASA also found weaknesses in the ability of the Competent Authority to conduct effective oversight.

2.17.5 Intra-Community Air Services

This accident flight was an intra-Community air service as defined in Regulation (EC) No 1008/2008, and under the requirement for '*a high and uniform level of protection of the European citizen through the adoption of common safety rule*s', as detailed in Regulation (EC) No 216/2008. Neither the Ticket Seller nor the Owner had any accountability under these Regulations, as neither held either an Operating Licence or an Air Operator Certificate. Whereas Regulation (EC) No 1008/2008 provides for the operation of an intra-Community air service by a Community air carrier, the oversight role of Member States except the State which has issued the Air Operator Certificate and Operating Licence, appears to be limited:

> '*Member States shall not subject the operation of intra-Community air services by a Community air carrier to any permit or authorisation. Member States shall not require Community air carriers to provide any documents or information which they have already supplied to the competent licencing authority, provide that the relevant information may be obtained from the competent licencing authority in due time.*'

The Investigation is concerned that the commercial model of an intra-Community air service provided by a ticket seller is not in the best interests of passenger safety as it can facilitate utilisation of resource-constrained undertakings to provide air services, thus allowing a ticket seller to exercise an inappropriate and disproportionate role with no accountability regarding air safety. The responsibilities of an air carrier are set out in Regulation (EC) No 1008/2008 but the role of a ticket seller is not clear nor are its activities defined.

3. CONCLUSIONS

(a) Findings

1. The aircraft had sufficient fuel for the planned flight.

2. The aircraft weight and centre of gravity were within limits.

3. The Flight Crew held Commercial Pilot Licences with Type Ratings on the SA 227 Metro III which were valid at the time of the accident. Class I Medical Certificates were held by both Flight Crew members.

4. The flight was undertaken without adequate consideration of the weather conditions at the destination and alternate aerodromes.

5. The Flight Plan specified one alternate aerodrome, whereas weather conditions at the destination were such that two alternate aerodromes were required.

6. The Flight Crew were not aware of the weather conditions at the alternate aerodrome specified on the Flight Plan.

7. Deviations from Standard Operating Procedures by the Flight Crew were apparent from the CVR recording.

8. The CVR recording did not contain any reference by the Flight Crew to an aircraft system anomaly or failure.

9. Three instrument approaches were commenced and continued beyond the outer marker equivalent position while meteorological conditions were below the required minima.

10. All three approaches were continued below Decision Height without adequate visual reference being acquired.

11. The power levers were operated by the PNF on the final approach contrary to normal operating procedures, which resulted in a lack of coordination between the Flight Crew in the control of the aircraft at a critical phase of flight.

12. During the third attempt to land in low visibility conditions, the aircraft descended below decision height and the power levers were retarded below Flight Idle, an action prohibited in flight.

13. Recorded data indicates that the No. 1 (left) powerplant entered a negative torque regime (-9% minimum value) whereas No. 2 (right) reached a minimum torque value of 0%. This asymmetric condition was coincident with an initial roll to the left to a bank angle of 40 degrees.

14. A go-around was initiated at a height of approximately 100 feet. The aircraft then rolled rapidly to the right resulting in the right wingtip striking the runway surface following which the aircraft inverted.

15. The aircraft came to rest in soft ground, 72 metres to the right of the runway centreline, 189 metres from the initial impact point.

16. Post impact fires occurred in both engine nacelles which were expeditiously extinguished by the Airport Fire Service.

17. Six persons, including both Flight Crew members, were fatally injured. Four passengers suffered serious injuries and two minor injuries.

18. Toxicology Reports relating to the Commander and Co-pilot, show that carbon monoxide, ethanol, prescribed drugs, or drugs of abuse were not detected.

19. The ILS on RWY 17 was functioning normally with no warning or failure indications evident during the final approach of EC-ITP. A post-accident calibration flight revealed no anomalies with the ILS system.

20. Air Traffic Control personnel at Cork performed their duties in accordance with procedures and promptly sounded the alarm when they lost radio contact with the aircraft.

21. The Technical Log for EC-ITP recorded no defects between 9 November 2010 (when the aircraft re-entered service following heavy landing repairs) and the date of the accident.

22. The aircraft was regularly changed between passenger and cargo configuration by unauthorised flight crew and without appropriate entries being made in the aircraft Technical Log.

23. The last 75-hour Service Check before the accident was carried out on the 5 February 2011 at Barcelona. No defects were recorded on the documentation related to this Check.

24. The No. 2 engine P_{T2}/T_{T2} sensor was inspected for damage, condition and security as part of a major inspection which was certified on 11 October 2010. It was also checked for condition and security on a Service Check in the week before the accident. No sensor defect was noted during these inspections.

25. During the rectification work carried out on the major inspection, engine ground runs were carried out using Form 503 from the Phase Inspection Manual. As both engines had been installed during the inspection it would have been appropriate to use the ground run procedures detailed in AMM 71-00-30. This would have included a power lever split check at Flight Idle.

26. At the time of the accident, the No. 2 engine P_{T2}/T_{T2} sensor was defective, resulting in non-normal fuel scheduling and power delivery from that engine. FDR data shows that this defect was present throughout the 106 hours of available FDR recording but it was not recorded on the Technical Log.

27. A torque split between the engines, caused by the defective P_{T2}/T_{T2} sensor, became significant when the power levers for both powerplants were operated below Flight Idle.

28. The Investigation identified no other pre-accident aircraft defects that were relevant to the accident.

29. The Operator was unable to make the FDR data frame layout available, contrary to Regulation.

30. The seating arrangement in EC-ITP comprised 18 passenger seats in a non-standard layout.

31. No evidence was found of the effective employment of Crew Resource Management principles.

32. Command decision making was not effective with a flat cockpit authority gradient being evident.

33. The aircraft Commander was inadequately trained in the command role and thus was ill prepared for the situation in which he found himself on the day of the accident.

34. The implementation of the Operator's command training programme was inadequate, and was not in accordance with its Operations Manual Part D.

35. The Co-pilot's training and final line check were not completed.

36. The pairing of a newly promoted Commander with a Co-pilot, who had recently joined the Operator, was inappropriate and was contrary to EU-OPS.

37. The Commander did not have sufficient rest prior to commencing duty on the day of the accident.

38. Two days prior to the accident, the Co-pilot exceeded flight and duty time limitations and operated a final sector in breach of Regulations.

39. The Co-pilot did not have sufficient rest prior to commencing duty on the day of the accident.

40. It is likely that the Commander and particularly the Co-pilot, who had hand-flown three raw data approaches, were suffering from tiredness and fatigue at the time of the accident.

41. The aircraft was operated on the Belfast City – Cork scheduled service without establishing a line maintenance station at either location.

42. The Air Traffic Services flight plan for FTL400C, the accident flight, was filed by a Ground Handling company in Denmark.

43. The Operator had neither a contract nor communications with the Ticket Seller.

44. There was inadequate and ineffective oversight of the remote UK/Ireland Operation by the Operator, which did not have effective disposal of the use or operation of the aircraft.

45. The Owner, which did not hold an Operating Licence or Air Operator Certificate, had effective disposal of the use and operation of the aircraft.

46. The Ticket Seller had an arrangement with the Owner for the supply of an aircraft and crew according to its schedules.

47. The IATA 'NM' code, which had been issued exclusively to FLM Aviation by the International Air Transport Association, was used by the Ticket Seller for all its flights including the accident flight with the agreement of FLM Aviation.

48. The Ticket Seller's marketing and operational activity was such that it was portraying itself as an airline.

49. Some of the operational responsibilities of the Operator as AOC holder including operational control were being inappropriately exercised by the Owner and the Ticket Seller.

50. The Competent Authority of the State of the Operator informed the Investigation that it was unaware of the remote Operation in the UK and Ireland.

51. There was no oversight of the remote Operation by the Competent Authority of the State of the Operator.

52. The two SAFA inspections carried out on the aircraft involved in the Operation did not identify substantial operational deficiencies.

53. SAFA inspections are limited in scope and do not provide a substitute for oversight by the State of an operator.

54. The training standards prescribed under EU-OPS 1.955 regarding Nomination as Commander do not provide adequate requirements for Command upgrade.

(b) Probable Cause

Loss of control during an attempted go-around below Decision Height in Instrument Meteorological Conditions.

(c) Contributory Cause(s)
(Note that Contributory Causes are not listed in order of priority)

1. Continuation of approach beyond the outer marker equivalent position without the required minima.

2. Continuation of descent below Decision Height without adequate visual reference.

3. Uncoordinated operation of the power levers and the flight controls.

4. In-flight operation of the power levers below Flight Idle.

5. A torque split between the engines that became significant when the power levers were operated below Flight Idle.

6. Tiredness and fatigue on the part of the Flight Crew members.

7. Inadequate command training and checking during the command upgrade of the Commander.

8. Inappropriate pairing of Flight Crew members.

9. Inadequate oversight of the remote Operation by the Operator and the State of the Operator.

4. SAFETY RECOMMENDATIONS

No.	It is Recommended that:	Recommendation Ref.
1.	The Director-General for Mobility and Transport, European Commission should review the obligations of Member States to implement penalties, in accordance with the Standardisation Regulation (EU) No 628/2013, as a result of transgressions including Flight Time Limitations as provided for in Regulation (EC) No 216 /2008	IRLD2014001
2.	The European Aviation Safety Agency should provide guidance to Operators concerning successive instrument approaches to an aerodrome in IMC or night VMC where a landing cannot be made due to weather reasons and incorporate such guidance in Commission Regulation (EU) No 965/2012 accordingly.	IRLD2014002
3.	The European Aviation Safety Agency should review Council Regulation (EEC) No 3922/91 as amended by Commission Regulation (EC) No 859/2008, to ensure that it contains a comprehensive syllabus for appointment to commander and that an appropriate level of command training and checking is carried out.	IRLD2014003
4.	Flightline S.L. should review its current operational policy of an immediate diversion following a missed approach due to weather.	IRLD2014004
5.	Flightline S.L. should implement suitable and appropriate training for personnel responsible for flight safety and accident prevention.	IRLD2014005
6.	The Director-General for Mobility and Transport, European Commission should review the role of the ticket seller when engaged in providing air passenger services and restrict ticket sellers from exercising operational control of air carriers providing such services, thus ensuring that a high and uniform level of safety is achieved for the travelling public.	IRLD2014006
7.	The European Aviation Safety Agency should review the process by which AOC variations are granted to ensure that the scope of any new operation is within the competence of the air carrier.	IRLD2014007

No.	It is Recommended that:	Recommendation Ref.
8.	*Agencia Estatal de Seguridad Aérea* should review its policy with regard to continuing oversight of air carriers, in particular those conducting remote operations.	IRLD2014008
9.	The Director-General for Mobility and Transport, European Commission should review Regulation (EC) No 216/2008 in the context of Implementing Regulation (EU) No 628/2013 in order to improve safety oversight including the efficacy and scope of SAFA Inspections and to provide for the extension of oversight responsibilities, particularly in cases where effective oversight may be limited due to resource issues, remote operation or otherwise.	IRLD2014009
10.	The Director-General for Mobility and Transport, European Commission should review the scope of the Air Safety Committee, and consider including oversight of Operating Licences issued by Member States and the processes by which such oversight is carried out.	IRLD2014010
11.	The International Civil Aviation Organization should consider the inclusion of information regarding the flight-specific approach capability of aircraft/flight crew within the proposed 'Flight and flow – Information for a Collaborative Environment (FF-ICE)'.	IRLD2014011

View Safety Recommendations for Report 2014-001

Appendix A

Record of flights crewed by the Commander or Co-pilot from 6 February 2011

Date:	Aircraft:	Flight No:	Dep:	Time:	Arr:	Time:	P1:	P2:
6.2.11	EC-GPS	FTL 3529	EGAC	12.50	EGNS	13.40	Commander	
	EC-GPS	FTL 3534	EGNS	15.15	EGAC	15.50	Commander	
	EC-GPS	FTL 310C	EGAC	16.10	EICK	17.35	Commander	
	EC-GPS	FTL 311B	EICK	17.45	EGAC	18.55	Commander	
7.2.11	EC-GPS	FTL 300C	EGAC	07.50	EICK	09.15	Commander	
	EC-GPS	FTL 301B	EICK	09.25	EGAC	10.35	Commander	
	EC-GPS	FTL 310C	EGAC	16.05	EICK	17.15	Commander	
	EC-GPS	FTL 311B	EICK	17.25	EGAC	18.45	Commander	
	EC-GPS	FTL 311P	EGAC	19.45	EGAA	20.20		Co-pilot
	EC-GPS	FTL 3111	EGAA	22.55	EGPH	23.55		Co-pilot
8.2.11	EC-GPS	FTL 3112	EGPH	00.40	EGAA	01.30		Co-pilot
	EC-GPS	FTL 3113	EGAA	07.00	EGAC	07.30		Co-pilot
	EC-GPS	FTL 300C	EGAC	08.00	EICK	09.15	Commander	
	EC-GPS	FTL 301B	EICK	09.25	EGAC	10.35	Commander	
	EC-GPS	FTL 310C	EGAC	16.10	EICK	17.35	Commander	
	EC-GPS	FTL 311B	EICK	17.50	EGAC	18.55	Commander	
	EC-GPS	'ECGPS'	EGAC	19.10	EGNS	19.50	Commander	
9.2.11	EC-ITP	FTL 4113	EGAA	07.00	EGAC	07.35	Commander	Co-pilot
	EC-ITP	FTL 400C	EGAC	08.10	EICK	09.20	Commander	Co-pilot
	EC-ITP	FTL 401B	EICK	09.30	EGAC	10.35	Commander	Co-pilot
	EC-ITP	FTL 410C	EGAC	16.05	EICK	17.20	Commander	Co-pilot
	EC-ITP	FTL 411B	EICK	17.30	EGAC	18.40	Commander	Co-pilot
10.2.11	EC-ITP	FTL 400P	EGAA	06.40	EGAC	07.15	Commander	Co-pilot
	EC-ITP	FTL 400C	EGAC	07.55	EICK	09.50	Commander	Co-pilot

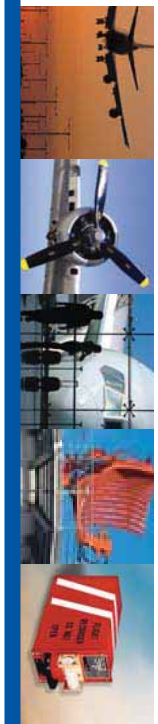
Note: Times indicated are 'block times' or the time the aircraft commenced its taxi for flight to the time it arrived on stand following the flight. Crew duty times are calculated from a reporting time 45 minutes before scheduled departure and end when the aircraft arrived on stand at the end of the last sector. The final sector is the accident flight.

Appendix B

Flights Operated by EC-ITP and EC-GPS

For all crews operating accident aircraft EC-ITP between 5-10 February 2011

Date 2011	**Captain 'A'**	**Commander**	**Captain 'B'**	**Captain 'C'**	**First Officer 'D'**	**Co-pilot**	**First Officer 'E'**	**Routes**
5 Feb				14.25-16.30			14.25-16.30	LEBL-LEZL
6 Feb								(No flights operated by EC-ITP)
7 Feb				08.00-10.40 11.35-13.10 13.45-15.20 16.15-17.50			08.00-10.40 11.35-13.10 13.45-15.20 16.15-17.50	LEZL-DAAG-DAFH-DAOO-LEZL
8 Feb				06.00-08.35 15.30-19.05 20.20-21.00 22.50-23.45			06.00-08.35 15.30-19.05 20.20-21.00 22.50-23.45	LEZL-LEBL-EGNS-EGAA-EGPH
09 Feb		 **07.00-07.35** **08.10-09.20** **09.30-10.35** **16.05-17.20** **17.30-18.40**		00.20-01.25 19.20-19.50 22.45-23.45		 **07.00-07.35** **08.10-09.20** **09.30-10.35** **16.05-17.20** **17.30-18.40**	00.20-01.25 19.20-19.50 22.45-23.45	EGPH-EGAA **EGAA-EGAC-EICK-EGAC-EICK-EGAC** EGAC-EGAA-EGPH
10 Feb		 **06.40-07.15** **07.55-09.50**		02.30-03.25 04.00-05.10		 **06.40-07.15** **07.55-09.50**	02.30-03.25 04.00-05.10	EGPH-EGPE-EGAA **EGAA-EGAC-EICK** **(Accident Flight)**



For all crews operating sister aircraft EC-GPS between 1-8 February 2011

Date 2011	Captain 'A' (Note 1)	Commander	Captain 'B' (Note 2)	Captain 'C' (Note 3)	First Officer 'D'	Co-pilot	First Officer 'E' (Note 3)	Route
1 Feb	08.00-09.15 09.20-10.30 16.00-17.50 17.30-18.40				08.00-09.15 09.20-10.30 16.00-17.50 17.30-18.40			EGAC-EICK-EGAC-EICK-EGAC
2 Feb	07.50-09.10 09.20-10.30 16.05-17.15 17.35-18.45				07.50-09.10 09.20-10.30 16.05-17.15 17.35-18.45			EGAC-EICK-EGAC-EICK-EGAC
3 Feb	07.45-09.00 09.15-10.25 16.00-17.20 17.40-19.00					**07.45-09.00** **09.15-10.25** **16.00-17.20** **17.40-19.00**		**EGAC-EICK-EGAC-EICK-EGAC**
4 Feb	10.50-12.15 12.30-13.40 16.00-17.20 17.40-18.50				10.50-12.15 12.30-13.40 16.00-17.20 17.40-18.50			EGAC-EICK-EGAC-EICK-EGAC
5 Feb								(No flights operated by EC-GPS)
6 Feb		**12.50-13.40** **15.15-15.50** **16.10-17.35** **17.45-18.55**			12.50-13.40 15.15-15.50 16.10-17.35 17.45-18.55			**EGAC-EGNS-EGAC-EICK-EGAC**
7 Feb		**07.50-09.15** **09.25-10.35** **16.05-17.15** **17.25-18.45**			07.50-09.15 09.25-10.35 16.05-17.15 17.25-18.45			**EGAC-EICK-EGAC-EICK-EGAC**
			19.45-20.20 22.55-23.55			**19.45-20.20** **22.55-23.55**		**EGAC-EGAA-EGPH**

8 Feb		**08.00-09.15** **09.25-10.35** **16.10-17.35** **17.50-18.55** **19.10-19.50**	00.40-01.30 07.00-07.30		08.00-09.15 09.25-10.35 16.10-17.35 17.50-18.55 19.10-19.50	**00.40-01.30** **07.00-07.30**		**EGPH-EGAA-EGAC** **EGAC-EICK-EGAC-EICK-EGAC-EGNS** (EC-GPS arrived in EGNS/Isle of Man for maintenance and was replaced by EC-ITP which operated the schedule).

Note 1:
Captain 'A' operated on 1, 2, 3 & 4 February 2011. He started and finished duties in Belfast City (EGAC) and operated two round trips EGAC-EICK (Cork) each day.

Note 2:
Captain 'B' operated only cargo flights on the night of 7-8 February: On 7 Feb he commenced duty at EGAC and positioned the aircraft to Belfast Aldergrove (EGAA). He then operated a flight on sub-contract to Royal Mail EGAA-EGPH (Edinburgh)to EGAA, arrived at 01.30 hrs (8 Feb) and subsequently positioned the aircraft back to EGAC (07.00-07.30 hrs). The duty time commenced at 19.00 hrs (7 Feb) and terminated at 07.30 hrs (8 Feb), a total duty time of 12 hours 30 minutes. The Co-pilot also operated this series of flights.

Note 3:
Captain 'C' and First Officer 'E'. On 7 February, they operated a series of flights to Algeria, returning to Seville (LEZL) that evening, with duty terminating at 17.50 hrs. On 8 February, they commenced operating from LEZL, routing LEZL-LEBL-EGNS (Isle of Man)-EGAA-EGPH-EGAA. This work-day commenced at 05.15 hrs (45 minutes prior to departure), and terminated at 01.25 hrs on 09 February, a total duty time of 20 hours 10 minutes. During this period, the aircraft was on the ground at LEBL from 08.35 hrs to 15.30 hrs, providing a break for the crew. Under CO 16B, a 'partial rest on the ground' may have been availed of lasting 6 hrs 55 minutes, which would have extended the allowable FDP by 3 hours 27 minutes. Under the provisions of EU-OPS (Subpart Q) and the Operator's OM, Part A, Section 7, the maximum duty permissible was 14 hours 57 minutes (exceeding the permissible Flight Duty Time by 5 hours 13 minutes). This crew then returned to duty at 18.35 hrs on 9 February; the earliest time they should have commenced duty, based on the provision of a rest period equal to the length of the preceding duty, was 21.35 hrs (EU-OPS 1.1110, 1.2 – Minimum Rest) resulting in the flight crew achieving less than required minimum rest. In addition, the flight duty period on 9-10 February encompassed the WOCL which imposed a maximum FDP of 10 hours; the actual duty was 10 hours 35 minutes resulting in an exceedance of the allowable FDP by 35 minutes.

Appendix C

Review of continuing airworthiness management and maintenance arrangements

Table No. 1 - Review of Operator Part M compliance

This table provides detailed information on the Part M requirements together with details of areas of the requirements that are deemed not subject to review or not compliant.

PART M **SECTION A TECHNICAL REQUIREMENTS**

SUBPART A **GENERAL**	**Operator Compliance/Non-compliance**
M.A.101 Scope	
This Section establishes the measures to be taken to ensure that airworthiness is maintained, including maintenance. It also specifies the conditions to be met by the persons or organisations involved in such continuing airworthiness management.	
SUBPART B ACCOUNTABILITY	**Operator Compliance/Non-compliance**
M.A.201 Responsibilities	
M.A.201(a) The owner is responsible for the continuing airworthiness of an aircraft and shall ensure that no flight takes place unless:	In the case of commercial air transport operations (CAT) the operator and not the owner is responsible for compliance with this sub-section.
1. The aircraft is maintained in an airworthy condition, and	**<u>Non-compliance No. 1</u>** The reconfiguration of the aircraft was performed by unauthorised personnel without reference to approved data and was not recorded or certified. **<u>Non-compliance No. 2</u>** There was a pre-existing engine defect at the time of the accident which was not recorded, rectified or deferred. **<u>Non-compliance No. 3</u>** The aircraft passenger seat arrangement was not configured in accordance with the Operator's Ops Manual Part B, Section 1.1(b). **<u>Non-compliance No. 4</u>** The operator did not fulfil its responsibility to ensure that the aircraft was maintained in an airworthy condition.

2. Any operational and emergency equipment fitted is correctly installed and serviceable or clearly identified as unserviceable, and;	**Refer to Non-compliance No. 1**
3. The airworthiness certificate remains valid, and;	A valid airworthiness certificate was in place.
4. The maintenance of the aircraft is performed in accordance with the approved maintenance programme as specified in M.A.302.	Refer to Section M.A.302.
M.A.201(b) When the aircraft is leased, the responsibilities of the owner are transferred to the lessee if: 1. The lessee is stipulated on the registration document, or; 2. Detailed in the leasing contract. When reference is made in this Part to the 'owner', the term owner covers the owner or the lessee, as applicable.	In the case of commercial air transport operations (CAT) the operator and not the owner/lessee is responsible for compliance with this sub-section.
M.A.201 (c) Any person or organisation performing maintenance shall be responsible for the tasks performed.	**Non-compliance No. 1** The reconfiguration of the aircraft was performed by unauthorised personnel without reference to approved data and was not recorded or certified.
M.A.201 (d) The pilot-in-command or, in the case of commercial air transport, the operator shall be responsible for the satisfactory accomplishment of the pre-flight inspection. This inspection must be carried out by the pilot or another qualified person but need not be carried out by an approved maintenance organisation or by Part-66 certifying staff.	**Non-compliance No. 5** The Operator did not ensure that all pre-flight inspections were recorded appropriately.
M.A.201 (e) In order to satisfy the responsibilities of paragraph (a),	

(i) The owner of an aircraft may contract the tasks associated with continuing airworthiness to a continuing airworthiness management organisation approved in accordance with Section A, Subpart G of this Annex (Part M). In this case, the continuing airworthiness management organisation assumes responsibility for the proper accomplishment of these tasks.	All continuing airworthiness tasks were managed directly by the Operator.
(ii) An owner who decides to manage the continuing airworthiness of the aircraft under its own responsibility, without a contract in accordance with Appendix I, nevertheless may make a limited contract with a continuing airworthiness management organisation approved in accordance with Section A, Subpart G of this Annex (Part M), for the development of the maintenance programme and its approval in accordance with point M.A.302. In that case, the limited contract transfers the responsibility for the development and approval of the maintenance programme to the contracted continuing airworthiness management organisation.	All continuing airworthiness tasks were managed directly by the Operator.
M.A.201 (f) In the case of large aircraft, in order to satisfy the responsibilities of paragraph (a) the owner of an aircraft shall ensure that the tasks associated with continuing airworthiness are performed by an approved continuing airworthiness management organisation. A written contract shall be made in accordance with Appendix I. In this case, the continuing airworthiness management organisation assumes responsibility for the proper accomplishment of these tasks.	All continuing airworthiness tasks were managed directly by the Operator.

M.A.201 (g) Maintenance of large aircraft, aircraft used for commercial air transport and components thereof shall be carried out by a Part-145 approved maintenance organisation.	All maintenance for the aircraft was contracted to the Maintenance Provider via contract reference 'The Maintenance & Assistance Agreement EU-OPS 1, Edition 1 Revision 2' dated April 2009.
M.A.201(h) In the case of commercial air transport the operator is responsible for the continuing airworthiness of the aircraft it operates and shall:	
1. Be approved, as part of the air operator certificate issued by the competent authority, pursuant to M.A. Subpart G for the aircraft it operates; and	The Operator was Part M Subpart G approved. Refer to EASA Form 14 approval reference ES.MG.034 dated '17/09/09'.
2. Be approved in accordance with Part-145 or contract such an organisation; and	All maintenance for the aircraft was contracted to the Maintenance Provider via contract reference 'The Maintenance & Assistance Agreement EU-OPS 1, Edition 1 Revision 2' dated April 2009.
3. Ensure that paragraph M.A.201(a) is satisfied.	Refer to paragraph M.A.201(a).
M.A.201(i) When an operator is requested by a Member State to hold a certificate for commercial operations, other than for commercial air transport, it shall:	Not relevant to this review as the Operator was conducting commercial air transport (CAT).
M.A.201(j) The owner/operator is responsible for granting the competent authority access to the organisation/aircraft to determine continued compliance with this Part.	Not subject to review.
M.A.202 Occurrence Reporting	Not subject to review.

SUBPART C CONTINUING AIRWORTHINESS	Operator Compliance/Non-compliance
M.A.301 Continuing Airworthiness Tasks	
The aircraft continuing airworthiness and the serviceability of both operational and emergency equipment shall be ensured by:	
1. The accomplishment of pre-flight inspections; *(AMC M.A.303.1 lists typical actions necessary to ensure that the aircraft is fit to make the intended flight).*	**Non-compliance No.6** The Operator's pre-flight inspection did not contain the following items required by AMC M.A.301.1; An inspection of the aircraft and its emergency equipment for condition including, in particular, any obvious signs of wear, damage or leakage. In addition, the presence of all required equipment including emergency equipment should be established. An inspection of the aircraft continuing airworthiness record system or the operators technical log as applicable to ensure that the intended flight is not adversely affected by any outstanding deferred defects and that no required maintenance action shown in the maintenance statement is overdue or will become due during the flight. A control that consumable fluids, gases etc. uplifted prior to flight are of the correct specification, free from contamination and correctly recorded.
2. The rectification in accordance with the data specified in point M.A.304 and/or point M.A.401, as applicable, of any defect and damage affecting safe operation, taking into account, for all large aircraft or aircraft used for commercial air transport, the minimum equipment list and configuration deviation list as applicable to the aircraft type;	**Non-compliance No. 2** There was a pre-existing engine defect at the time of the accident which was not recorded, rectified or deferred. **Non-compliance No. 3** The aircraft passenger seat arrangement was not configured in accordance with the Operator's OM Part B, Section 1.1(b).

3. The accomplishment of all maintenance, in accordance with the M.A.302 approved aircraft maintenance programme;	Not subject to review.
4. For all large aircraft or aircraft used for commercial air transport the analysis of the effectiveness of the M.A.302 approved maintenance programme;	Not subject to review.
5. The accomplishment of any applicable (i) airworthiness directive, (ii) operational directive with a continuing airworthiness impact, (iii) continued airworthiness requirement established by the Agency, (iv) measures mandated by the competent authority in immediate reaction to a safety problem;	Not subject to review.
6. The accomplishment of modifications and repairs in accordance with M.A.304;	Refer to Section M.A.304.
7. For non-mandatory modifications and/or inspections, for all large aircraft or aircraft used for commercial air transport the establishment of an embodiment policy;	Not subject to review.
8. Maintenance check flights when necessary.	Not subject to review.

M.A.302 Aircraft Maintenance Programme	**Operator Compliance/Non-compliance**
M.A.302(a) Maintenance of each aircraft shall be organised in accordance with an aircraft maintenance programme.	Maintenance programme reference FTL-PM-SA227 Edition 1 Revision 0 dated 21/12/2009 was reviewed and found generally compliant with M.A.302 requirements. No further comment on M.A.302 sub-sections is therefore required.
M.A.302(b) The aircraft maintenance programme and any subsequent amendments shall be approved by the competent authority.	The maintenance programme was approved by AESA, the competent authority for Spain.

M.A.303 Airworthiness Directives	Not subject to review.

M.A.304 Data for Modifications and Repairs	
Damage shall be assessed and modifications and repairs carried out using data approved by the Agency or by an approved Part-21 design organisation, as appropriate.	**<u>Non-compliance No. 7</u>** It could not be established that data approved by EASA or by an approved Part-21 design organisation was available to support the regular reconfiguration of the aircraft from passenger to cargo operations and vice versa.

M.A.305 Aircraft Continuing Airworthiness Record System	Operator Compliance/Non-compliance
	Deficiencies in updating the continuing airworthiness record system are identified in Non-compliances 1, 2, 5, 9 and 10.

M.A.306 Operator's Technical Log System	Operator Compliance/Non-compliance
M.A.306 (a) In the case of commercial air transport, in addition to the requirements of M.A.305, an operator shall use an aircraft technical log system containing the following information for each aircraft:	This M.A.306 deals specifically with the layout and information required to be entered in the Technical Log. AMC M.A.306(a) refers.
1. Information about each flight, necessary to ensure continued flight safety, and;	**<u>Non-compliance No. 8</u>** The layout and content of the Technical Log did not contain the following items required by AMC M.A.306(a); There is no provision for the commander to date and sign the entry of aircraft defects. The Technical Log page is not divided to show clearly what is required to be completed after flight and what is to be completed in preparation for the next flight. **<u>Non-compliance No. 9</u>** There were no maintenance entries or aircraft defects, nor was the nil defect state required for the continuity of the record, entered or recorded in the Technical Log of EC-ITP from 9 November 2010 until 10 February 2011.

2. The current maintenance statement giving the aircraft maintenance status of what scheduled and out of phase maintenance is next due except that the competent authority may agree to the maintenance statement being kept elsewhere, and;	**Non-compliance No. 10** The current maintenance statement for the complete aircraft was not located in the Technical Log or the aircraft documentation folder and was not located on the aircraft.
3. All outstanding deferred defects rectifications that affect the operation of the aircraft, and;	**Non-compliance No. 11** The current hold item list (HIL) [list of deferred defects] was not located in the Technical Log or the aircraft documentation folder and was not found in the aircraft.
4. Any necessary guidance instructions on maintenance support arrangements.	**Non-compliance No. 12** The aircraft Technical Log did not contain any necessary guidance instructions on maintenance support arrangements for each aircraft.
M.A.306 (b) The aircraft technical log system and any subsequent amendment shall be approved by the competent authority.	Not subject to review.
M.A.306 (c) An operator shall ensure that the aircraft technical log is retained for 36 months after the date of the last entry.	Not subject to review.

M.A.307 Transfer of aircraft continuing airworthiness records.	Not subject to review.

SUBPART D MAINTENANCE STANDARDS	**Operator Compliance/Non-compliance**
M.A.401 Maintenance Data	
M.A.401(a) The person or organisation maintaining an aircraft shall have access to and use only applicable current maintenance data in the performance of maintenance including modifications and repairs.	Not subject to review.

M.A.401(b) For the purposes of this Part, applicable maintenance data is: 1. Any applicable requirement, procedure, standard or information issued by the competent authority or the Agency,	Not subject to review.
2. Any applicable airworthiness directive,	Not subject to review.
3. Applicable instructions for continuing airworthiness, issued by type certificate holders, supplementary type certificate holders and any other organisation that publishes such data in accordance with Part 21	**Non-compliance No. 7** It could not be established that data approved by EASA or by an approved Part-21 design organisation was available to support the regular reconfiguration of the aircraft from passenger to cargo operations and vice versa.
4. Any applicable data issued in accordance with 145.A.45(d).	Not subject to review.
(c) The person or organisation maintaining an aircraft shall ensure that all applicable maintenance data is current and readily available for use when required. The person or organisation shall establish a work card or worksheet system to be used and shall either transcribe accurately the maintenance data onto such work cards or worksheets or make precise reference to the particular maintenance task or tasks contained in such maintenance data.	Not subject to review.

M.A.402 Performance of Maintenance	**Operator Compliance/Non-compliance**
(a) All maintenance shall be performed by qualified personnel, following the methods, techniques, standards and instructions specified in the M.A.401 maintenance data. Furthermore, an independent inspection shall be carried out after any flight safety sensitive maintenance task unless otherwise specified by Part-145 or agreed by the competent authority	**Non-compliance No. 1** The reconfiguration of the aircraft was performed by unauthorised personnel without reference to approved data and was not recorded or certified.

(b) All maintenance shall be performed using the tools, equipment and material specified in the M.A.401 maintenance data unless otherwise specified by Part-145. Where necessary, tools and equipment shall be controlled and calibrated to an officially recognised standard	Not subject to review.
(c) The area in which maintenance is carried out shall be well organised and clean in respect of dirt and contamination.	Not subject to review.
(d) All maintenance shall be performed within any environmental limitations specified in the M.A.401 maintenance data.	Not subject to review.
(e) In case of inclement weather or lengthy maintenance, proper facilities shall be used.	Not subject to review.
(f) After completion of all maintenance a general verification must be carried out to ensure the aircraft or component is clear of all tools, equipment and any other extraneous parts and material, and that all access panels removed have been refitted.	Not subject to review.

M.A.403 Aircraft Defects	**Operator Compliance/Non-compliance**
(a) Any aircraft defect that hazards seriously the flight safety shall be rectified before further flight.	**<u>Refer to Non-compliances 2 and 3.</u>**
(b) Only the authorised certifying staff, according to points M.A.801 (b) 1, M.A.801 (b) 2, M.A.801 (c), M.A.801 (d) or Annex II (Part-145) can decide, using M.A.401 maintenance data, whether an aircraft defect hazards seriously the flight safety and therefore decide when and which rectification action shall be taken before further flight and which defect rectification can be deferred. However, this does not apply when:	**Refer to Non-compliances 2 and 3.**

1. The approved minimum equipment list as mandated by the competent authority is used by the pilot; or,	Not subject to review.
2. Aircraft defects are defined as being acceptable by the competent authority.	Not subject to review.
(c) Any aircraft defect that would not hazard seriously the flight safety shall be rectified as soon as practicable, after the date the aircraft defect was first identified and within any limits specified in the maintenance data.	**Refer to Non-compliances 2 and 3.**
(d) Any defect not rectified before flight shall be recorded in the M.A.305 aircraft maintenance record system or M.A.306 operator's technical log system as applicable.	**Refer to Non-compliances 2 and 3.**

SUBPART E COMPONENTS	Not subject to review.
SUBPART F MAINTENANCE ORGANISATION	Not subject to review.

SUBPART G CONTINUING AIRWORTHINESS MANAGEMENT ORGANISATION	Operator Compliance/Non-compliance.
M.A.701 Scope	
This Subpart establishes the requirements to be met by an organisation to qualify for the issue or continuation of an approval for the management of aircraft continuing airworthiness.	

M.A.702 Application	Not subject to review.

M.A.703 Extent of Approval	**Operator Compliance/Non-compliance**
M.A.703(a) The approval is indicated on a certificate included in Appendix VI issued by the competent authority.	Refer to EASA Form 14 approval reference ES.MG.034 dated 17/09/09.

M.A.703(b) Notwithstanding paragraph (a), for commercial air transport, the approval shall be part of the air operator certificate issued by the competent authority, for the aircraft operated.	The Operator, AOC No E-AOC-34 issued by AESA.
M.A.703(c) The scope of work deemed to constitute the approval shall be specified in the continuing airworthiness management exposition in accordance with point M.A.704.	CAME edition 0 revision 17 dated 01/02/2011 Section 0.2 refers.

M.A.704 Continuing Airworthiness Management Exposition	**Operator Compliance/Non-compliance**
M.A.704(a) The continuing airworthiness management organisation shall provide a continuing airworthiness management exposition containing the following information:	CAME edition 0 revision 17 dated 01/02/2011 approved by AESA on 02/02/2011 was effective on the date of the accident. **Non-compliance No. 13** The CAME was found to have the following discrepancies; CAME Section 0.2 does not describe the type of operation and makes no reference to the operation of the SA-227 aircraft in the Isle of Man, UK and Ireland. Section 5.4 does not list contracted Part-145 maintenance organisations. There is no list of approved maintenance programmes contained in the CAME.
1. A statement signed by the accountable manager to confirm that the organisation will work in accordance with this Part and the exposition at all times, and;	Refer to CAME Section 1.1.
2. The organisation's scope of work, and;	Refer to CAME Section 0.2.
3. The title(s) and name(s) of person(s) referred to in points M.A.706(a), M.A.706(c), M.A.706(d) and M.A.706(i), and;	Refer to CAME Section 1.3

4. An organisation chart showing associated chains of responsibility between all the person(s) referred to in points M.A.706(a), M.A.706(c), M.A.706 (d) and M.A.706(i), and;	Refer to CAME Section 0.4 and 1.5.
5. A list of the airworthiness staff referred to in point M.A.707, specifying, where applicable, the staff authorised to issue permits to fly in accordance with point M.A.711(c), and;	Refer to CAME Section 9.1.2.
6. A general description and location of the facilities, and;	Refer to CAME Section 1.8.
7. Procedures specifying how the continuing airworthiness management organisation ensures compliance with this Part, and;	Refer to CAME Section 2.
8. The continuing airworthiness management exposition amendment procedures, and;	Refer to CAME Section 1.11.
9. The list of approved aircraft maintenance programmes, or, for aircraft not involved in commercial air transport, the list of 'generic' and 'baseline' maintenance programmes.	**Refer to non-compliance No. 13**
M.A.704(b) The continuing airworthiness management exposition and its amendments shall be approved by the competent authority.	Edition 0 revision 17 dated 01/02/2011 approved by AESA on 02/02/2011.
M.A.704(c) Notwithstanding paragraph (b), minor amendments to the exposition may be approved indirectly through an indirect approval procedure. The indirect approval procedure shall define the minor amendment eligible, be established by the continuing airworthiness management organisation as part of the exposition and be approved by the competent authority responsible for that continuing airworthiness management organisation.	Not subject to review.

M.A.705 Facilities	Not subject to review.

M.A.706 Personnel Requirements	Not subject to review.

M.A.707 Airworthiness Review Staff	Not subject to review.

M.A.708 Continuing Airworthiness Management	**Operator Compliance/Non-compliance**
M.A.708(a) All continuing airworthiness management shall be carried out according to the prescriptions of M.A Subpart C.	Refer to Subpart C.
M.A.708 (b) For every aircraft managed, the approved continuing airworthiness management organisation shall:	
1. Develop and control a maintenance programme for the aircraft managed including any applicable reliability programme,	Refer to M.A.302(a).
2. Present the aircraft maintenance programme and its amendments to the competent authority for approval, unless covered by an indirect approval procedure in accordance with point M.A.302(c), and provide a copy of the programme to the owner of aircraft not involved in commercial air transport,	Refer to M.A.302(b).
3. Manage the approval of modification and repairs,	Refer to M.A.301.6.
4. Ensure that all maintenance is carried out in accordance with the approved maintenance programme and released in accordance with M.A. Subpart H,	Refer to M.A.301.3. and Subpart H.
5. Ensure that all applicable airworthiness directives and operational directives with a continuing airworthiness impact, are applied,	Refer to M.A.301.5.
6. Ensure that all defects discovered during scheduled maintenance or reported are corrected by an appropriately approved maintenance organisation,	Refer to M.A.301.2.

7. Ensure that the aircraft is taken to an appropriately approved maintenance organisation whenever necessary,	**Refer to non-compliance No. 1**
8. Coordinate scheduled maintenance, the application of airworthiness directives, the replacement of service life limited parts, and component inspection to ensure the work is carried out properly,	**Refer to non-compliance No. 1**
9. Manage and archive all continuing airworthiness records and/or operator's technical log.	Refer to M.A.305 and M.A.306.
10. Ensure that the Weight and Balance statement reflects the current status of the aircraft.	Refer to the Maintenance Facility (Cologne) weighing report of 11 October 2010 for aircraft weight with passenger seats removed and the Maintenance Provider weighing report of 12/11/2010 for aircraft weight with passenger seats installed.
M.A.708 (c) In the case of commercial air transport, when the operator is not appropriately approved to Part-145, the operator shall establish a written maintenance contract between the operator and a Part-145 approved organisation or another operator, detailing the functions specified under M.A.301-2, M.A.301-3, M.A.301-5 and M.A.301-6, ensuring that all maintenance is ultimately carried out by a Part-145 approved maintenance organisation and defining the support of the quality functions of M.A.712(b). The aircraft base, scheduled line maintenance and engine maintenance contracts, together with all amendments, shall be approved by the competent authority. However, in the case of:	All maintenance for the aircraft was contracted to the Maintenance Provider via contract reference 'The Maintenance & Assistance Agreement EU-OPS 1, Edition 1 Revision 2' dated April 2009. **Refer to Non-compliances 1, 2, 3 and 4.**
1. An aircraft requiring unscheduled line maintenance, the contract may be in the form of individual work orders addressed to the Part-145 maintenance organisation.	All maintenance for the aircraft was contracted to the Maintenance Provider via contract reference 'The Maintenance & Assistance Agreement EU-OPS 1, Edition 1 Revision 2' dated April 2009.

2 Component maintenance, including engine maintenance, the contract as referred to in paragraph (c) may be in the form of individual work orders addressed to the Part-145 maintenance organisation.	Not subject to review.

M.A.709 Documentation	Not subject to review.

M.A.710 Airworthiness Review	Not subject to review.

M.A.711 Privileges of the Organisation	Not subject to review.

M.A.712 Quality System	Not subject to review.

M.A.713 Changes to the Approved Continuing Airworthiness Organisation	Not subject to review.

M.A.714 Record-Keeping	Not subject to review.

M.A.715 Continued Validity of Approval	Not subject to review.

M.A.716 Findings	Not subject to review.

SUBPART H **CERTIFICATE OF RELEASE TO SERVICE – CRS**	*Subpart H does not apply to aircraft released to service by a Part-145 organisation. Compliance therefore with 145.A.50 Certification of Maintenance applies in this case. Please see Part-145.A.50 below.*

SUBPART I **AIRWORTHINESS REVIEW CERTIFICATE**	ARC issued by AESA. This section not subject to review.

PART 145 **SECTION A** **TECHNICAL REQUIREMENTS.**	
145.A.50 Certification of maintenance.	
145.A.50 (a) A certificate of release to service shall be issued by appropriately authorised certifying staff on behalf of the organisation when it has been verified that all maintenance ordered has been properly carried out by the organisation in accordance with the procedures specified in point 145.A.70, taking into account the availability and use of the maintenance data specified in point 145.A.45 and that there are no non-compliances which are known to endanger flight safety.	**Non-compliance No. 1** The reconfiguration of the aircraft was performed by unauthorised personnel without reference to approved data and was not recorded or certified. **Non-compliance No. 2** There was a pre-existing engine defect at the time of the accident which was not recorded, rectified or deferred. **Non-compliance No. 3** The aircraft passenger seat arrangement was not configured in accordance with the Operator's OM Part B, Section 1.1(b).
145.A.50 (b) A certificate of release to service shall be issued before flight at the completion of any maintenance.	**Refer to Non-compliances 1, 2 and 3.**
145.A.50 (c) New defects or incomplete maintenance work orders identified during the above maintenance shall be brought to the attention of the aircraft operator for the specific purpose of obtaining agreement to rectify such defects or completing the missing elements of the maintenance work order. In the case where the aircraft operator declines to have such maintenance carried out under this paragraph, paragraph (e) is applicable.	**Refer to Non-compliances 1, 2 and 3.**

145.A.50 (d) A certificate of release to service shall be issued at the completion of any maintenance on a component whilst off the aircraft. The authorised release certificate 'EASA Form 1' referred to in Appendix II to Annex I (Part-M) constitutes the component certificate of release to service. When an organisation maintains a component for its own use, an EASA Form 1 may not be necessary depending upon the organisation's internal release procedures defined in the exposition.	Not subject to review.
145.A.50 (e) By derogation to paragraph (a), when the organisation is unable to complete all maintenance ordered, it may issue a certificate of release to service within the approved aircraft limitations. The organisation shall enter such fact in the aircraft certificate of release to service before the issue of such certificate.	Not subject to review.

145.A.75 Privileges of the organisation.	
In accordance with the exposition, the organisation shall be entitled to carry out the following tasks:	
145.A.75 (a) Maintain any aircraft and/or component for which it is approved at the locations identified in the approval certificate and in the exposition;	**Refer to non-compliance No. 14**
145.A.75 (b). Arrange for maintenance of any aircraft or component for which it is approved at another organisation that is working under the quality system of the organisation. This refers to work being carried out by an organisation not itself appropriately approved to carry out such maintenance under this Part and is limited to the work scope permitted under 145.A.65(b) procedures. This work scope shall not include a base maintenance check of an aircraft or a complete workshop maintenance check or overhaul of an engine or engine module;	Not subject to review.

145.A.75 (c). Maintain any aircraft or any component for which it is approved at any location subject to the need for such maintenance arising either from the unserviceability of the aircraft or from the necessity of supporting occasional line maintenance, subject to the conditions specified in the exposition;	**Refer to non-compliance No. 14**
145.A.75 (d). Maintain any aircraft and/or component for which it is approved at a location identified as a line maintenance location capable of supporting minor maintenance and only if the organisation exposition both permits such activity and lists such locations;	**Non-compliance No. 14** The Operator in conjunction with its contracted maintenance provider did not establish a line maintenance facility in the Isle of Man, UK or Ireland to support scheduled line maintenance.
145.A.75 (e). Issue certificates of release to service in respect of completion of maintenance in accordance with 145.A.50.	Refer to Part-145.A.50.

Table No. 2 - Summary of areas of Non-compliance

The following Table consolidates the areas of the Operator's non-compliance with the requirements of Part M based on the evidence available and lists them as findings.

PART M SECTION A TECHNICAL REQUIREMENTS		
No.	**Operator Non-Compliances.**	**M.A. Reference**
1.	The reconfiguration of the aircraft was performed by unauthorised personnel without reference to approved data and was not recorded or certified.	**M.A.201(a)** **M.A.201(c)** **M.A.305** **M.A.402(a)** **M.A.708** **145.A.50**
2.	There was a pre-existing engine defect at the time of the accident which was not recorded, rectified or deferred.	**M.A.201(a)** **M.A.301.2** **M.A.305** **M.A.403(a)** **M.A.708** **145.A.50**
3.	The aircraft passenger seat arrangement was not configured in accordance with the Operator's OM Part B, Section 1.1(b).	**M.A.201(a)** **M.A.301.2** **M.A.403** **M.A.708** **145.A.50**
4.	The Operator did not fulfil its responsibility to ensure that the aircraft was maintained in an airworthy condition.	**M.A.201(a)** **M.A.708**
5.	The Operator did not ensure that all pre-flight inspections were recorded appropriately.	**M.A.201(d)** **M.A.305**
6.	The Operator's pre-flight inspection did not contain the following items required by AMC M.A.301.1; An inspection of the aircraft and its emergency equipment for condition including, in particular, any obvious signs of wear, damage or leakage. In addition, the presence of all required equipment including emergency equipment should be established.	**M.A.301.1**

	An inspection of the aircraft continuing airworthiness record system or the operators technical log as applicable to ensure that the intended flight is not adversely affected by any outstanding deferred defects and that no required maintenance action shown in the maintenance statement is overdue or will become due during the flight. A control that consumable fluids, gases etc. uplifted prior to flight are of the correct specification, free from contamination and correctly recorded.	
7	It could not be established that data approved by the Agency or by an approved Part-21 design organisation was available to support the regular reconfiguration of the aircraft from passenger to cargo operations and vice versa.	**M.A.304** **M.A.401(b)**
8.	The layout and content of the Technical Log did not contain the following items required by AMC M.A.306(a); There is no provision for the commander to date and sign the entry of aircraft defects. The technical log page is not divided to show clearly what is required to be completed after flight and what is to be completed in preparation for the next flight.	**M.A.306(a)**
9.	There were no maintenance entries or aircraft defects, nor was the nil defect state required for the continuity of the record, entered or recorded in the Technical Log of EC-ITP from 9th November 2010 until 10th February 2011.	**M.A.305** **M.A.306(a)**
10.	The current maintenance statement for the complete aircraft was not located in the Technical Log or the aircraft documentation folder and was not located on the aircraft.	**M.A.305** **M.A.306(a)**
11.	The current hold item list (HIL) [list of deferred defects] was not located in the Technical Log or the aircraft documentation folder and was not found located on the aircraft.	**M.A.306(a)**
12.	The aircraft technical log did not contain any necessary guidance instructions on maintenance support arrangements for each aircraft.	**M.A.306(a)**

13.	The CAME was found to have the following discrepancies: CAME Section 0.2 does not describe the type of operation and makes no reference to the operation of the SA-227 aircraft in the Isle of Man, UK and Ireland. Section 5.4 does not list contracted Part-145 maintenance organisations. There is no list of approved maintenance programmes contained in the CAME.	**M.A.704(a)**
14.	The Operator in conjunction with its contracted maintenance provider did not establish a line maintenance facility in the Isle of Man, UK or Ireland to support scheduled line maintenance.	**145.A.75**

Appendix D

Engine Ground Run Worksheet, 31 August 2010

SA227 AC,BC

FAIRCHILD
AIRCRAFT

PHASE INSPECTION MANUAL

ENGINE GROUND RUN WORKSHEET

P/L SPLIT, DRY TAKE OFF POWER, BLEED AIR OFF

NOTE: Temperature required to reach a specified chart torque is the referenced EGT.

Step changes in referenced EGT indicates possible problems with the engine or indicating system and the need for maintenance action.

REFERENCED OAT 22 PRESSURE ALTITUDE 140

1. CHART TORQUE____
2. S/L - HIGH
3. P/L - STABILIZE TO POWER

   L ENG .... EGT 660 %TQ 100 %RPM 100 FF(PPH) 540

   R ENG .... EGT 640 %TQ 100 %RPM 100 FF(PPH) 550

4. SEPARATION AT TO SETTING - 0.05 ...... YES ✓ NO___
   INCH MAX (Determined at pedestal cover)

P/L SPLIT, DRY TAKE OFF POWER, BLEED AIR ON

1. CHART TORQUE____
2. S/L - HIGH
3. P/L - STABILIZED TO POWER

   L ENG .... EGT 630 %TQ 100 %RPM 100 FF(PPH) 550

   R ENG .... EGT 650 %TQ 100 %RPM 100 FF(PPH) 560

4. SEPARATION AT TO SETTING - 0.05 ...... YES ✓ NO___
   INCH MAX (Determined at pedestal cover)
5. CALCULATE TORQUE LOSS
6. REPEAT WITH S/L @ 97% AND
   EGT @ 650°C

   L ENG .... 650°C EGT %TQ / 97%RPM FF(PPH) /

   R ENG .... 650°C EGT %TQ / 97%RPM FF(PPH) /

7. SEPARATION WITHIN 0.05 INCH .... YES___ NO___
   @ CRUISE RPM (Determined at pedestal cover)

EFFECTIVITY:
AC 420-999
BC 762-999

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Appendix E

Phase maintenance carried out on 5 February 2011

BCP AEROTECNICS

EASA PART 145.ES.171

WORK ORDER

N° L-012-11

SUPERVISOR: (SIGN & STAMP)	Name Removed	START DATE	05/02/2011
		END DATE	05/02/2011
		CUSTOMER W.O.	1315

AC MODEL	SA227	AC S/N	BC789	AC TT	32632,3	AC TTC	34137
ENG MODEL	TPE331-12UHR-701G	ENG1 S/N	P70204	ENG1 TT		ENG1 TTC	
AC REG	EC-ITP	ENG2 S/N	P70189	ENG2 TT		ENG2 TTC	

WORK ORDER PROJECT LIST

SEC N°	PROJECT N°	CODE	DESCRIPTION	PERF Y/N TECH
1	I-001		PERFORM SERVICE CHECK	CB
2	I-002		PERFORM SOAP TEST LH & RH	QC
3	I-003		REPLACE PRESSURIZATION CONTROLLER EXTERNAL FILTER	JP
4	I-004		REPLACE PRESSURIZATION CONTROLLER INTERNAL FILTER	JP
5	I-005		REPLACE OUTFLOW VALVE FILTER	JP
6	I-006		PERFORM PITCH TRIM ACTUATOR, TRAVEL TIME CHECK	CB
7	I-007		PERFORM SAS VISUAL INSPECTION (250h)	JP
8	I-008		INSPECT STARTER GENERATOR DRIVE LH&RH	QC
9	I-009		INSPECT BATTERY RELAY AND WIRE TERMINATIONS LH&RH	JP
10	I-010		INSPECT EMERGENCY RELEASE CABLE LH & RH SIDE	JP
11	I-011		PERFORM PLENUM DRAIN VALVES INSP. 600h RH&LH	QC
12	I-012		PERFORM ST-UN-M001, 1-3 LOWER AFT CORNER	QC
13	I-013		PERFORM ST-UN-M001, 2-2	QC
14	I-014		PERFORM ST-UN-M001,6-3 OUTSIDE AIRCRAFT BELOW CARGO DOOR	QC
15	I-015		PERFORM EGT COMPENSATING RESISTOR TEST	QC
16	D-001		SOME LAMPS FUSED ON CWP	CB
17	D-002		RH RECOGNITION LAMP FUSED	CB

Appendix F

Actual and Forecast Meteorological Reports for Irish airports about the time of the accident

Kerry Airport (EIKY)

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METAR
EIKY 10 0850Z VRB03KT 9999 FEW031 03/03 Q1010=
EIKY 10 0920Z 09008KT 9999 FEW028 05/05 Q1010=
EIKY 10 1020Z 11007KT 080V140 9999 FEW026 07/06 Q1010=

TAF
valid 100500/101400
VRB03KT BECMG 0810 11005KT BECMG 1012 13010KT 9999
TEMPO 0510 3000 PROB40 TEMPO 0510 0500 NSW TEMPO 0510 BR PROB40 TEMPO
0510 FG FEW/SCT020 SCT/BKN040 TEMPO 0510 SCT005 PROB40 TEMPO 0510
BKN001
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Waterford Airport (EIWF)

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METAR
EIWF 100800Z 00000KT 9000 MIFG SKC 03/03 Q1011=
EIWF 100900Z 00000KT 1100 BR SKC 05/04 Q1011=

TAF
valid 100500/101400
360/05KT BECMG 0709 04005KT BECMG 1012 10010KT 9999 TEMPO 0510 4000
NSW TEMPO 0510 BR SCT010 BKN020 TEMPO 0510 BKN007 TEMPO 1315 BKN010
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Shannon Airport (EINN)

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METAR
EINN 100830Z 04005KT 0300 R24/0700D R06/0400D FG VV001 03/03 Q1011
NOSIG
EINN 100900Z 03003KT 0300 R24/0400D R06/0300U FG VV001 02/02 Q1011
NOSIG
EINN 100930Z 04002KT 0300 R24/0300N R06/0325N FG VV001 03/03 Q1011
NOSIG
EINN 101000Z 01004KT 0300 R24/0300N R06/0325N FG VV001 03/03 Q1011
NOSIG

TAF
issued at 0500Z valid 100500Z 1006/1106
VRB03KT 0200 FG OVC001 BECMG 1008/1010 09005KT 3000 BR SCT003 BECMG
1010/1012 9999 FEW020 SCT040 BECMG 1013/1015 11011KT TEMPO 1015/1020
SCT010 BKN015 BECMG 1022/1101 15009KT SCT010 BKN015 TEMPO 1101/1106
5000 -RADZ BR BKN008=

TAF amended at 0922 UTC as follows:
TAF AMD EINN 100922UTC 1009/1106 VRB03KT 0200 FG OVC001 BECMG
1010/1012 3000 BR BKN005 BECMG 1012/1014 9999 SCT020 BECMG 1013/1015
11011KT TEMPO 1015/1020 SCT010 BKN015 BECMG 1022/1101 15009KT SCT010
BKN015 TEMPO 1101/1106 5000 -RADZ BR BKN008=
```

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Dublin Airport (EIDW)

METAR
EIDW 100830Z 27004KT 9999 FEW014 BKN029 04/04 Q1011 NOSIG=
EIDW 100900Z VRB03KT 0700 R16/0900U R28/P1500 R10/P1500 BCFG FEW002
SCT029 04/04 Q1012 TEMPO 0500=
EIDW 100930Z 00000KT 0900 R16/P1500 R28/P1500 R10/P1500 BCFG FEW002
SCT029 04/04 Q1012 TEMPO 0500=
EIDW 101000Z 36003KT 6000 MIFG FEW003 SCT029 04/04 Q1012 NOSIG=

TAF
issued at 0500Z valid 100500Z 1006/1106
32007KT 9999 SCT015 BKN030 PROB40 TEMPO 1006/1010 3000 BR BKN005
PROB30 TEMPO 1006/1009 0400 FG BKN001 BECMG 1010/1012 36006KT BECMG
1013/1015 11011KT BECMG 1022/1024 15010KT TEMPO 1022/1103 BKN010 BECMG
1103/1106 SCT010 BKN015=

TAF amended at 0946 UTC as follows:
AMD EIDW 0940UTC 1009/1106 VRB03KT 5000 BR BKN020 TEMPO 1009/1012 0800
FG BECMG 1011/1014 9999 BECMG 1015/1018 11011KT BECMG 1022/1024
15010KT TEMPO 1022/1103 BKN010 BECMG 1103/1106 SCT010 BKN015=
```

Abbreviations used in above METAR and TAF Reports:

AMD	Amended	P1500	Greater than 1500 m visibility
BECMG	Becoming	PROB40	Probable change (e.g. 40%)
BCFG	Fog patches	Q1010	QNH (e.g. 1010 hPa)
BKN	Broken (cloud cover)	R24	Runway (e.g. 24)
BR	Mist	-RADZ	Light rain and drizzle
D	Downward trend in IRVR	SCT	Scattered (cloud cover)
FEW	Few (cloud cover)	SKC	Sky Clear
FG	Fog	TEMPO	Temporary change
KT	Knots	U	Upward trend in IRVR
MIFG	Shallow fog	V	Varying between (wind)
N	No trend in IRVR	VRB	Variable (wind)
NOSIG	No significant change	VV001	Vertical visibility (e.g. 100ft)
NSW	No significant weather	Z	Time (UTC)
OVC	Overcast (cloud cover)		

Appendix G

ATC Transcripts

Certified Transcript of Shannon Control (124.650 MHz) on 10 February 2011 (Low Level Radar 2 position)

Time:	Station:	Transmission:
08.34:12	Shannon	*RYR5MH continue descent to Shannon Transition Flight Level 65*
	RYR5MH	*Continue descent RYR5MH*
	Shannon	*Affirm FL65 RYR5MH*
	RYR5MH	*FL65 RYR5MH*
	FLT400C	*Shannon good morning the FLT400C maintaining FL120 inbound TISMO*
	Shannon	*FLT400C good morning – identified*
08.34:45	Shannon	*FLT400C TISMO 1G arrival Runway 35 Cork*
	FLT400C	*TISMO 1G arrival for Runway 35 thank you 400C*
08.47:51	Shannon	*FLT400C contact Cork Approach 119.9, you're released to Cork for descent, good morning*
	FLT400C	*119.9 thank you very much, talk to you later (???) bye*

Certified Transcript of Cork Approach (119.900 MHz) on 10 February 2011

Time:	Station:	Transmission:
08.48:05	FLT400C	*Cork, good morning this is Flightavia 400C, we're maintaining 120 inbound TISMO, standing by for descent*
08.48:13	Approach	*Flightavia 400C good morning, radar identified and I have the latest weather conditions, ready to copy?*
08.48:19	FLT400C	*Affirm Sir*
08.48:20	Approach	*OK, surface wind 080 degrees, 4 knots. Runway 35 is the active runway, with CAT II available for runway 17. The latest IRVR's on runway 17 are showing 300 metres, midpoint 350, stop-end 550 and advise your choice of runway*
08.48:43	FLT400C	*Standby, 400C, do you confirm that IRVR of the runway 35 is 300 metre?*
08.48:51	Approach	*OK, on 35 the IRVR's are five fifty on touchdown, that's five five zero, midpoint 350 and stop-end three zero zero runway 35*
08.49:10	FLT400C	*OK, with this visibility for us it would be better to take runway 35 please*
08.49:20	Approach	*400C that's copied, route direct to ATLAM, expect vector ILS approach runway 35 descend flight level 80*

08.49:30	FLT400C	*To ALTAM descending 80 for the runway 35, Flightavia 400C*
08.50:16	FLT400C	*Approach Flightavia 400C, my mistake, is possible runway 17?*
08.50:28	Approach	*400C, that's copied, just check IRVR's runway 17 for CAT II, currently at 350, 350 and 450*
08.50:42	FLT400C	*OK, anyway we request if possible runway 17 please*
08.50:47	Approach	*400C that's copied, route direct to BARNU, make a right turn, route direct to BARNU*
08.50:50	FLT400C	*Right to BARNU, Flightavia 400C, thank you*
08.52:00	Approach	*Flightavia 400C descend altitude 4,000 feet QNH 1010*
08.52:06	FLT400C	*4,000, 1010, 400C*
08.54:15	Approach	*Flightavia 400C descend altitude 3,000 feet QNH 1010*
08.54:21	FLT400C	*3,000, 1010, 400C*
08.56:36	Approach	*Latest IRVR check runway 17, touchdown 300 metres, mid point 375, stop-end 400 metres*
08.56:48	FLT400C	*All copied, thank you, 400C*
08.57:06	Approach	*400C turn left heading 200, establish ILS, cleared approach, call established 17*
08.57:12	FLT400C	*200, will call back established runway 17, 400C*
08.58:29	FLT400C	*Established 17, 400C*
08.58:33	Approach	*Flightavia 400C, roger, cleared for the approach, number one, contact tower 119.3*
08.59:02	FLT400C	*Tower good morning Flightavia 400C we're established ILS runway 17*
08.59:10	Tower	*Flightavia 400C Cork Tower good morning, cleared to land runway 17, the wind is 080 degrees at 4 knots*
08.59:16	FLT400C	*Cleared to land, Flightavia 400C*
09.00:40	Tower	*Touchdown RVR's 300, mid point 400, stop-end is 375, wind is calm*
09.03:10	FLT400C	*Go-around 400C*
09.03:14	Tower	*Roger, 070, 3 knots, straight ahead 3,000 feet*
09.03:32	Tower	*Flightavia 400C Approach Director 119.9*
09.03:37	FLT400C	*All copied 400C, excuse me, any possibility to proceed to ATLAM for approach and runway 35, and maybe on the other side the sun is not shining on us*
09.03:54	Tower	*OK Sir, you can route to ATLAM and Approach 119.9, you can expect landing runway 35*
09.03:59	FLT400C	*OK, we proceed to ATLAM and we can expect runway now 35, thanks a lot 400C*
09.04:51	Tower	*Flightavia 400C Approach 119.9 please*
09.04:56	FLT400C	*Say again, sorry*
09.04:58	Tower	*Flightavia 400C Approach 119.9 please*
09.05:01	FLT400C	*119.9 Approach, thank you very much 400C*

09.05:09	FLT400C	*Approach hello again, this is 400C, we perform a missed approach, we proceeding to ATLAM*
09.05:18	Approach	*Flightavia 400C good morning you're identified again, QNH is 1010 hectoPascals, maintain 3,000 feet*
09.05:26	FLT400C	*3,000 feet, 1010, proceed to ATLAM and request please, vectors to perform approach to runway 35 please*
09.05:37	Approach	*400C roger, report you heading*
09.05:40	FLT400C	*Our heading now is 170*
09.05:43	Approach	*Roger, turn right heading 185, vectors for 35*
09.05:48	FLT400C	*185, vectors for 35, 400C*
09.05:52	Approach	*Affirm*
09.06:51	Approach	*Flightavia 400C, 12 miles south of the field now, make a left turn to radar heading 050 degrees*
09.07:01	FLT400C	*Left 050, Flightavia 400C*
09.07:06	Approach	*Affirm*
09.08:01	Approach	*Flightavia 400C continue left 020, intercept the localiser, cleared ILS approach runway 35*
09.08:10	FLT400C	*020, close the localiser from the left and clear ILS runway 35, 400C*
09.08:16	Approach	*Affirm*
09.09:01	Approach	*400C, if you need it, continue left heading 320 to intercept*
09.09:07	FLT400C	*All copied, no problem, thank you 400C*
09.10:45	Approach	*Flightavia 400C 8 miles from touchdown, cleared for the approach, contact Tower 119.3*
09.10:51	FLT400C	*119.3, thanks a lot 400C*
09.10:56	FLT400C	*Tower good morning again, 400C we're on the ILS established, 5 miles to run*
09.11:03	Tower	*Flightavia 400C good morning to you, you are cleared to land, wind is calm, RVR's all showing 350 meters*
09.11:11	FLT400C	*OK we're cleared to land runway 35, 400C*
09.14:15	FLT400C	*Go-around 300C*
09.14:19	Tower	*Flightavia 400C roger straight ahead 3,000 feet 1010*
09.14:24	FLT400C	*3,000 feet 1010, 300C*
09.14:28	Tower	*400C, Approach Director 119.9*
09.14:32	FLT400C	*119.9 thanks for your help 400C*
09.15:01	FLT400C	*Approach good afternoon, good morning again this is 400C going-around from Cork*
09.15:08	Approach	*Flightavia 400C roger, hello again, you're identified QNH 1010, maintain 3,000 feet on reaching*
09.15:15	FLT400C	*3,000 on 1010, and we would like to hold maybe 15, 20 minutes to try to see if the weather is improving at Cork*
09.15:30	Approach	*Flightavia 400C that's copied, cleared to ROVAL, to enter the ROVAL hold*
09.15:35	FLT400C	*To ROVAL and the ROVAL hold, 400C*

09.21:22	Approach	*Flightavia 400C Cork, confirm alternate airport is Waterford?*
09.24:45	FLT400C	*Cork approach this is Flightavia 400C*
09.24:50	Approach	*Flightavia 400C, Cork*
09.24:52	FLT400C	*Yes…Flightavia 400C, I think before you cannot listen in...just…there's any chance to, to get the weather of Waterford*
09.25:02	Approach	*Affirm sir, just confirm Waterford is your alternate?*
09.25:07	FLT400C	*Yes Sir, that's our alternative, is possible to get the last weather report from Waterford?*
09.25:14	Approach	*Wilco, listen out*
09.25:16	FLT400C	*Thank you*
09.26:19	Approach	*Flightavia 400C Cork, I have the Waterford weather if you're ready*
09.26:24	FLT400C	*Ready to copy Sir*
09.26:26	Approach	*Roger, surface wind is calm, visibility 300 metres, in fog, sky is clear, temperature plus 05, dew point plus 04, QNH 1011 hectoPascals*
09.26:42	FLT400C	*OK, with this, the weather is copied, with this weather, in that case we shall proceed to our second alternative, ah that is Shannon*
09.26:57	Approach	*400C roger. Are you ready to go now or would you like to check the weather first?*
09.27:02	FLT400C	*Check the weather please, you can check the, get the weather information please from Shannon*
09.27:07	Approach	*Wilco, listen out*
09.27:09	FLT400C	*Thanks a lot*
09.28:15	Approach	*Flightavia 400C have the Shannon weather if you're ready to copy*
09.28:20	FLT400C	*Ready to copy Sir*
09.28:21	Approach	*Surface wind is calm, visibility 300 metres in fog. Vertical visibility 100 feet, temperature plus 02, dew point plus 02 QNH 1011 hectoPascals. IRVR ah, is 300 metres at Shannon*
09.28:43	FLT400C	*It's the same weather as Waterford so not very nice thank you and please is possible to get the last weather of Dublin, hopefully maybe is better?*
09.28:54	Approach	*OK we'll check Dublin and Kerry Airport as well, just about 40 miles to your west, we could check there as well*
09.29:02	FLT400C	*Yes please, if it's possible*
09.29:06	Approach	*Wilco*
09.29:07	FLT400C	*Thanks a lot*
09.30:22	Approach	*Flightavia 400C I have the weather for Kerry if you're ready to copy*

09.30:28	FLT400C	*Copy Kerry, 400C*
09.30:30	Approach	*Roger surface wind 070 degrees, 6 knots, visibility is greater than 10 kilometres, cloud Few 3,000 feet, temperature plus 05, dew point plus 05, QNH 1010 hectoPascals*
09.30:50	FLT400C	*OK Sir, visibility 10 kilometres, Few 3,000 and 1010, that's much better, thanks, and also do you have Dublin?*
09.31:00	Approach	*Just checking Dublin now, I'll call you back*
09.31:03	FLT400C	*OK, thanks a lot*
09.32:55	[Callsign #]	*Cork approach, good morning* [Callsign #]
09.32:59	Approach	[Callsign #]*, Cork approach*
09.33:01	[Callsign #]	*Roger, just over Strumble at the moment, working London, what's the wind and RVR at the moment in Cork?*
09.33:06	Approach	*Surface wind 090, 7 knots, visibility 300 metres in fog, Broken 100 feet, IRVR's runway 17 now at 400 metres all round*
09.33:23	[Callsign #]	*That's all understood, and does it look like there's any improvement on the way or is it well down?*
09.33:27	Approach	*There is just a very slight improvement in the last couple of minutes from about 325 metres up to 400, but it seems to be holding at that now again*
09.33:36	[Callsign #]	*OK, and last question, have you had any recent arrivals on 17?*
09.33:40	Approach	*No arrivals, I have one aircraft holding at ROVAL at the moment, he's been holding for 10 minutes or so at this stage*
09.33:47	[Callsign #]	*OK, we'll talk to you on the handover, thanks* [Callsign #]
09.33:49	Approach	*OK*
09.34:25	Approach	*Flightavia 400C, have the Dublin weather now if you're ready*
09.34:29	FLT400C	*Ready to copy Sir*
09.34:30	Approach	*Surface wind is calm, visibility is 900 metres in fog patches, cloud Few 200 feet, Broken 2,900 feet, temperature plus 4, dew point plus 4, QNH 1012 hectoPascals, trend, tempo visibility 500 metres*
09.34:57	FLT400C	*All copied, and thank you very much, and ah you say before that, the weather is it improving in Cork?*
09.35:06	Approach	*Just a slight improvement here now, the IRVR's are at 400 metres all round*
09.35:14	FLT400C	*OK in that case we'll continue holding for a little bit more and hopefully become better*
09.35:21	Approach	*OK, just another little improvement now at runway 17 touchdown zone at 450, mid point 400, stop-end 400*
09.35:31	FLT400C	*All copied, in that case we'll hold a little bit more and hopefully expect it to improve a little bit more thank you*

09.35:37	Approach	*Roger, we'll keep you advised*
09.39:51	Approach	*Flightavia 400C Cork, another improvement now in the IRVR runway 17 touchdown zone 500 metres, midpoint 450, stop-end 400*
09.40:05	FLT400C	*OK in that case we'll proceed, and do you confirm that is for the runway 17?*
09.40:11	Approach	*Affirm Sir runway 17 touchdown zone 500 metres*
09.40:15	FLT400C	*OK in that case… any chance to proceed to vectors to perform one approach there?*
09.40:23	Approach	*400C affirm no problem, you can turn left please heading 300*
09.40:30	FLT400C	*Left heading 300 Flightavia 400C. Affirm, expect a right hand pattern then for runway 17, joining finals at about 12 miles or so*
09.40:40	FLT400C	*OK right pattern, no problem 400C*
09.41:36	Approach	*Flightavia 400C, you can make a right turn now to heading 110 degrees*
09.41:44	FLT400C	*Right turn heading 110 degrees, Flightavia 400C*
09.41:48	Approach	*Affirm*
09.43:36	Approach	*Flightavia 400C, turn right heading 140, intercept the localiser, cleared ILS approach runway 17*
09.43:43	FLT400C	*140, and clear localiser for runway 17, 400C*
09.45:22	FLT400C	*Flightavia 400C established runway 17*
09.45:26	Approach	*Flightavia 400C roger cleared for the approach, you're 11 miles from touchdown, IRVR now runway 17 touchdown zone at 550 metres*
09.45:34	FLT400C	*That sounds great thank you Flightavia 400C*
09.45:38	Approach	*400C roger, contact Tower 119.3, goodbye*
09.45:41	FLT400C	*119.3, talk to you later, thanks very much for your help*
09.46:00	FLT400C	*Tower good morning again, this is Flightavia 400C, we're established 9 miles inbound*
09.46:05	Tower	*Flightavia 400C good morning to you again, you are cleared to land runway 17, the wind is 090 degrees, niner knots*
09.46:12	FLT400C	*Cleared to land 17, Flightavia 400C*
09.46:15	Tower	*Touchdown RVRs 500 mid point 400 stop-end 400*
09.46:20	FLT400C	*Copied thank you very much*
09.48:21	Tower	*090 degrees, niner knots*
09.48:24	FLT400C	*Copied, thank you*
09.50:39	Tower	[ELT audible in background] *Flightavia 400C*
09.50:43	Tower	*Flightavia 400C*
09.50:49	Tower	*Flightavia 400C*
		[End of Transcript]

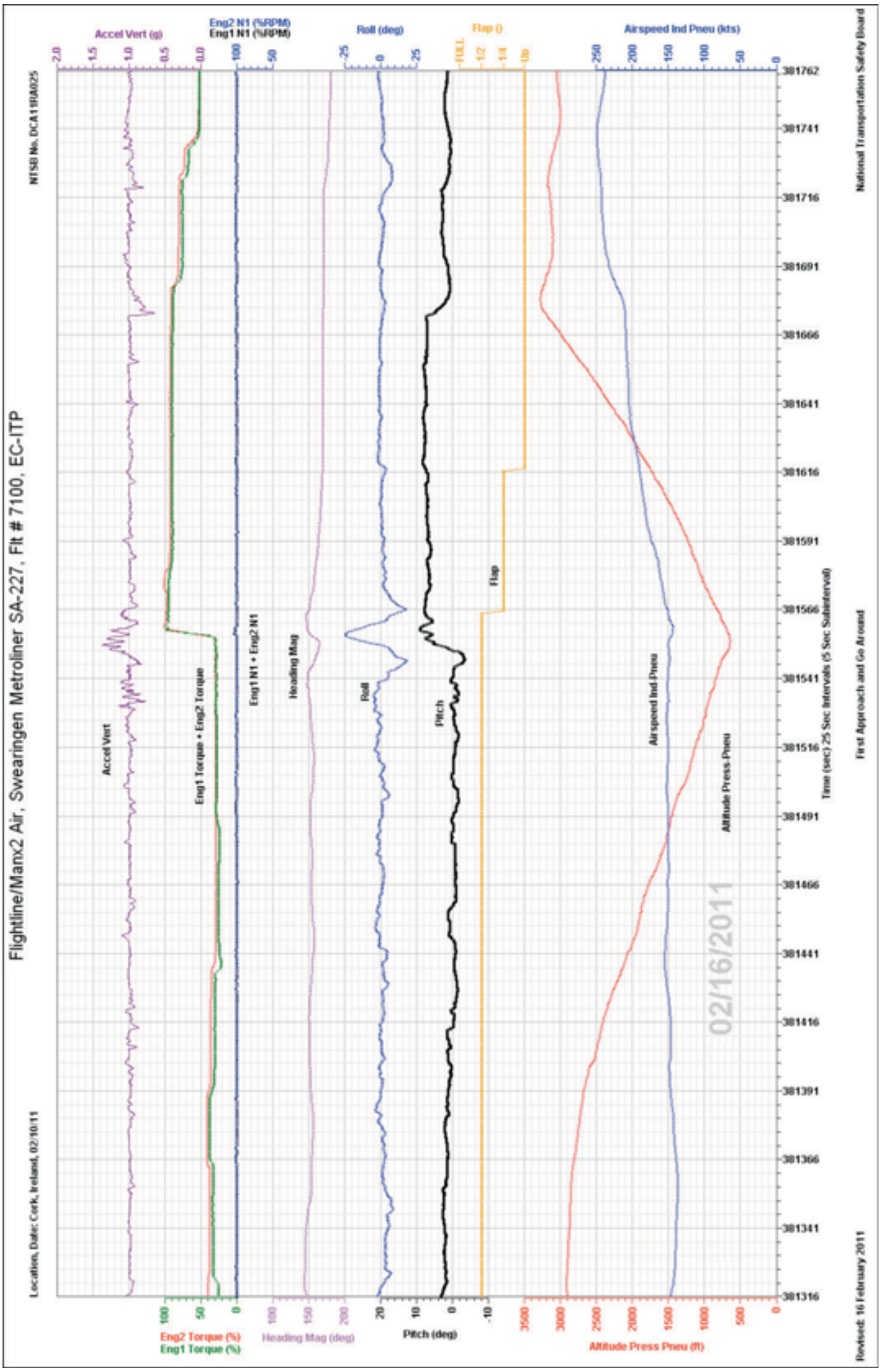
Certified Transcript of Cork Ground (121.850 MHz)
on 10 February 2011

Time:	Station:	Transmission:
09.51:36	Ground	*Flightavia 400C Ground, you on frequency?*
09.52:14	AFO	*Ground, AFO at the station*
09.52:18	Ground	*AFO, Ground*
09.52:19	AFO	*Ground AFO, turning out from the station area, any other information?*
09.52:24	Ground	*AFO, we have no contact with the aircraft, we suspect it has crashed on landing, unsure of the position [ELT sounding in the background] proceed unrestricted onto Taxiway Alpha out on to 17-35*
09.52:33	AFO	*That's copied Ground, and have you any information on the aircraft type please?* [no response on Mains Comms or RBS]
09.53:18	AFO	*That's copied*
09.53:21	AFO	*Ground AFO*
09.53:23	Ground	*AFO Ground*
09.53:24	AFO	*Confirm crash, crash, crash, I repeat, crash, crash, crash, just the western side of 17, there is a fire, I repeat there is a fire*
09.53:36	Ground	*AFO that's copied, thank you*
09.53:43	Rescue 4	*Ground Rescue 4 request permission to cross the red line to the site via Charlie*
09.53:48	Ground	*Rescue 4 proceed unrestricted*
09.53:51	Rescue 4	*Rescue 4 proceeding*
09.53:59	Ground	*AFO Ground*
09.54:05	AFO	*AFO Ground, go ahead*
09.54:07	Ground	*AFO ten passengers, two crew, total twelve*
09.54:11	AFO	*Two, twelve, that's copied*
09.55:25	AFO	*Ground, AFO*
09.55:27	Ground	*AFO Ground*
09.55:29	AFO	*Fire and Rescue operations under way at this time, the fire crew are dealing with an external fire*
09.55:47	Ground	*AFO Ground*
09.55:49	AFO	*AFO, go ahead*
09.55:50	Ground	*Roger, do you need external assistance?*
09.55:52	AFO	*Affirm Ground, affirm, the watchroom has initiated that to the external services*
09.55:58	Ground	*That's copied, thank you*
09.57:03	Police 1	*Ground, Police 1*
09.57:06	Ground	*Police 1, Ground*
09.57:07	Police 1	*Ground, can I have permission to go to the site via Charlie please?*
09.57:11	Ground	*Affirm Police 1, proceed via Charlie, 17-35*

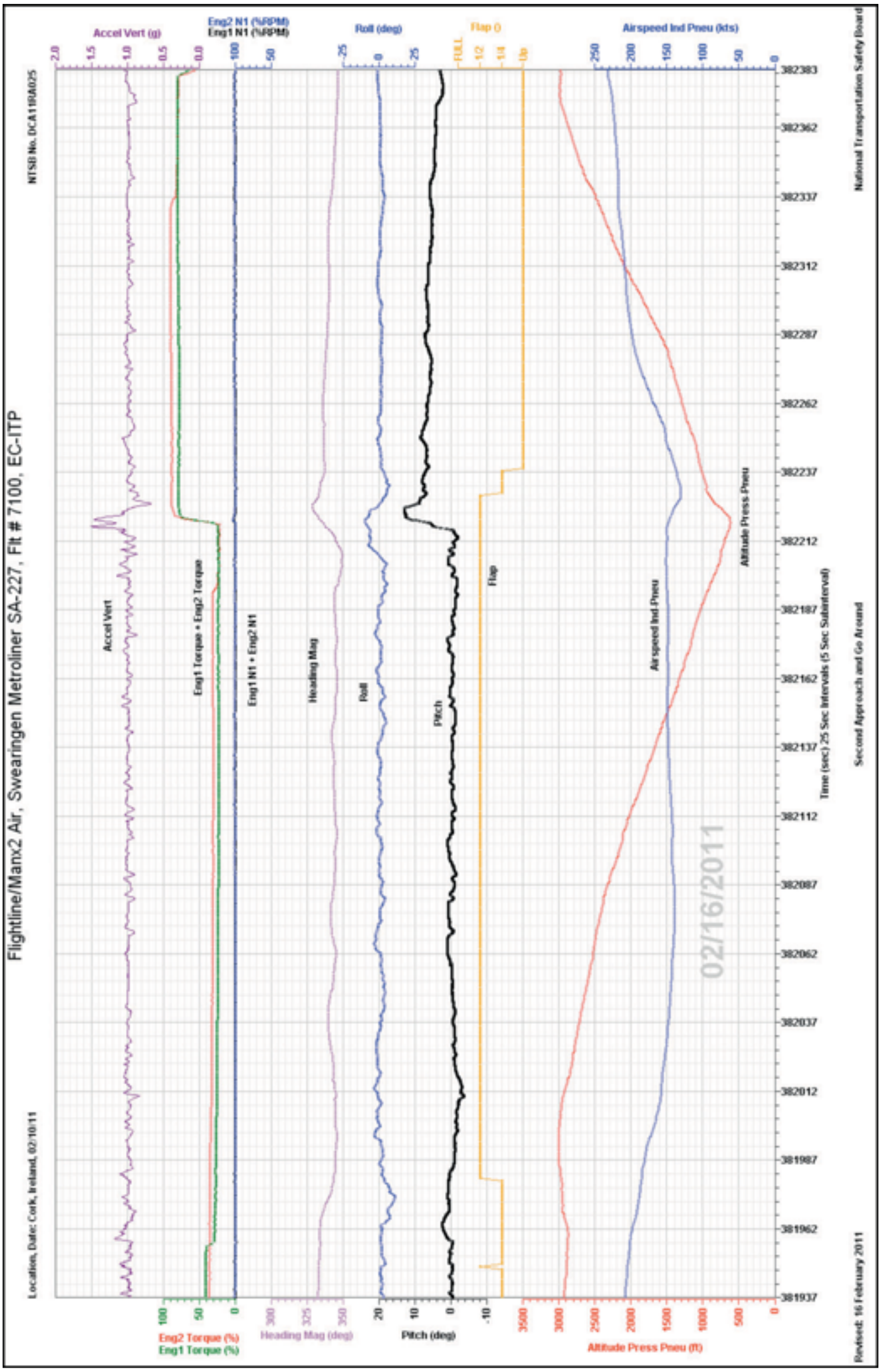
09.57:15	Police 1	*Proceeding via Charlie on to 17-35*
09.57:20	Police 2	*Tower, Police 2 proceeding with Police 1*
09.57:22	Ground	*Police 2 roger, thank you*
09.57:43	AFO	*Ground AFO*
09.57:44	Ground	*AFO Ground*
09.57:47	AFO	*For information, there is some debris on the runway between Taxiway Alpha and the crash site*
09.57:57	Ground	*AFO that's copied, and can you give us the location of the crash site since we can't see it from the tower*
09.58:02	AFO	*It's immediately opposite Taxiway Charlie*
09.58:07	Ground	*That's understood, opposite Taxiway Charlie, west side*
09.58:10	AFO	*Affirm*
09.58:37	Police 1	*Ground Police 1 returning to the Station to get some equipment*
09.58:41	Ground	*Police 1 Ground roger*
09.59:39	AFO	*Ground AFO*
09.59:42	Ground	*AFO Ground*
09.59:43	AFO	*For information, external fire now extinguished and we are now attempting to gain access into the aircraft, and can you confirm again please the souls on board*
09.59:54	Ground	*Total of twelve, ten passengers, two crew*
09.59:58	AFO	*Twelve in total, copy Ground*
10.01:25	Ops 2	*Cork Ground, Operations 2*
10.01:27	Ground	*Operations 2, Ground*
10.01:29	Ops 2	*Cork ground, permission please, permission out to crash zone*
10.01:35	Ground	*Ops 2 Ground, proceed Taxiway Alpha or Charlie as you wish*
10.01:39	Ops 2	*Proceeding onto Taxiway Alpha or Taxiway Charlie as I wish*
10.01:44	AFO	*Ground AFO*
10.01:45	Ground	*AFO Ground*
10.01:47	AFO	*First casualty removed*
10.01:49	Ground	*AFO Ground, that's copied, thank you*
		[End of Transcript]

Appendix H

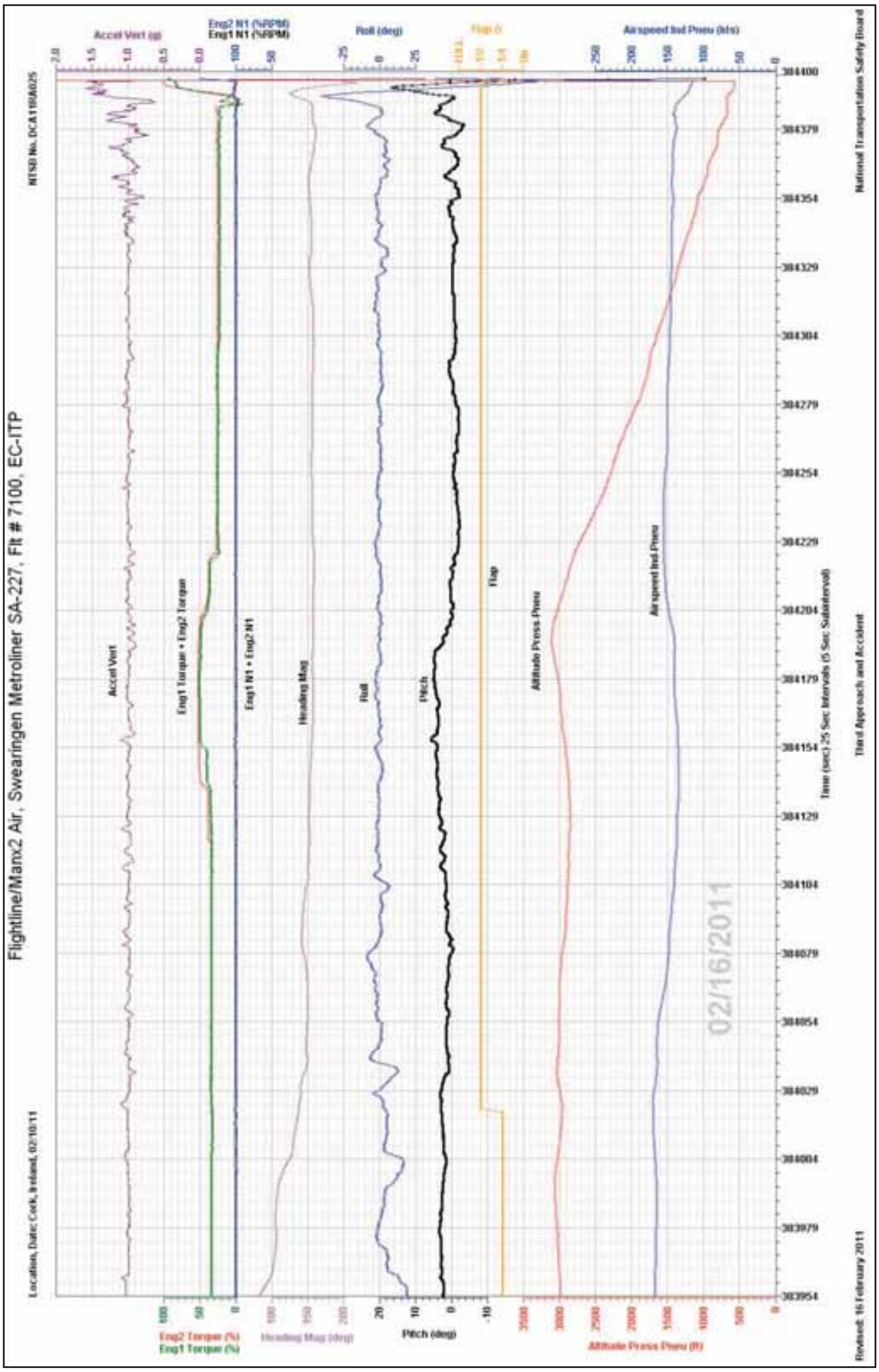
FDR data for first approach and go-around



FDR data for second approach and go-around



FDR data for third approach and impact



Appendix I

Debris Field

Distance from datum point (m)	Offset left/right	Description
0.0	0.0	DATUM REF POINT C/L 195 °M
0.0	0.0	initial wingtip contact
8.4	0.0	impact mark
13.8	0.0	fairing
17.7	0.0	light fragment
19.8	-1.0	1st blade strike
20.3	-1.0	2nd blade strike
20.8	-1.0	3rd blade strike
20.8	1.0	fitting
21.2	-1.0	4th blade strike
22.8	-1.0	5th blade strike
24.5	0.0	engine strike
25.8	-2.5	fuselage impact
27.1	0.0	strobe light
29.5	0.0	metal tag
30.3	0.0	wiper blade
32.8	-2.0	blue paint transfer
32.8	10.0	metal skin
36.5	4.0	tubing
36.5	0.0	metal tag
36.5	-5.0	wiper rubber
36.5	5.2	strip
42.1	-5.0	fragment
42.1	-9.0	fragment
42.1	-13.0	fragment
44.5	3.0	fragment
49.3	0.0	prop boot
52.3	8.0	blue paint transfer
53.5	11.0	fragment
54.0	15.0	fragment
57.3	-5.0	clear plastic
61.1	0.0	prop scraping
66.9	11.0	radome
68.0	10.0	wing fence
71.0	-8.0	wiper part

Distance from datum point (m)	Offset left/right	Description
71.0	0.0	cowling latch
72.5	0.0	fragment
77.0	3.0	fin top fairing
77.5	0.0	fragment
78.1	0.0	wiper
86.2	-2.0	Windscreen part
88.0	-3.0	antenna
90.3	0.0	insulation
94.2	0.0	spinner support
94.3	6.0	fragment
94.4	8.0	wing leading edge
96.0	0.0	wing part
96.0	0.0	outer right wing section
96.0	0.0	wing part
96.0	5.0	door latch
97.0	6.0	wingtip fairing
99.3	0.0	prop hub
99.5	3.0	wingtip fairing
99.6	3.2	static wick
102.0	0.0	fragment
108.5	3.0	wing leading edge
108.5	3.0	prop hub
108.5	1.0	counter balance
109.0	-3.0	radar antenna
115.7	0.0	de-icing part
126.5	0.0	rear spar attach
129.9	0.0	prop hub
132.5	10.0	R prop blade
137.5	7.0	right aileron
140.0	85.0	R prop blade
145.0	8.0	fuel tank
146.0	7.0	navigation antenna (blue)
149.1	23.0	R prop blade
156.0	5.0	wing part
164.9	0.0	extension union
167.5	0.0	tip of fin
169.8	-10.0	checklist
180.4	0.0	Tailcone
189.0	0.0	Fuselage

Appendix J

Summary of Propeller Examination Report

The propellers were crated and sent to the manufacturer McCauley Propeller Systems for detailed examination and disassembly. The examinations were observed by the AAIU with the assistance of the US National Transportation Safety Board Accredited Representative and US Technical Advisors.

The four aluminium blades have a feathered blade angle of +88.5° ±0.2°, a maximum reverse blade angle of -5° (±0.5°) and a start lock blade angle of +6° (±0.2°). The maximum propeller speed (Np) is 1,591 RPM for takeoff and maximum continuous operation. The propeller rotates counter-clockwise, observed from aft looking forward. All directional references to front and rear, right and left, top and bottom, and clockwise and counter-clockwise are made aft looking forward as is the convention. All numbering in the circumferential direction starts with the No. 1 position at the 12 o'clock position, or immediately clockwise from the 12 o'clock position and progresses sequentially clockwise.

On inspection, the serial numbers indicated on the blade identification stickers was at variance with the serial numbers embossed on the blade hubs. The adhesive stickers on the propeller blades reflected the correct hub identification number and blade position number, but had the serial numbers for the blades on the other (right or left) propeller. The propeller components were identified as follows with reference to the serial numbers embossed on the butt of each blade:

Left Propeller		**Right Propeller**	
Propeller Type:	4HFR34C652-EFJ	**Propeller Type:**	4HFR34C652-FGHJ
L Blade Type:	BL106LA-0	**R Blade Type:**	BL106LA-0
Left Hub:	S/N 890763	**Right Hub:**	S/N 900201
Blade No. 1:	S/N MB-065	**Blade No. 1:**	S/N YD31001
Blade No. 2:	S/N JC-085	**Blade No. 2:**	S/N YD31002
Blade No. 3:	S/N JC-132	**Blade No. 3:**	S/N YC31007
Blade No. 4:	S/N JC-137	**Blade No. 4:**	S/N YD31010

<u>Propeller No.1</u> (Left hand side)

Three of the propeller blades were still attached to the hub. The propeller model change letters EFJ were on the hub at the No. 1 blade position and the hub serial number S/N 890763 was found marked between blade sockets 2 and 3. The propeller was identified as Type 4HFR34C652-EFJ, S/N 890763.

The spinner was not attached to the bulkhead but was loose in the shipping container. The spinner at the No. 1 propeller blade location was flattened, exhibited two tears, and was covered with dirt.

The spinner at the No. 2 and No. 3 blade locations were torn at the forward end of the cut-out while the cut-out at the No. 4 blade location was undamaged. No positive blade counterweight marks or bents were noted on the spinner. The bulkhead exhibited a rearward impact hole in the location consistent with the counterweight from the No. 4 propeller blade contacting the bulkhead.

The feather spring house was no longer attached to the cylinder. All four bolts that attach the feather spring housing to the cylinder were sheared and their shanks remained within the cylinder. Looking through the hub fracture at the No. 1 blade socket location revealed that all four pitch change links were still attached to the pitch change rod. The links were distorted but intact – none of the eyelets were pulled through. The pitch change rod appeared to be intact and slightly bent. The 'Beta' tube located inside the pitch change rod was still treaded to the outer end of the pitch change rod.

Propeller Blade No. 1 (Left)

This propeller blade was found loose from the hub. The counterweight, the blade retaining hardware, and the pitch change pin were all missing. Examination of the butt of the blade revealed that all 4 pitch change pin installation bolts shanks remained in their respective bolt holes. The butt of the blade exhibited a single hard impact mark on the bottom and one on the side of the butt of the blade. The propeller blade was complete and intact with the tip of the leading edge exhibiting two hard impact marks. The propeller blade was bent in the direction opposite rotation creating an 'L' shape with the hard bend at the 25% span location where the airfoil exhibited a trailing edge impact and tear. The leading edge near the blade shank exhibited significant scraping along the length of the de-icing boot with the boot split in half exposing the blade underneath. The forward (thrust) side of the blade exhibited some scrape marks across the airfoil near the bend location and the aft side exhibited non-directional scrape marks near the tip.

Propeller Blade No. 2 (Left)

This propeller blade was still attached to the hub and was not removed for examination. The counterweight and the pitch change pin were not attached and all 4 retaining bolt shanks remained in their respective holes. However the counterweight remained attached to the bulkhead by the electrical wires. The butt of the blade exhibited three impact marks, one heavy gouging at the bore opposite to where the pitch change pin was located, one on the outer rim behind where the pitch change pin would have been located and one on the outer rim opposite where pitch change pin would be located. Within the butt damage, opposite where the pitch change pin would be located (180° opposite), there was a smooth round bottom mark. The propeller blade was missing a small portion of the blade tip and a small piece of the leading edge near the blade tip. The leading exhibited impact damage and missing material from about the 50% span out to what remained of the blade tip. The trailing edge exhibited two impact marks located near the 75% span location. The blade was gently bent upwards in the direction opposite rotation to create a crescent shape. Only the aft side of the tip exhibited any scrape marks and they were non-directional.

Propeller Blade No. 3 (Left)

This propeller blade was still attached to the hub and was not removed for examination. The counterweight was still attached as was the pitch change pin. The pitch change pin was bent. No visible impact marks were observed on the butt of the blade. The blade was intact and was not missing its tip. The leading edge exhibited a hard impact at about 75% span. The forward (thrust) side exhibited no scrape marks; however, the aft side exhibited longitudinal scrape marks near the tip. The blade was slightly bent in the direction opposite rotation.

Propeller Blade No. 4 (Left)

This propeller blade was still attached to the hub and was not removed for examination. The counterweight was still attached as was the pitch change pin. The pitch change pin was bent. The butt of the blade exhibited one impact mark near the outer rim. The blade was intact and was not missing its tip. The leading edge exhibited a hard impact at about 75% span and another out by the tip. The forward (thrust) side exhibited no scrape marks; however, the aft side exhibited longitudinal scrape marks near the tip. The blade was slightly bent in the direction opposite rotation.

Propeller No. 2 (Right hand side)

Three of the propeller blades had detached, blade No. 3 was identified as the remaining blade attached to the hub. The propeller model changes letters - FGHJ were on the hub at the No. 1 blade position and the hub S/N 900201 was found marked between blade sockets 2 and 3. The propeller was identified as Type 4HFR34C652-FGHJ, S/N 900201.

The spinner was still attached to the bulkhead but only at the No. 3 blade position and exhibited impact damage, tears, and missing material. The spinner exhibited a flat crushing and longitudinal (axial) scrape mark at the No. 1 blade position. The tip of the spinner was torn and peeled open and on the inside of the peeled skin was circular impression mark consistent with contact with the top of the feature spring housing. No positive blade counterweight marks or dents were noted on the spinner.

The featuring assembly – cylinder and feature spring housing remained intact and attached to the propeller hub. The only propeller blade socket in the hub that remained intact was the No. 3 blade position. All the other three sockets were fractured allowing the respective blades to come loose. A loose piece of a propeller hub blade socket was identified as coming from the No. 4 blade (right hand propeller) by matching the fracture surfaces. Looking through the fractured hub revealed that all four pitch change links were still attached to the pitch change rod. The links were distorted but intact – none of the eyelets were pulled through. The pitch change rod appeared to be intact and slightly bent. The 'Beta' tube located inside the pitch change rod was still treaded to the outer end of the pitch change rod.

Propeller Blade No. 1 (Right)

This propeller blade was found loose from the hub. A piece of the propeller hub blade socket remained still around the butt of the blade. The counterweight, the blade retaining bearing roller elements, the split retainers, and the pitch change pin were all missing; however, bearing races were still around the blade shank. Examination of the butt of the blade revealed that the 2 of the 4 pitch change pin installation bolts shanks remained in the bolt hole while the other 2 remaining holes were distorted. The butt of the blade exhibited a single hard impact mark in-line with the leading edge of the blade with a corresponding 180° circumferential scrape mark near the bore of the blade.

Four additional impact marks were also noted on the blade butt. The propeller blade was missing about 10 inches of its blade tip. The propeller blade had a gradual bent upwards in the direction opposite rotation creating a ‘C’ shape. The leading edge did not exhibit any significant impact marks and the de-icing boot was intact while the trailing edge did exhibited small impact marks along the airfoil length. The forward side (thrust side) of the propeller airfoil did not exhibit any scrape marks; however the aft side exhibited three sets of translational scrape marks – one near the butt, one at about mid-span and the other about 75% span.

A blade tip piece was recovered loose and matching fractures surfaces; it was identified as being part of the No. 1 propeller blade (right-hand). The piece of the recovered blade tip was twisted in both directions.

Propeller Blade No. 2 (Right)

This propeller blade was found loose from the hub. The counterweight, all the blade retaining hardware, and the pitch change pin were all missing. Examination of the butt of the blade revealed that all 4 pitch change pin installation bolt shanks remained in their respective bolt holes. The butt of the blade exhibited eight impact marks situated around the circumference of the blade – one of which is a shallow round bottom mark located almost 190° (clockwise looking at the butt of the blade) opposite of the pitch change pin. Using the exemplar propeller to match the location of the round bottom mark found on the propeller butt with a blade angle, a blade pitch angle of about +40° was observed at the 30-inch reference station.

Based on parameters recovered from the FDR, the calculated position of the propeller blade pitch was about +37° at the 30-inch reference station. The propeller blade was missing about 6 inches of the leading edge tip and the tip was bent up in the direction opposite rotation and aft. The propeller blade had two separate upwards bends, one at about 1/3 span and the other at about the 2/3 span. The bend at the 2/3 span location corresponding to the area of the missing blade tip and with heavy leading edge damage and distortion. The forward side (thrust side) of the propeller airfoil did not exhibit any scrape marks; however the aft side had scrape marks along the trailing edge near the butt of the blade and leading edge scrape marks at the 2/3 span location corresponding with the bend in the blade.

Propeller Blade No. 3 (Right)

This propeller blade was still attached to the hub. The counterweight was missing and looking through the fractured hub, the pitch change pin was still attached, intact and the pin itself was slightly bent. The butt of the blade had one round bottom impact mark located almost 190° opposite of the pitch change pin. Using the exemplar propeller to match the location of the round bottom mark found on the propeller butt with a blade angle, a blade pitch angle of about +40° was observed at the 30-inch reference station similar to what was observed on the propeller blade No. 2. The propeller blade was missing a small portion of the tip. The entire outer half of the blade was curled and twisted in a decreased pitch manner and in the direction opposite rotation and along its longitude axis. The forward side (thrust side) of the propeller blade exhibited heavy scrape marks on the curled outer half from the leading edge to the trailing edge.

Propeller Blade No. 4 (Right)

This propeller blade was found loose from the hub and was the largest and most intact of the blades. The counterweight, all the blade retaining hardware, and the pitch change pin were all missing. The butt of the blade had 3 impact marks located around the circumference. The propeller blade tip exhibited leading edge impact marks and was curled towards the aft side of the blade in the direction opposite rotation. The propeller blade exhibited a leading edge tear located at about the 75% span location. The forward (thrust) side of the blade exhibited scrape marks on both the trailing and leading edges with the trailing edge exhibited impact marks along its length. The aft side of the blade did not exhibit scrape marks.

Appendix K

Summary of Test Report on No. 2 (Right) Engine P_{T2}/T_{T2} Sensor

The examination was carried out at the facilities of the original equipment manufacturer Woodward under the supervision of the NTSB. The component was identified as Woodward P/N 8901-016, S/N 2495266, Honeywell P/N 869169-1.

According to the component manufacturer, the P_{T2}/T_{T2} Sensor was produced in August 1999 and was not returned to the manufacturer for any subsequent maintenance. The P_{T2}/T_{T2} sensor bellows displacement was measured using measuring tool WT-51467 # 1 (**Photo No. 1**). The height of the bellows was measured from the inside of the outer flange to the center of the bellows stem measured was 0.947 inches at a room temperature of approximately 75°F (specification is 1.023 ± 0.002 inches at 75°F). This is consistent with the sensor reading a lower temperature value than actual. The height of the bellows being considerably shorter than required would be consistent with a breach within the system (**Photo No. 2**).

Photo No. 1:
Bellows displacement measuring tool

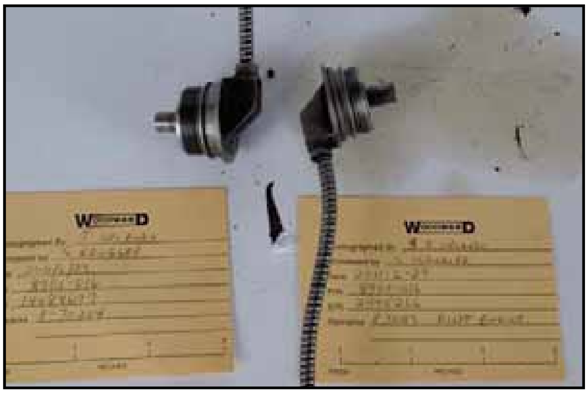


Photo No. 2:
Bellows height comparison

The P_{T2}/T_{T2} sensor was cut midway in the capillary tube to isolate the bellows from the probe to determine which end may be breached. Each half was pressured using helium, then dunked into a tank of Stoddard Fluid (MIL-F-7024 type II) (**Photo No. 3**).

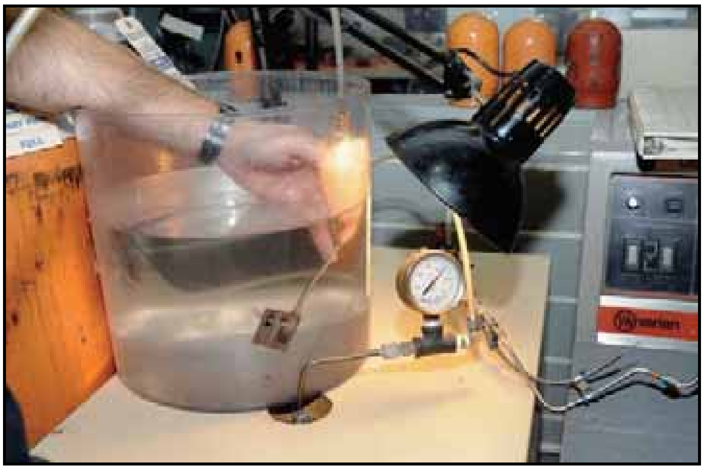


Photo No. 3: P_{T2}/T_{T2} leak check test

No leak (bubbles) was noted coming from the bellows but a streak of bubbles was noted coming from the sensing tube (**Photo No. 4** & **Photo No. 5**). The sensing tube was marked where the bubbles appeared to have been coming from (**Photo No. 6**). Additional examination will be needed to determine the exact location and cause of the breach.

Photo No. 4: Sensing tube leak

Photo No. 5: Sensing tube leak

Photo No. 6: Possible sensing tube breach location

In order to determine a possible leak rate, the capillary tube that was connected to the probe and the capillary tube that was connected to bellows were brazed to a ‘T’ fitting (manifold) as well as a fill tube.

The modified P_{T2}/T_{T2} sensor was then put under vacuum to draw any air trapped out the system and then it was filled with N-butyl alcohol (**Photo No. 7**).

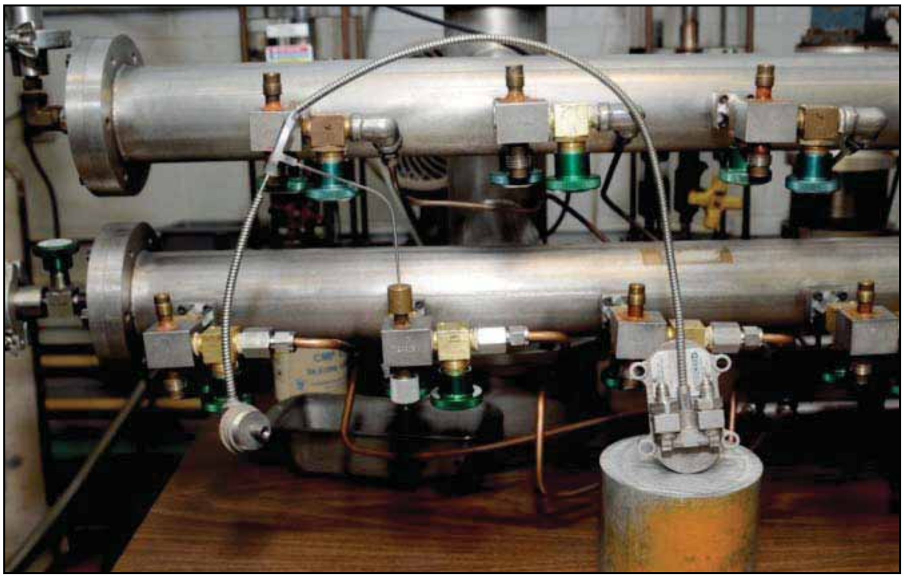
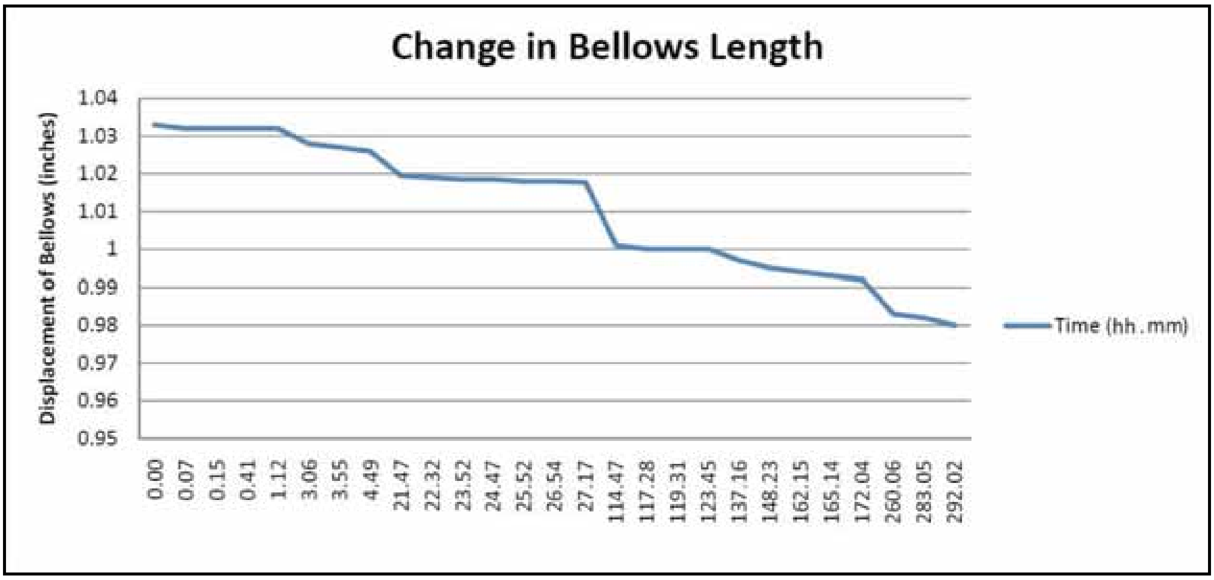


Photo No. 7: pressurizing the P_{T2}/T_{T2} sensor to determine leak rate

A 15-pound load was then applied to the bellows that simulates the load it would experience when attached to the engine. Under this load, the bellows displacement was measured to be 1.33-inches. The loss of internal pressure (bellows displacement) was monitored and recorded as a function of time (**Plot 1** and **Table 1**). The following displacements and times were recorded:



Plot 1: Bellows Length Change vs Time

Date Time	Elapsed Time (hh.min)	Displacement (inch)
30/06/2011 13.13	00.00	1.033
30/06/2011 13.20	00.07	1.032
30/06/2011 13.28	00.15	1.032
30/06/2011 13.54	00.41	1.032
30/06/2011 14.25	01.12	1.032
30/06/2011 16.19	03.06	1.028
30/06/2011 17.08	03.55	1.027
30/06/2011 18.02	04.49	1.026
01/07/2011 11.00	21.47	1.020
01/07/2011 11.45	22.32	1.019
01/07/2011 13.05	23.52	1.019
01/07/2011 14.00	24.47	1.019
01/07/2011 15.05	25.52	1.018
01/07/2011 16.07	26.54	1.018
01/07/2011 16.30	27.17	1.018
05/07/2011 08.00	114.47	1.001
05/07/2011 10.41	117.28	1.000
05/07/2011 12.44	119.31	1.000
05/07/2011 16.58	123.45	1.000
06/07/2011 06.29	137.16	0.997
06/07/2011 17.36	148.23	0.995
07/07/2011 07.28	162.15	0.994
07/07/2011 10.27	165.14	0.993
07/07/2011 17.17	172.04	0.992
11/07/2011 09.19	260.06	0.983
12/07/2011 08.18	283.05	0.982
12/07/2011 17.15	292.02	0.980

Table 1: Recorded values for Bellows Length Change vs Time

Appendix L

Investigation of Recorded Engine Parameters During the Final 20 Seconds of the Flight

Engine – General

The SA 227-BC is powered by two TPE331-12UHR-701G turboprop engines. The TPE331-12UHR-701G is a single-shaft engine with a two-stage centrifugal compressor driven by a three stage axial-flow turbine, a single reverse flow annular combustor and an integral reduction gearbox that runs the engine controls and drives the propeller. The TPE331 is designed to operate at a specific constant speed or RPM, which is dependent on the particular phase of flight.

Engine Controls

The engine controls consist of power levers, speed levers (also known as condition levers or RPM levers), negative torque sensing (NTS) systems, single red line computers and temperature limiting systems. The AFM states that *'The power lever controls engine operation in Beta and propeller governing ranges. Beta range* [also known as Beta mode] *is used only during ground operations and occurs when the power lever is positioned between Flight Idle and reverse. When operating in Beta range, propeller blade angles are hydraulically selected. Engine speed is controlled by a fuel metering device called the underspeed governor* (USG) *which is part of the fuel control. Propeller governing range is used during all flight operations and occurs when the power lever is positioned between Flight Idle and take-off. When operating in propeller governing range, the power lever assumes the function of a fuel throttle and regulates the amount of fuel metered to the engine for producing desired power.'*

When the power levers are advanced forward from the Flight Idle gate, which is at a power lever angle of 40°, they control fuel flow on what is known as the *'Power Lever Schedule'*. In this mode, the propeller governors automatically maintain the set engine speed by varying propeller blade angle in response to changing flight conditions and/or power. The AFM continues, *'During landing flare, the power levers are positioned in Flight Idle to establish predictable thrust and drag and to allow the airplane to settle to the runway at an established rate of descent.'* On the ground, the power levers, when retarded behind the Flight Idle gate, directly control propeller angle, i.e. Beta mode. In Beta mode, the USGs maintain selected engine speed by assuming control over fuel flow (Wf). The AFM Limitations Section contains the following:

<u>WARNING</u>

- **PROPELLER REVERSING IN FLIGHT IS PROHIBITED**
- **DO NOT RETARD POWER LEVERS AFT OF THE FLIGHT IDLE GATE IN FLIGHT. SUCH POSITIONING MAY LEAD TO LOSS OF AIRPLANE CONTROL OR MAY RESULT IN AN ENGINE OVERSPEED CONDITION AND CONSEQUENT LOSS OF ENGINE POWER.**

Engine manufacturer training material notes that *'The use of Beta mode in-flight is prohibited because placing one or more power levers below the Flight Idle gate sets the corresponding propeller blades at an angle lower than that certified for in-flight conditions. Moreover, setting one or more power levers below Flight Idle in-flight produces high drag conditions which may result in excessive airspeed deceleration, and may induce an uncontrollable roll rate due to asymmetric thrust and drag.'*

The speed lever's sole function is to select the engine's operating RPM. The AFM states: '*The speed levers are placarded Low RPM and High RPM. These levers set the speed governors. When the power lever is in Beta range, engine speed is controlled by the underspeed governor which limits speed between 70%* [Low RPM] *and 96% to 97.5% RPM* [High RPM]. *The speed lever can reset the underspeed governor anywhere within this range. When the power lever is in propeller governing mode, engine speed is controlled by the propeller governor. The speed lever can be used to set the propeller governor anywhere within the normal range of 96% to 100% RPM when in the propeller governing mode of operation.*'

Engine RPM is selected according to the flight or ground conditions, and once set, requires resetting only when the flight conditions change. Low RPM is used for engine starting and ground/taxi operations. The AFM after-engine start checks require that the engine RPM should be stabilised at 70% to 72%. Immediately before take-off the speed levers are moved to High RPM and the AFM requires that the engine speeds are checked at 96% to 97.5% RPM. Thereafter the power levers are advanced to take-off power and the engine speeds are checked at 100% to 101% prior to brake release.

In the cruise, the engine speeds are set at 97% RPM.

The AFM before landing checks require confirmation that the speed levers are at High RPM. For landing the power levers are set at Flight Idle position and after touchdown they are retarded to Ground Idle position. If required, the power levers may be further retarded into the Reverse position to assist aircraft deceleration. Reverse should only be selected on the ground after Beta mode has been indicated by illumination of the cockpit Beta light, signifying that sufficient oil pressure is built in the propeller system to achieve reverse. The AFM cautions '*Attempted reverse with the speed levers aft of the High RPM position may result in an engine over temperature condition.*'

Once the aircraft has decelerated and reverse is no longer required, the power levers are returned to the Ground Idle position and the speed levers are moved back to the Low RPM position for taxiing. The AFM cautions '*Do not retard speed levers while power levers are aft of ground idle*' and also '*Do not retard the speed levers to the full aft (Low RPM) position until a normal taxi speed is reached.*'

To maintain constant engine speed, the primary control devices are the Fuel Control Unit (FCU) and the Propeller Governor (PG). The FCU is the main fuel-metering device on the engine and it receives input signals from the power lever, speed lever, P_{T2}/T_{T2} sensor, and P3 pressure sensor. The FCU incorporates the USG and an Overspeed Governor (OSG).

The USG is a flyweight operated fuel metering device, which maintains engine RPM during Beta mode and when the speed lever is selected below 96%. When the speed lever is at High RPM the USG has a set point of 97%, i.e. if the engine speed drops to 97% the USG becomes active and boosts fuel flow to prevent engine speed from further drop. The OSG is a flyweight-type, gear driven safety device which controls excess engine speed by restricting fuel flow to oppose any excess engine speed increase. The OSG has a set point of 104.5% RPM at a typical fuel flow of 250 lb/hr, but it can actually begin limiting the FCU's maximum fuel schedule at 101%. The OSG is located upstream of the FCU main metering valve.

A hydraulically actuated, constant speed, full feathering propeller control system is an integral feature of the TPE331 engine installation. The propeller governing system incorporates an NTS system and is interconnected with the fuel control system. During flight, the propeller governing system automatically maintains set engine speed by varying the pitch angle of the propeller blades in response to changing conditions of flight. If negative torque is sensed, the NTS system will actuate and allow the NTS oil pressure to build up until it is sufficient to hydraulically actuate the feather valve. This causes the propeller blade angle to increase, i.e. to move towards the feather position, thus counteracting the negative torque.

The AFM describes the NTS system as follows: *'The negative torque sensing system operates automatically and requires no cockpit controls. Negative torque occurs whenever the propeller tends to drive the engine rather than when the engine drives the propeller. When negative torque is sensed, propeller pitch will automatically increase towards feather and thus reduce the drag of the windmilling propeller.'*

After landing, moving the power levers below the Flight Idle gate would cause the NTS system to activate. This could adversely affect directional control on the ground. To counteract this, the system incorporates an NTS Lockout valve. This valve begins to open at a power lever angle of 37° and it is fully open at a power lever angle of 21°. The effect of NTS lockout is to disable the NTS system.

Laboratory Examination of Engine Control Components

Following the examination of the propellers and engines at the respective manufacturers' facilities under the supervision of the Investigation, it was decided that the fuel control units, the propeller governors and the P_{T2}/T_{T2} sensors would be sent to the facilities of Woodward, the original equipment manufacturer, for examination under the supervision of the United States NTSB, which was accredited to the Investigation.

The examination of the P_{T2}/T_{T2} sensors found that the bellows length of the unit removed from the No. 2 engine was 0.947 inches. This measurement was carried out at a room temperature of approximately 75°F (24°C). The specification for this length is 1.023 ± 0.002 inches at a temperature of 75°F. **Photo No. 1** shows the relative difference in bellows length between the P_{T2}/T_{T2} sensors from the two engines.

The length of the No. 2 engine bellows being considerably shorter than specified is consistent with a breach or leak within the system.

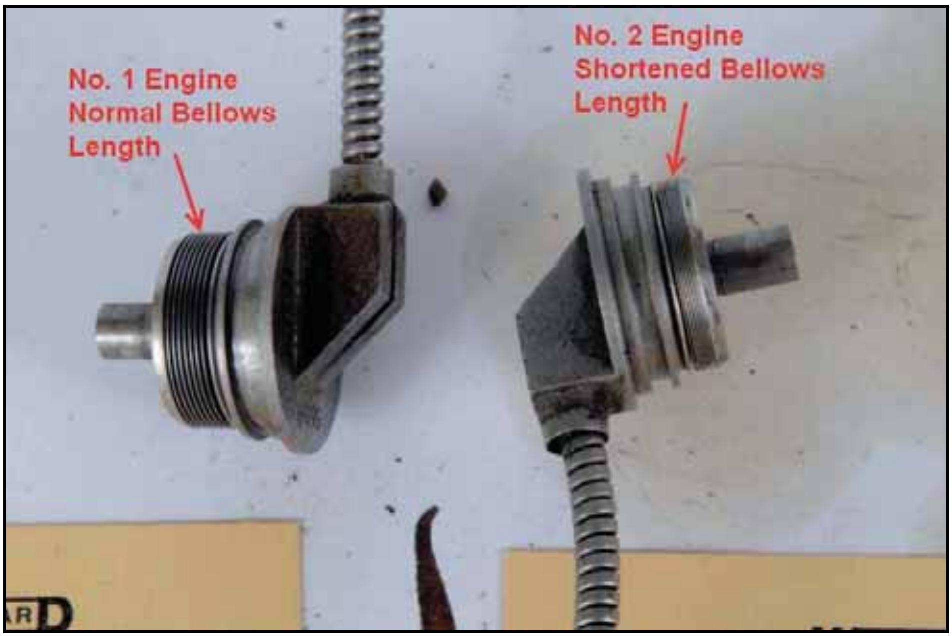


Photo No. 1: P_{T2}/T_{T2} sensor bellows from No. 1 and No. 2 Engines

Further tests were carried out to ascertain at which end of the assembly the breach had occurred. The P_{T2}/T_{T2} sensor was cut midway along the capillary tube to isolate the bellows from the probe. No leak was noted from the bellows itself but a streak of bubbles was noted coming from the sensing tube. Woodward installed a manifold with a fill tube, connecting the two sections, and refilled the sensor. A load was applied to the bellows which was equivalent to that which would be experienced by the bellows when attached to an engine. The bellows length reduced from 1.033 inches to 0.98 inches over a period of 292 hrs.

Effects of a Shortened P_{T2}/T_{T2} Bellows

The effect of a leak in a P_{T2}/T_{T2} sensor is to create a negative temperature bias on the ambient total temperature being sensed. When the P_{T2}/T_{T2} sensor with the shortened bellows was tested at Woodward, it was found to transmit a temperature signal 135°F below the ambient temperature. The bellows had remained installed on the FCU between the time of the accident and its arrival at Woodward for examination. Since there was a load from the FCU on the bellows until the time it was disassembled in the laboratory, an indeterminate amount of leakage would have occurred in transit. Thus it was impossible to state definitively how large the negative temperature bias was on the date of the accident.

For the purposes of the Investigation, it was estimated that the sensor was transmitting a T_{T2} signal of -40°F to the respective engine fuel control unit at the time of the accident, rather than sending a signal representing the actual total air temperature, as it is designed to do. This has three effects on engine performance parameters.

a. Effect on Engine RPM Rise

Firstly, when the speed levers are advanced by the crew, while the power levers remain in the Ground Idle position, the increase in engine speed on the side with the shortened bellows lags behind that with a correctly operating bellows. During this phase, the FCUs are operating on an *'Acceleration Schedule'* and the colder temperature signal sent by the sensor with the shortened bellows to the FCU results in a reduced fuel flow to the affected engine. This in turn results in a slower increase of the affected engine speed between 70% and 97% RPM when the speed levers are moved from Low RPM to High RPM.

Figure No. 1 shows FDR recorded parameters from EC-ITP on a take-off several weeks before the accident flight indicating that the P_{T2}/T_{T2} anomaly existed at that time.

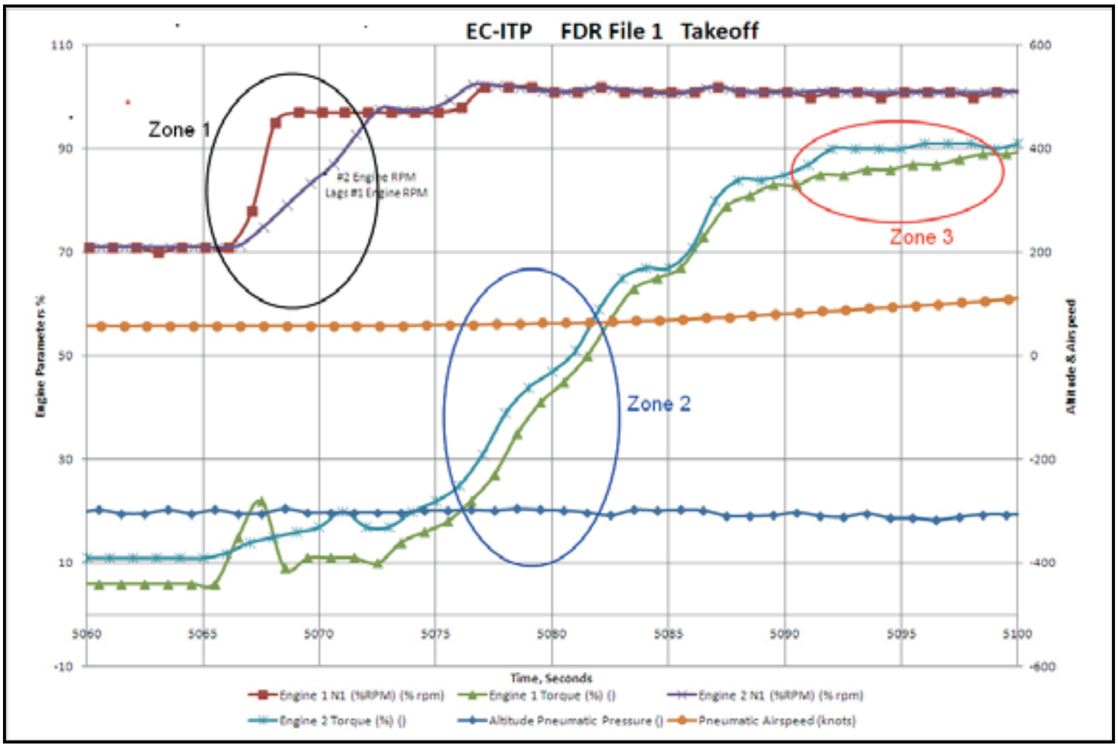


Figure No. 1: Previous Take-off FDR Parameters

In Zone 1, the two curves show the engine speeds measured in RPM for the No. 1 engine (red) and the No. 2 engine (purple). The curves show that when the speed levers were advanced from Low RPM to High RPM in preparation for take-off and the engine speeds increased from 70% to approximately 97%, the speed response of the No. 2 engine lagged behind that of the No. 1 engine by approximately 5 seconds.

b. Effect on Torques as Power Levers are advanced

When the engine speeds are stabilised at approximately 97% RPM, and the power levers are advanced from Ground Idle towards high power, the fuel control transitions from the underspeed governor fuel schedule to the power lever schedule. The power lever schedule is compensated for inlet temperature (T_{T2}) in accordance with the characteristics shown in **Figure No. 2**. In this case the lower nearly horizontal line represents the fuel flow with the power lever at Flight Idle while the upper blue line is the fuel flow with the power lever fully forward. Power lever settings between Flight Idle and maximum power would be represented by similar lines between the two. The x-axis is the engine inlet temperature in degrees Fahrenheit (°F). There is a maximum flow stop at 650 lb/hr which is represented by the dashed black line.

As the power lever is moved from Flight Idle to full forward, which is illustrated at an arbitrary power lever position by the dashed red line, there is a proportionally higher fuel flow to the No. 2 engine than to the No. 1 engine.

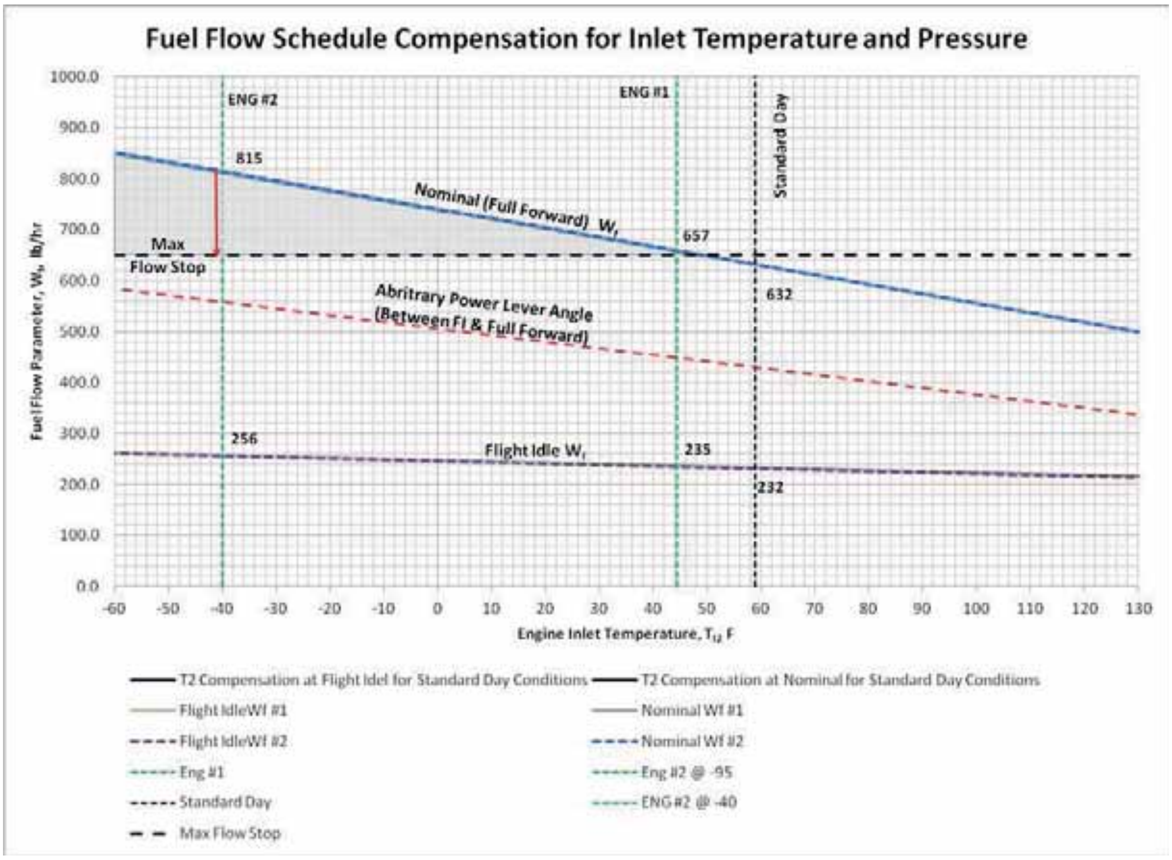


Figure No. 2: Fuel Flow Schedule Compensation (Source Honeywell)

Thus, as the power levers are advanced for take-off, the effect of a shortened bellows is to increase the fuel flow to the engine on the side with the shortened bellows, i.e. the No. 2 engine on EC-ITP.

The effects of this on EC-ITP can be seen in Zone 2 of **Figure No. 1**, where the engine torques increase as the power levers are advanced. Since, during this phase of engine operation, the fuel flow to engine No. 2 is higher due to the low temperature signal being transmitted by the shortened bellows, the torque of engine No. 2 advances ahead of that of engine No. 1.

c. Effect on Torques at Steady Power Lever Angles

Figure No. 3 shows the comparative power lever schedules for the two engines on EC-ITP. The power lever position fuel flow schedule for engine No. 1 is shown in green, representing compensation for the correct inlet temperature as sensed by the normal P_{T2}/T_{T2} sensor. The schedule for engine No. 2 (in purple), shows fuel flow against power lever position compensated for the negative temperature bias being transmitted from the P_{T2}/T_{T2} sensor with the shortened bellows. It can be seen that, for a given power lever angle, No. 2 engine fuel flow is higher than that for No. 1 engine.

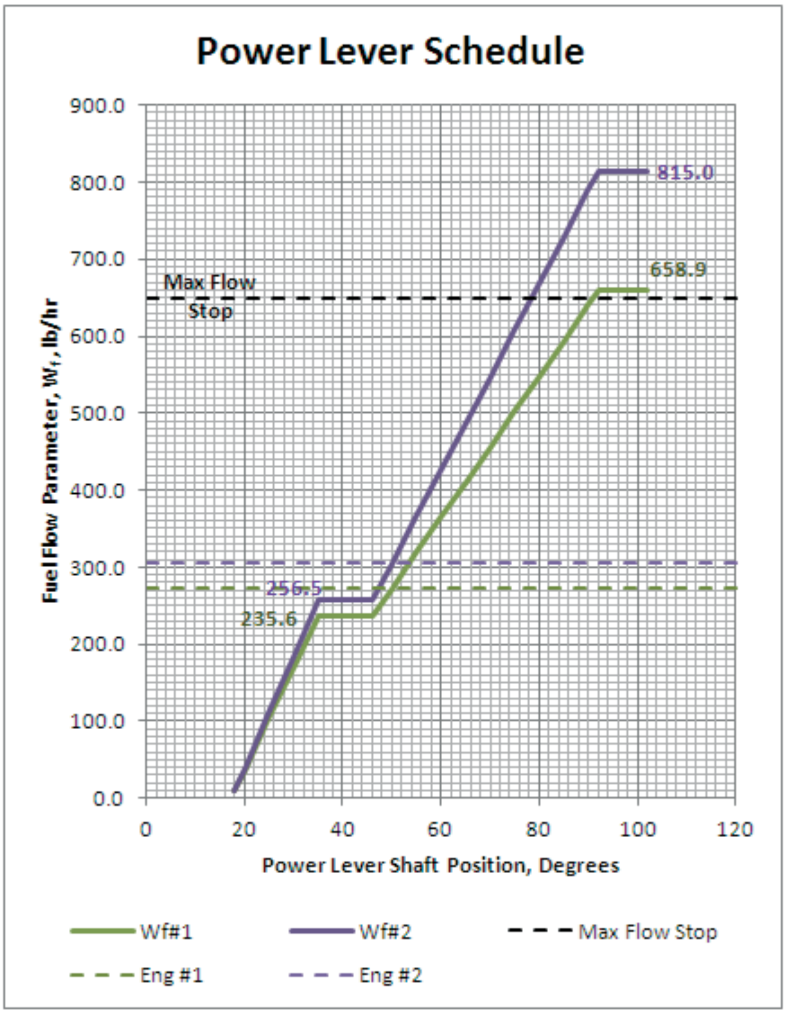


Figure No. 3: Power Lever Schedule for EC-ITP Engines (*Honeywell*)

This effect can be seen in Zone 3 of **Figure No. 1** where the engine torques are settling close to take-off values, the torque achieved by engine No. 2 is several percentage points greater than that for engine No. 1.

Figure No. 4 and **Figure No. 5** present FDR data for two further take-offs made by EC-ITP some weeks before the accident flight. Similar characteristics are seen, in that the engine No. 2 RPM lags that of engine No. 1 as the speed levers are advanced in each case. Also, the torque achieved by engine No. 2 advances ahead of that achieved by engine No. 1 and, particularly as seen in **Figure No. 5**, the No. 2 engine torque remains higher than that of No. 1 engine as the aircraft speed increases during its take-off run.

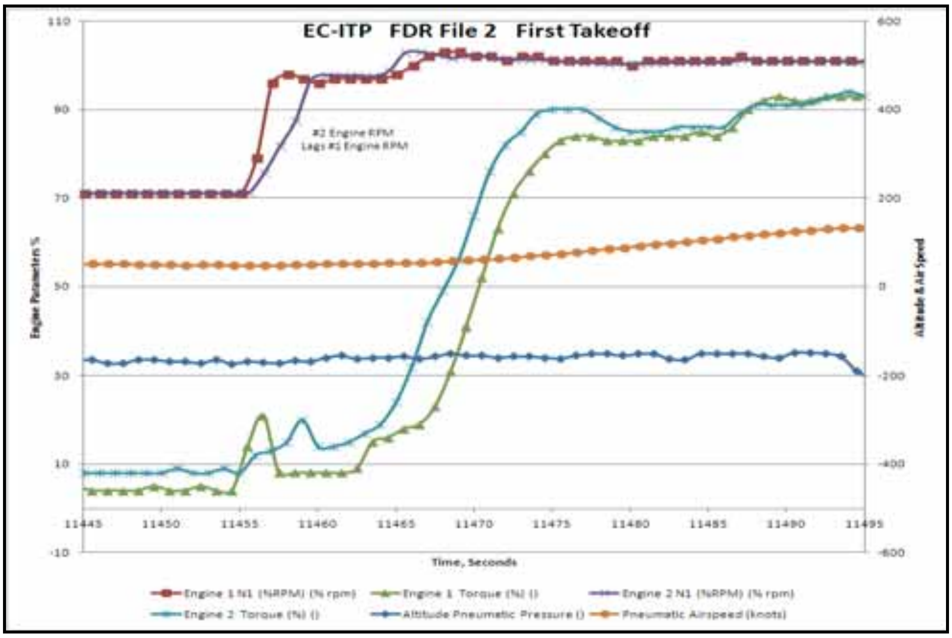


Figure No. 4: Sample of take-off FDR parameters weeks prior to accident

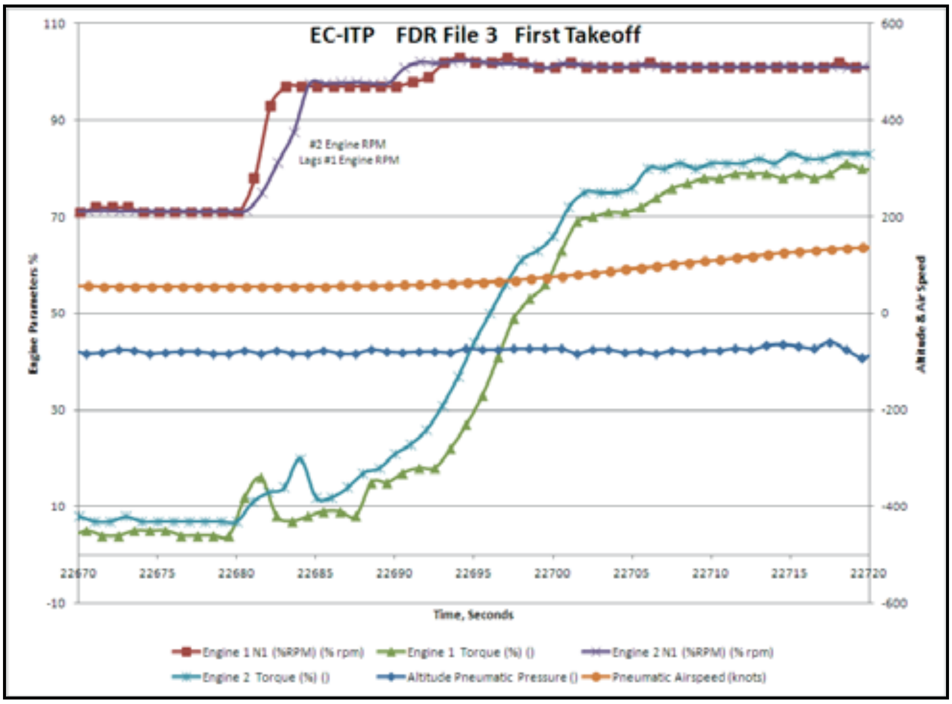


Figure No. 5: Additional sample of take-off FDR parameters weeks prior to accident

The Accident Sequence

Figure No. 6 illustrates various FDR parameters recorded during the accident sequence. The x-axis represents time measured in seconds with the “0” point representing a time approximately one second before commencement of the impact sequence, when the values of recorded parameters became unreliable.

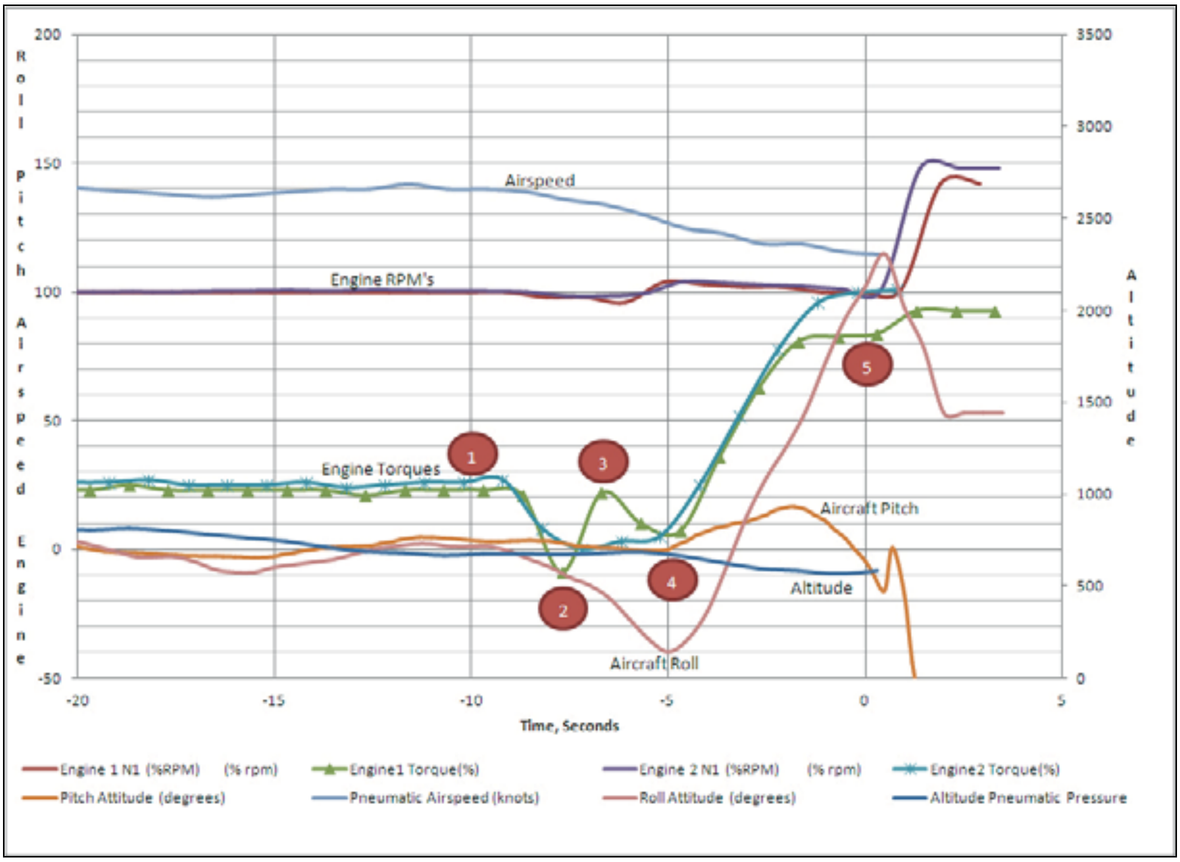


Figure No. 6: FDR Parameters during final approach (accident flight)

The Investigation selected five datapoints during the final seconds of coherent recorded data, as follows:

- Datapoint 1, approximately 11 seconds before impact.
- Datapoint 2, when the torque value recorded on No. 1 engine was -9%.
- Datapoint 3, one second after datapoint 2, when the torque recorded on No. 1 engine was +22%.
- Datapoint 4, when the engine speeds were measured at 104% and 104.1% respectively.
- Datapoint 5, approximately one second before impact.

Note:- The FDR recorded the value of each of the engine parameters once per second. Due to the characteristics of the FDR, each parameter was recorded at a different time during the one second cycle.

If engine No. 1 speed was taken as being recorded at the start of each cycle, then engine No. 1 torque was recorded at 0.4 seconds, engine No. 2 speed at 0.5 seconds and engine No. 2 torque at 0.9 seconds into the respective cycle. For this reason, it was necessary for the Investigation to interpolate values at the various datapoints.

The data shows that, as the aircraft descended towards the runway during the time period from -20 secs to approximately -9 secs, the engine torque for the No. 1 engine was recorded at values generally in the range 21 to 23% while that for the No. 2 engine was in the range 25 to 27%. During this period, the engine speeds were recorded as 100% for No. 1 engine and at values in a range between 100.0% and 100.7% for No. 2 engine. These values are illustrated in **Figure No. 6** from the left hand axis until a time just after datapoint 1.

Thereafter the recorded data indicates that the No. 1 engine torque reduced to -9%, as shown at datapoint 2, then increased in one second to +22%, as shown at datapoint 3, at which point the No. 1 engine speed dropped towards 97%.

A value of 8% for the torque on No. 2 engine was recorded by the FDR 0.5 seconds before datapoint 2, a value of 0% was recorded one second later and a value of 3% a further one second later. Using linear interpolation, a value of 4% was calculated for No. 2 engine at datapoint 2 and of 1.5% at datapoint 3. A similar methodology was used for the calculation of engine speeds at these two datapoints.

At datapoint 4 the recorded data shows that both engine speeds increased significantly. The engine torque for the two engines was interpolated at the times where the engine speed reached their respective recorded maxima, 104.0% for engine No. 1 and 104.1% for engine No. 2. Due to the recording characteristics of the FDR, these two points were 0.5 seconds apart.

Datapoint 5 represents a point approximately one second prior to the impact.

Table No. 1 sets out the values, either recorded or interpolated from the FDR data, for the five datapoints shown in **Figure No. 6**.

Data Point	Engine No.1 RPM (%)	Engine No.1 Torque (%)	Engine No.2 RPM (%)	Engine No.2 Torque (%)
1	100.0	23.0	100.3	26.2
2	98.0	-9.0	98.6	4.0
3	97.2	22.0	98.4	1.5
4	104	8.2	104.1	17.0
5	100.1	83.7	100.8	100.2

Table No. 1: FDR Data

With the aid of an engine manufacturer's computer model, the Investigation used the data shown in **Table No. 1** to calculate the fuel flows required to run each engine at the recorded and interpolated torques and speeds for the five datapoints noted in **Figure No. 6**, with the fuel control characteristics not being taken into account.

To arrive at those figures, certain assumptions were made about the performance of the two engines. The most recent engine test cell fuel flow data for each engine was taken as a starting point. The No. 1 engine had demonstrated 4.8% lower fuel flow consumption than the figure for a minimum new engine model with SA227-BC installation losses, during its most recent test cell run. The No. 2 engine had demonstrated 3.8% lower fuel flow consumption under similar circumstances.

A fuel flow decrement of 0.5% per 1,000 hrs of field usage since the last test cell run was then added. The No. 1 engine had accomplished 313 hrs of field usage since its last test cell run and a figure of 0.2% additional fuel flow consumption was arrived at representing performance deterioration since the last test cell run. This 0.2% was decremented, giving a final figure of 4.6% lower fuel consumption than the minimum new engine performance figure.

The No. 2 engine had 2,642 hrs of field usage and thus a figure of 1.3% was decremented from the test cell figure, giving a result of 2.5% lower fuel consumption than the minimum new engine performance figure.

Taking these assumptions into account, the computer model was used to calculate the fuel flow required to run the engine at the five datapoints during the final approach, as shown in **Tables No. 2** and **No. 3**.

Datapoint	RPM (%)	Torque (%)	Fuel Flow (lb/hr)
1	100.0	23.0	292.0
2	98.0	-9.0	187.7
3	97.2	22.0	272.0
4	104.0	8.2	272.9
5	100.1	83.7	497.9

Table No. 2: Parameters for Engine No. 1

Datapoint	RPM (%)	Torque (%)	Fuel Flow (lb/hr)
1	100.3	26.2	309.5
2	98.6	4.0	231.4
3	98.4	1.5	222.9
4	104.1	17.0	305.9
5	100.8	100.2	573.9

Table No. 3: Parameters for Engine No. 2

The Investigation then introduced the performance characteristics of the individual FCUs, as determined during testing carried out at the original equipment manufacturers under the oversight of the Investigation.

For engine No. 1, the recorded engine speed figures and the computed fuel flows show that at datapoints 1 and 2 the active schedule was the power lever schedule, i.e. at these datapoints, as stated in the AFM, the power lever was assuming the function of a fuel throttle and regulating the amount of fuel metered to the engine for producing desired power.

At datapoint 3, No. 1 engine had a computed fuel flow of 272 lb/hr, with a recorded torque of 22.0% and an interpolated speed of 97.2% RPM. At these values, the FCU operating logic would have selected the USG schedule as being applicable and thus the USG would be active and boosting the fuel flow to maintain engine RPM at or above the set point of 97%. The test data for the FCU installed on the No. 1 engine indicates that the USG outputs 272 lb/hr at an actual engine speed of 96.7%.

At datapoint 4, the No. 1 engine RPM had increased to 104.0% and the computed fuel flow was 272.9 lb/hr. These parameters indicate that the OSG, which is upstream of the main metering valve and which can commence limiting fuel flow at an engine speed of 101%, was now active and was restricting the fuel flow to maintain engine RPM at or below the set point of 104.5%.

At datapoint 5, just before impact, the engine RPM had settled at 100.1% with a torque of 83.7% and the computed fuel flow had risen to 497.9 lb/hr. These figures indicate that the fuel flow was again on the power lever schedule and that the USG and OSG had again become inactive.

For engine No. 2, the data indicates that at datapoints 1, 2 and 3 the fuel flow was on the FCU power lever schedule and that the USG and OSG were not active. At point 4, the RPM had risen to 104.1% and the fuel flow was computed to be 305.9 lb/hr. These parameters indicate that the OSG was now active and was limiting the fuel flow to maintain engine RPM at or below the set point of 104.5%.

At datapoint 5, the engine RPM had decreased to 100.8% with a torque of 100.0% and a fuel flow of 573.9 lb/hr. These figures indicate that the fuel flow was again on the power lever schedule and that the USG and the OSG were inactive.

All of the above calculations take no account of the effects of the shortened P_{T2}/T_{T2} sensor bellows height and the consequent negative temperature bias. In order to calculate the power lever angle at those data points where the fuel flow was on the respective power lever schedule, it is necessary to use the curves shown in **Figure No. 7** (which is a reproduction of **Figure No. 3**) and takes into account the effects of the shortened bellows.

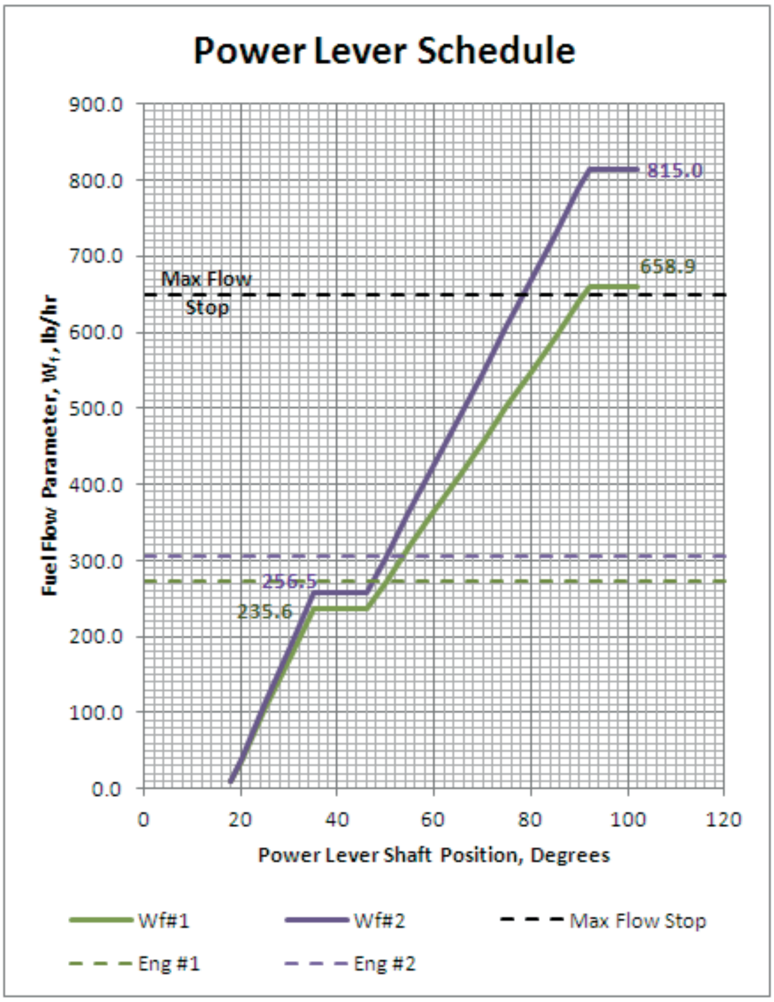


Figure No. 7: Fuel Flow/Power Lever Angle (PLA) Curves

In this figure, the curve of fuel flow (Wf#1) against PLA for the No. 1 engine, is shown in green while that for the No. 2 engine is shown in purple. If each of the fuel flow figures shown in **Table No. 3** is brought across to the applicable curve in **Figure No. 7**, then the equivalent power lever angles for each point can be derived. This data is shown for engines No. 1 and No. 2 in **Tables No. 4** and **No. 5** respectively**.**

Datapoint	Fuel Flow (lb/hr)	Power Lever Angle (°)	Underspeed Governor	Overspeed Governor
1	292.0	52.0		
2	187.7	31.3		
3	272.0	-	272.0 lb/hr @ 96.7% RPM	
4	272.9	-		272.9 lb/hr @ 104.5% RPM
5	497.9	74.5		

Table No. 4: Data for No. 1 Engine

Datapoint	Fuel Flow (lb/hr)	Power Lever Angle (°)	Underspeed Governor	Overspeed Governor
1	309.5	50.2		
2	231.4	33.2		
3	222.9	32.6		
4	305.9	-		305.9 lb/hr @ 104.1% RPM
5	573.9	72.2		

Table No. 5: Data for No. 2 Engine

In summary, the data indicates that at datapoint No. 1, both power levers were in the PLA range 50° to 52°**.** At datapoint No. 2, the torques and engine speeds for both engines are seen to decrease, with a corresponding reduction in computed fuel flow. From the Fuel Flow/PLA curve shown in **Figure No. 7**, it can be seen that both power levers were now at angles in the range 31° to 33°, i.e. they were both at an angle below (or behind) the Flight Idle gate.

At datapoint No. 2, the No. 1 engine torque was recorded at -9.0% while at datapoint no. 3 it had recovered to +22%. The engine speeds at these datapoints were 98.0% and 97.2 % respectively.

At datapoint No. 3, the No. 1 engine speed having dropped close to the USG set-point of 97.0%, the fuel flow was no longer on the power lever schedule, but was being boosted by the USG. The No. 2 engine at a speed of 98.4% was still on the power lever schedule and the computed fuel flow indicates a PLA of 32.6°, i.e. still at an angle below the Flight Idle gate.

At datapoint No. 4, both engine speeds increased to 104% and the OSG had become active, or partially active, in each case to limit the engine speed.

At datapoint No. 5, when both engine fuel controls had returned to the power lever schedule, the computed fuel flow data indicates that the power levers had been advanced into the range 72.2° to 74.5°.

Power Lever Rigging

The Investigation looked at a landing which had been made by EC-ITP at a Spanish airport several weeks before the accident, and for which FDR data was available. **Figure No. 8** illustrates the FDR data for this landing in similar format to that shown for the accident. Time in seconds is shown on the x-axis while the various engine parameters along with altitude and airspeed are shown on the y-axis. The touchdown occurred at FDR time reference 3460.

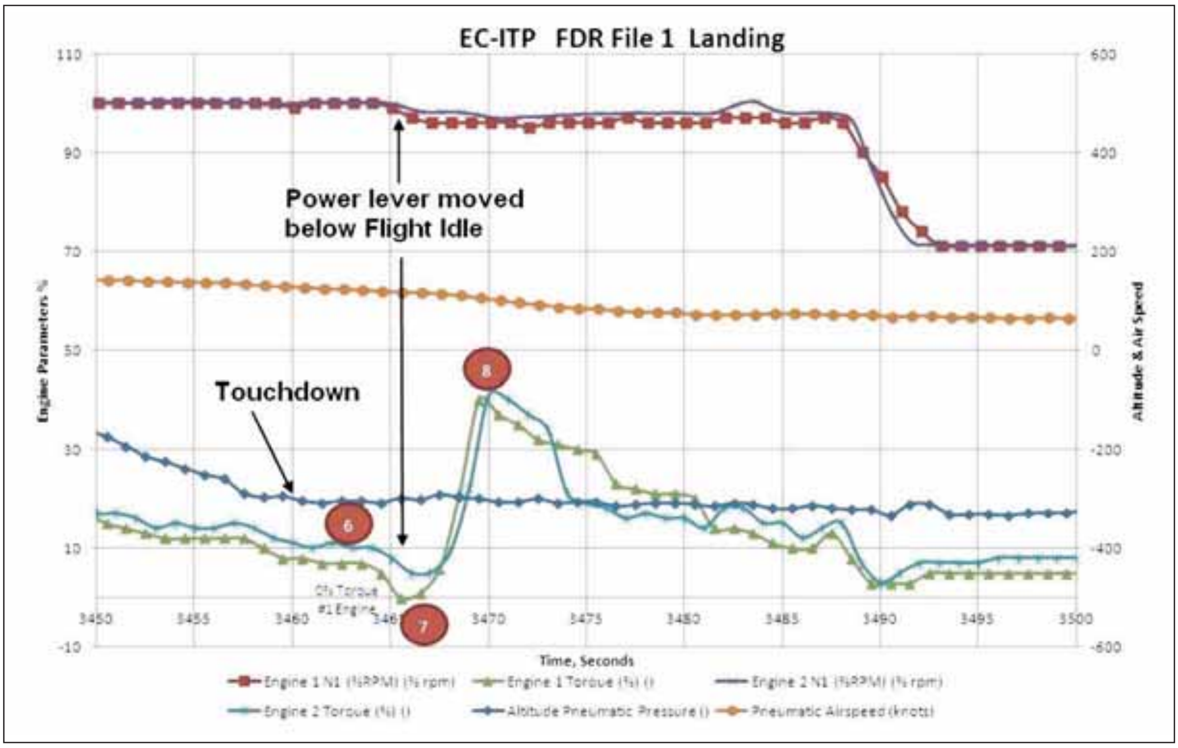


Figure No. 8: FDR Data from Previous Landing

A similar analysis was carried out for this landing, and the manufacturer's computer model was used to calculate the fuel flows at datapoints 6, 7 and 8 as shown in **Figure No. 8.** The data is shown for the No. 1 engine in **Table No. 6** and for No. 2 engine in **Table No. 7**.

Datapoint	Engine RPM (%)	Engine Torque (%)	Fuel Flow (lb/hr)	Power Lever Angle (°)	Underspeed Governor
6	100.0	7.0	248.3	47.4	
7	96.6	1.0	211.1	33.2	
8	96.0	40.0	324.4	-	324.4 lb/hr at 96.0% RPM

Table No. 6: Data for No. 1 Engine

Datapoint	Engine RPM (%)	Engine Torque (%)	Fuel Flow (lb/hr)	Power Lever Angle (°)	Underspeed Governor
6	100.1	10.0	262.5	46.3	
7	98.3	5.0	236.4	33.4	
8	97.2	41.0	340.9	-	340.9 lb/hr at 97.2% RPM

Table No. 7: Data for No. 2 Engine

From the data, it can be seen that at datapoint 6, approximately three seconds after touchdown, both of the power levers remained above the Flight Idle angle of 40°. At datapoint 7, approximately six seconds after touchdown, both power levers had been moved through Flight Idle into the Beta range of operation. The power lever angles for both engines were approximately 33° at this time, a position which is comparable to the angle selected in flight during the accident sequence. After this, at datapoint 8, the engine torques are seen to increase as reverse thrust is used to decelerate the aircraft on the runway.

This analysis of the power lever operation on a previous successful landing illustrates that the rigging of the power levers was satisfactory and that, in this case, the levers were brought back into Beta range from Flight Idle after landing to assist in decelerating the aircraft.

ANALYSIS

Regarding the final approach and the time period from -20 seconds to approximately -9 seconds, the engine torque for the No. 1 engine was recorded at values generally in the range 21 to 23% while that for the No. 2 engine was in the range 25 to 27%. During this period, the engine speeds were recorded as 100% for No. 1 engine and at values in a range between 100.0% and 100.7% for No. 2 engine, **Figure No. 9**.

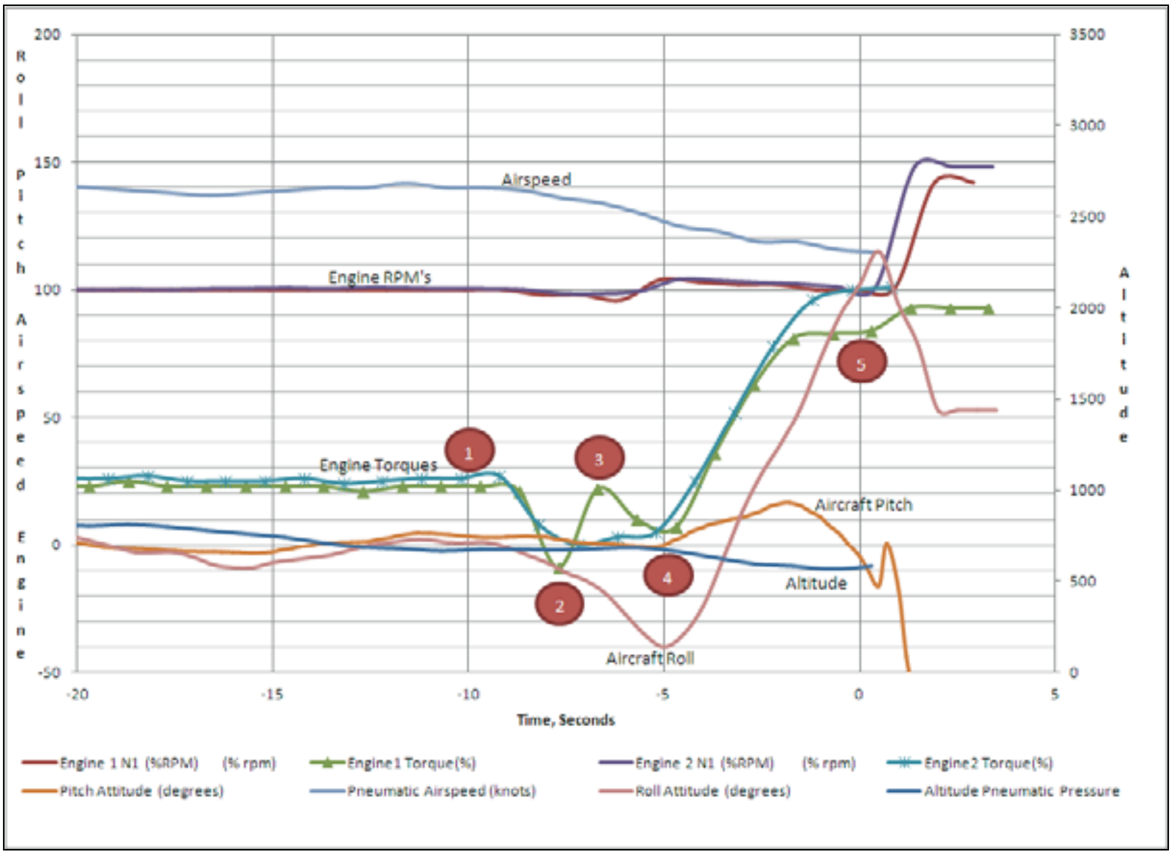


Figure No. 9: FDR Parameters during final approach (accident flight)

The altitude can be seen to be slowly decreasing while the airspeed was being maintained around 140 kts. During this phase, the final approach appears to be stabilised with the speed levers set to High RPM and the power levers throttled back to low positive torque values consistent with values recorded during other approaches. The split between the torques of approximately 4% is consistent with the torque split identified throughout the FDR data where the torque output by No. 2 engine exceeded that of No. 1 engine due to the negative temperature bias caused by the shortened bellows of the P_{T2}/T_{T2} sensor on No. 2 engine.

At datapoint 2, the recorded torque value being delivered by No. 1 engine can be seen to decrease to -9% while the interpolated torque for No. 2 engine was calculated at 4%.

The Investigation used an engine manufacturer's computer model to arrive at fuel flow figures for these two datapoints. These fuel flow figures were then inserted into the power lever schedule curves, which took into account the different characteristics of the two FCUs due to the No. 2 engine P_{T2}/T_{T2} sensor issue, to arrive at probable power lever angles for the two datapoints.

The calculations showed that at datapoint 1, the power levers were both in the range 50° to 52°, which was in the expected operating range for this phase of flight. However, at datapoint 2, the data indicates that both power levers had been retarded to angles in the range 31° to 33°, i.e. both power levers were now in the Beta range between Flight Idle (40°) and Reverse.

At datapoint 3, the recorded torque on No. 1 engine increased to +22%, while the interpolated value of torque for No. 2 engine was 1.5%. The data shows that the torque on engine No. 1 then dropped again before both torque values started to increase after datapoint 4.

The most likely explanation for the rapid increase in No. 1 engine torque to 22% is that the NTS system sensed the negative torque and it automatically acted to increase the propeller blade angle towards the feather position. The increased aerodynamic loading on the propeller and hence the engine is illustrated by the significantly increased torque at data point No. 3. It also resulted in dropping the No. 1 engine speed down to 97.2% and activating the USG.

The NTS lock-out system is designed to disable the NTS system for operation on the ground. The lock-out is graduated according to the power lever angle and commences operation as the power lever is moved back from 37° and is fully operative when the power lever reaches an angle of 21°. As the PLA for engine No. 1 was calculated to be 31.3° at datapoint 2, the NTS lock-out would have partially activated but would not have acted to fully disable the NTS system.

At datapoint 3, the No. 1 engine speed was seen to fall towards the USG set point of 97%. This resulted from the increase in propeller blade angle and consequent aerodynamic loading as the NTS activated.

The FCU operating logic would have selected the USG schedule as being applicable and thus the USG became active and boosted the fuel flow to maintain engine RPM at or above 97%. The test data for the FCU installed on the No. 1 engine indicates that the USG outputs 272 lb/hr at an actual engine speed of 96.7%.

For the No. 2 engine, the data suggests that it did not enter the negative torque regime around datapoints 2 and 3 and that the NTS system did not activate on that side. Furthermore, there was no significant drop in No. 2 engine speed towards the FCU set point at this time, which reinforces the theory that the NTS did not activate. The lowest recorded No. 2 engine speed was 98.4%. In this case the FCU operating logic would have continued to select the power lever schedule rather than the USG schedule. Therefore the curve shown in **Figure No. 7** for engine No. 2 may be used to derive the power lever angle at datapoint 3. The computed fuel flow was 222.9 lb/hr which gives an angle of 32.6°.

The probable reason why engine No.1 entered a negative torque regime while engine No. 2 did not when both power levers were brought into the Beta range, is the higher fuel flow which was being delivered to the No. 2 engine due to the negative temperature bias of the P_{T2}/T_{T2} sensor with the shortened bellows. This negative temperature bias was seen throughout the data to have boosted fuel flow and consequently delivered higher torque outputs from the No. 2 engine.

Datapoint 4 was selected to show the times when the engine speeds were recorded at their maximum values during the final sequence, 104.0% on the No. 1 engine and 104.1% for the No. 2 engine. Due to the characteristics of the FDR, these two values were recorded 0.5 seconds apart.

The torque outputs of both engines are both seen to increase rapidly immediately after datapoint 4, both rising to in excess of 80% within approximately 3 seconds.

At datapoint 4, the OSGs would have been active, or partially active, on both FCUs. The OSG is upstream of the main metering valve and can commence limiting fuel flow at an engine speed of 101%. Thus the OSGs on both FCUs were restricting the fuel flow to maintain engine RPM at or below the set point of 104.5%. Because the OSGs were active, it is not possible to derive an accurate power lever angle for datapoint 4. However, if the computed fuel flow figure for No. 1 engine of 272.9 lb/hr at datapoint 4 is inserted into the appropriate curve in **Figure No. 7**, a power lever angle of approximately 50° is derived. Since the OSG was active and was restricting the fuel flow to this figure, it can be stated that the power lever angle was probably greater than 50°.

Similarly, if the computed fuel flow figure for No. 2 engine of 305.9 lb/hr at datapoint 4 is inserted into the appropriate curve in **Figure No. 7**, a power lever angle of approximately 50° is derived. Again, since the OSG was active and was restricting the fuel flow to this figure, it can be stated that the power lever angle was probably greater than 50°.

Therefore, at datapoint 4, the FDR data suggests that both power levers had been taken out of Beta range and were being advanced towards high power settings.

At datapoint 5, approximately one second prior to impact, the engine torques were both recorded to be in excess of 83%, with the torque from No. 2 engine being considerably higher than that from No. 1 engine, as was recorded consistently throughout the data. The engine speeds were both recorded at less than 101%, and therefore both OSGs would again have become inactive. So at this point, the FCU logic would have selected the power lever schedule and the curves in **Figure No. 7** are applicable. The computed fuel flows indicate that the power lever angle for No. 1 engine was 74.5° while that for the No. 2 engine was 72.2°.

To summarise, the analysis of the engine parameters recorded by the FDR immediately preceding the impact indicate that the engines were operating at the expected torque and speed values up to a point approximately 10 seconds before impact. At that time, both power levers were retarded through Flight Idle into the Beta range, which resulted in the No. 1 engine producing a negative torque, recorded by the FDR as -9%. The No. 2 engine torque reduced to low recorded values (minimum 0%) but there was no recorded evidence of negative torque. This was probably due to the higher fuel flows to No. 2 engine caused by the negative temperature bias introduced by the shortened bellows of the P_{T2}/T_{T2} sensor.

As a result of the negative torque, the No. 1 engine NTS system activated, which increased the blade angle of the propeller, and this caused a significant rise in torque (+22% recorded) and a corresponding drop in engine speed towards 97% which in turn activated the USG. During these torque fluctuations on the No. 1 engine, the No. 2 remained relatively stable at low positive values.

Approximately six seconds before impact, the two power levers were rapidly advanced out of the Beta range, which caused the engine speeds to increase and the torques to rise. The increase in engine speeds caused the OSGs on both sides to activate temporarily until the speeds dropped back to normal operating ranges.

Approximately one second prior to impact the engine torques were both in excess of 80%, but the No. 2 engine torque significantly exceeded that of No. 1 engine, due to the higher fuel flow caused by the negative temperature bias.

Appendix M

Extract from European Commission Regulation (EC) No 859/2008, OPS 1.405, Commencement and continuation of approach

Commencement and continuation of approach

(a) The commander or the pilot to whom conduct of the flight has been delegated may commence an instrument approach regardless of the reported RVR/Visibility but the approach shall not be continued beyond the outer marker, or equivalent position, if the reported RVR/visibility is less than the applicable minima (see OPS 1.192).

(b) Where RVR is not available, RVR values may be derived by converting the reported visibility in accordance with Appendix1 to OPS 1.430, subparagraph (h).

(c) If, after passing the outer marker or equivalent position in accordance with (a) above, the reported RVR/visibility falls below the applicable minimum, the approach may be continued to DA/H or MDA/H.

(d) Where no outer marker or equivalent position exists, the commander or the pilot to whom conduct of the flight has been delegated shall make the decision to continue or abandon the approach before descending below 1 000 ft above the aerodrome on the final approach segment. If the MDA/H is at or above 1 000 ft above the aerodrome, the operator shall establish a height, for each approach procedure, below which the approach shall not be continued if RVR/visibility is less than applicable minima.

(e) The approach may be continued below DA/H or MDA/H and the landing may be completed provided that the required visual reference is established at the DA/H or MDA/H and is maintained.

(f) The touch-down zone RVR is always controlling. If reported and relevant, the mid point and stop end RVR are also controlling. The minimum RVR value for the mid-point is 125 m or the RVR required for the touch-down zone if less, and 75 m for the stop-end. For aeroplanes equipped with a roll-out guidance or control system, the minimum RVR value for the mid-point is 75 m.

Note: "Relevant", in this context, means that part of the runway used during the high speed phase of the landing down to a speed of approximately 60 knots.

Appendix N

Appointment of Commander

The following is reproduced from the Operator's OM, Part D, Section 2.1.5, Revision 8:

	OPERATIONS MANUAL **Part D – Training** 2. Training Programmes and Verification 2.1 For the Flight Crew 2.1.5 APPOINTMENT OF COMMANDER	Section 2.1.5 Revision 8 Page. 18

1. REQUIREMENTS

Before beginning the Course the copilots being promoted must Comply with the Conditions of Age (25 years), Physical Aptitude (Current Medical Certificate), know the theory (Theorical Certificate of Transport) and have flight experience (at least 1500 hours which complies with that specified in JAR FCL 1.280).

a. Aircraft certified for two Pilots – BAE FLEET, EMBRAER 120 and ATR 42:

i. ATPL Title (a) and Current Type Qualification with IR

or

ii. Current Type Qualification with IR provided that the skill test for the Attainment of the ATPL is combined with the proficiency check as CM-1 will be carried out in the final phase of this training course.

b. Aircraft certified for one Pilot – METROLINER FLEET:

i. CPL Licence (a) and Current Class Qualification with the associated IR

ii. Minimum of 700 hours of total flight time in fixed wing, of which 400 will be as pilot in command (in conformity with the requirements of the flight Crew Licences), and of them 100 have been under IFR, including 40 hours of multi-engine operation. The 400 hours as pilot in command may be replaced by co-pilot hours on the basis of two hours co-pilot equivalent to one hour as pilot in command, as long as they have occurred in a multi-crew environment according to the manual of operations;

II. <u>PROGRAMME</u>

1) <u>Flight Training</u>

A. If there is access to a Simulator BAE FLEET, EMBRAER 120 and ATR42

1. Simulator Training 2 Periods of 4 hours:

i. In the first they will practise all the normal, abnormal and emergency procedures, with special emphasis on those involving alteration of the flight profile.

ii. In the second a LOFT flight will be carried out during the first 2 hours.

2. Verification of Competency

In the last 2 hours of the second period on the simulator a competency verification will be carried out according to Appendix 2 of JAR FCL 1.240 and 1.295.

	OPERATIONS MANUAL Part D – Training 2. Training Programmes and Verification 2.1 For the Flight Crew 2.1.5 APPOINTMENT OF COMMANDER	Section 2.1.5 Revision 8 Page. 19

C. Training in Flight

One hour of actual flight will be carried out in which will occur:

1. Failure after V2,
2. Engine Failure on approach and
3. Engine failure in the G.A.

This flight includes a minimum of 4 touchdowns and landings and a circling manoeuver. The engine failures will be simulated.

B. If there is no access to a simulator – METROLINER FLEET

(a) All the normal, abnormal and emergency procedures will be carried out, that do not involve alteration of the flight profile in the aircraft cockpit on the ground, during two days , with a duration of 4 hours per period each day.

(b) Procedures that involve alteration of the flight profile will be carried out in actual flight of 2 hours duration in which a verification of competency will be carried out according to Appendix 2 of the JAR FCL 1.240 and 1.295.

(c) Training in Flight

Two hours of actual flight time in which will occur;

1. Failure after V2,
2. Engine Failure on approach and
3. Engine failure in the G.A.

This flight includes a minimum of 4 touchdowns and landings and a circling manoeuver. The engine failures will be simulated.

2. Company Procedures and Responsibilities of the Captain

Will include:

1. Flight Procedures (SOP'S)
2. Authority, Functions and Responsibilites of the Captain (Section 1.4 of the MO A).

Duration: 4 hours on ground

2) Line Training under Supervision.

One requires a minimum of 10 Sectors as line training in command under supervision for pilots that will be qualified for a type of aircraft.

	OPERATIONS MANUAL Part D – Training 2. Training Programmes and Verification 2.1 For the Flight Crew 2.1.5 APPOINTMENT OF COMMANDER	Section 2.1.5
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		Page. 20

4. CRM TRAINING

i. Human Error and Weakness, error chain, prevention and detection of errors (review)

ii. Culture of Safety in the Company, SOP's, Organisational Factors (in depth)

iii. Stress, stress management, fatigue and vigilance (in depth)

iv. Obtaining information, actions in known situations, management of work distribution (in depth)

v. Making decisions (in depth)

vi. Communication and coordination inside and outside of the flight cabin (in depth)

vii. Leadership and group synergy (in depth)

viii. Automation and philosophy of their use (if required)

ix. Specific differences related to different types of aircraft (if required)

x. Case studies of occurrences and issues which require additional attention in accordance with that established in the programme for the prevention of accidents and flight safety (in depth)

This training will take place over 2 days with a minimum of 10 hours of lectures.

5) Line Check.

During this verification the ability to satisfactorily perform a complete line operation must be checked, including preflight and postflight procedures, and the use of the equipment provided as specified in the operations manual.

The aptitude of the flightcrew must be evaluated in relation to CRM

Acting as PF and PNF will be carried out and must complete the format as set out in Section 3.1.4 of part D.

6. Qualification of Competency en Route and at the Airport

Having completed, with satisfactory results, the line check the pilot will be qualified to operate the routes and airports used by the company.

Appendix O

Extract from submission made by the Operator to the Air Safety Committee of the EU Commission and Extract from Operational Letter No. 4/11

4. MEASURES TAKEN TO REINFORCE OUR CONTROL SYSTEM

The measures taken and which are aimed at avoiding a repetition of the failures observed and strengthening our Operational control system are detailed below:

A. Flights which originate outside our base at the Barcelona airport

1st 45 minutes before departure, the commander will contact the Service Coordinator to verify with him all the information relating to the flight.

2nd The following will be verified:

1. The identity of the crew, which have enough duty time margin to perform the flight and which have had their required rest period.
2. Which are not incompatible and have a valid license, Cima, Language Skills and all training and checks required in Subsection N of OPS1.
3. The state of airworthiness of the scheduled airplane, the effectiveness of its operational approvals and the functionality of its equipment and instruments, as well as its radio and navigation equipment complying with the requirements in Subsections K and L of OPS1.
4. That the weight, pressure altitude, wind, bleed and temperature conditions allow the aircraft to maintain, with one non-operational engine, the climb gradient required by the Jeppesen file for the Airport for the possible SID's.
5. That the route and the chosen flight level meet the altitude margin requirements in the event of engine failure or depressurization and if necessary, the selected on route alternate aerodromes.
6. The PVO including:
    a. The updated weather information from the destination aerodrome and those of the selected alternatives and verification that in the period between ETA + / - 1 hours the visibility and ceiling requirements in OPS1 are met.
    b. The NOTAMS of the usable aerodromes and verification of their possible operational constraints.
    c. That the destination and alternate routes are fully developed.
    d. That the load and/or passage data in the cargo sheet are correct and match those of Handling.
    e. That the fuel load matches that entered in the PVO and is enough to perform the flight complying with that established in OPS1.

ANALYSIS OF THE ACCIDENT AND THE MEASURES TAKEN Page16

As the Coordinator checks all these points, he/she will be filling out the checklist below and only once it is adequately completed, will the commander be informed that the flight dispatch is OK and he/she may proceed with the flight.

(Page 17)

Checklist for flight dispatch

FLIGHT NUMBER	DATE	TIME	REGISTRATION	AIRPLANE STATE FOR MAINTENANCE	PVO COMPLETED BY

CREW	CM1	FO
Duty and rest		
Status of trainings and checks		
Crew compatibility		
AIRPORT ANALYSIS		
ROUTE ANALYSIS		
OPERATIONAL FLIGHT PLAN		
METEOROLOGICAL		
Alternative		
NOTAMS		
FUEL		
PAYLOAD		
PAYLOAD DATA		

COMMENTS:

Coordinator	CHECKED
Name: Date: .... Time:	At the FTL office ☐ By Phone ☐

PE(2) 03 F01 R00

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B. Flights which originate at our base at the Barcelona airport.

1st The commander with contact with the Flight Dispatch Office Coordinator 45 minutes before takeoff.

2nd The Coordinator will hand the envelope with the flight documents to the commander.

3rd The Commander will review and verify the documents, make any changes he/she deems appropriate and once the changes are approved by the coordinator, the commander will review and sign the documents.

4th The Coordinator will in turn fill in all the points in the flight dispatch Checklist and once he/she is sure that all are correct, he/she will inform the commander that the dispatch is correct and the flight may be carried out.

5. OUR OBJECTIVES

With the inclusion and enforcement of this Checklist, we intend to strengthen our operational control by:

1st Checking directly with the commander, before the flight, which crew members will take part in the flight and avoid what happened on 10 February in Belfast - Cork where we could not detect the change that the co-pilots made and which resulted in a flight which had an unauthorized and unscheduled crew.

2nd Ensuring that the crew knows the weather conditions at all aerodromes involved in the flight, that it has selected its alternatives within the standards and that their weight and fuel data are real.

3rd Strengthening the involvement of the Head of Maintenance in the dispatch of flights, which must send a daily report on the airplanes which are operational on that day including:

- The state of airworthiness of the scheduled airplane,
- the effectiveness of its operational approvals and
- the functionality of its equipment and instruments, as well as its radio and navigation equipment complying with the requirements in Subsections K and L of OPS1. *Please refer to the example in DOC 3.5*

4th Obtaining assurance from the Head of Education that the scheduled crew meets all the conditions of training and checking required by OPS1, for which he/she will send biweekly reports, and whenever there is a change to crew scheduling and flight dispatch the "Training and Checking Control Center" will be attached. DOC 3.6

3. **ANALYSIS OF THE ACCIDENT AND THE MEASURES TAKEN TO INCREASE SAFETY**

Likewise, he/she will inform both departments of the halt in operations of the new pilots and any restrictions or incompatibilities that may affect a crew. Please refer to the attached "Table of Crew Compatibility" DOC 3.7

5th Ensuring that the commander knows the analysis of the airport to be used, the route, and the limitations that may affect the flight.

6th Creating a procedure that allows us to prevent the departure of a flight before fulfilling all the legal requirements.

7th Increasing the safety of the operation.

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Extract from Operational Letter No. 4/11 (English Translation)

ii Start of approach and continued approach

a) The commander, or the pilot appointed for conducting the flight, may start an instrument approach regardless of the reported RVR/visibility, but the approach shall not continue beyond the exterior marker, or an equivalent position, if the reported RVR/visibility is lower than the applicable minimum.

b) When no RVR is available, RVR values may be calculated by converting the reported visibility.

c) If, after having passed the exterior marker or an equivalent position, the reported RVR/visibility is lower than the applicable minimum, the approach may continue as far as the DA/H or MDA/H.

d) When there is no exterior marker or equivalent position, the commander, or the pilot appointed for conducting the flight, may take the decision of continuing with the approach under 1000 feet over the aerodrome when the RVR/Visibility and ceiling are higher than the minimum set by the Jeppersen chart.

e) The approach might continue under the DA/H or MDA/H, and landing may be completed, as long as the visual reference required in the DA/H or MDA/H is established and respected.

NOTE: In case of a missed approach from minimum values due to weather causes, proceed to the alternative.

ABBREVIATIONS

°	degrees (angular measurement)
°C	Degrees Centigrade (temperature)
°F	Degrees Fahrenheit(temperature)
°M	Degrees Magnetic (direction)
AAIB	Air Accidents Investigation Branch (United Kingdom)
AAIU	Air Accident Investigation Unit (Ireland)
ACMI	Aircraft, Crew, Maintenance and Insurance
AESA	*Agencia Estatal de Seguridad Aérea*
AFM	Airplane Flight Manual (Fairchild SA 227)
AFO	Airport Fire Officer
AFS	Airport Fire Service
AFTN	Aeronautical Fixed Telecommunication Network
AMC	Air Movements Controller (Air Traffic Control)
AMM	Aircraft Maintenance Manual (Fairchild SA 227)
AMO	Approved Maintenance Organisations
AMP	Aircraft Maintenance Programme
AOA	Angle of Attack (Indicator)
AOC	Air Operator Certificate
AOP	Airline Operating Permit (United Kingdom)
APP	Approach Controller (Air Traffic Control)
ARC	Airworthiness Review Certificate
ATC	Air Traffic Control
ATM	Air Traffic Management
ATIS	Automatic Terminal Information Service
ATOL	Air Travel Organisers Licence
BCF	Bromochlorodifluoromethane (fire-fighting agent)
CAA	Civil Airworthiness Authority (United Kingdom)
CAME	Continuing Airworthiness Management Exposition
CAMO	Continuing Airworthiness Management Organisation
CAR	Commission for Aviation Regulation (Ireland)
CAT	Commercial Air Transport (EU Regulation)
CAT I/II/III	Category I, II or III Instrument Landing System
CDI	Course Deviation Indicator
CI	Chief Instructor
CIAIAC	*Comisión de Investigación de Accidentes e Incidentes de Aviación*
CPL	Commercial Pilot Licence
CRE	Class Rating Examiner
CRI	Class Rating Instructor
CRM	Crew Resource Management
CVR	Cockpit Voice Recorder
DfT	Department for Transport (United Kingdom)
DA/H	Decision Altitude/Decision Height
DG	Directional Gyro

DH	Decision Height
DME	Distance Measuring Equipment
DPT	*Descanso Parcial en Tierra* (partial rest on the ground)
EASA	European Aviation Safety Agency
ELP	English Language Proficiency
ELT	Emergency Locator Transmitter
EMM	Engine Maintenance Manual
FAA	Federal Aviation Administration (United States)
FCL	Flight Crew Licensing
FCU	Fuel Control Unit
FDR	Flight Data Recorder
FDP	Flight Duty Period
FFFP	Film-Forming Fluoro Protein (fire-fighting agent)
ft	feet
FOI	Flight Operations Inspector
FTO	Flight Training Organisation
GP	Glideslope
HDG	Heading
HIALS	Hi-Intensity Approach Lighting System
hPa	hectoPascals
HSI	Horizontal Situation Indicator
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
ILS	Instrument Landing System
IRVR	Instrument Runway Visual Range
JAA	Joint Aviation Authorities
JAR	Joint Aviation Requirements
kHz	kiloHertz
KIAS	Knots Indicated Airspeed
km	kilometre
L	Litres
lbs	Pounds (weight)
LC	Line Check
LLZ	Localizer
LOPA	Layout of Passenger Accomodation
LPC	Licence Proficiency Check
LVP	Low Visibility Procedures
m	metre
MDA/H	Minimum Descent Altitude/ Minimum Descent Height
MEL	Minimum Equipment List
MHz	MegaHertz
MM	Middle Marker
MNPS	Minimum Navigation Performance Specification
MOE	Maintenance Organisation Exposition
MSN	Manufacturer's Serial Number
MTOW	Maximum Take Off Weight
NAA	National Aviation Authority (generic term)

NM	Nautical Mile
NOTAM	Notices to Airmen
Np	Engine Speed (%)
NTS	Negative Torque Sensing
NTSB	National Transportation Safety Board (United States)
NWS	Nose Wheel Steering
OEM	Original Equipment Manufacturer
OEW	Operational Empty Weight
OM	Operations Manual
OM	Outer Marker (Navigation Aid)
OPC	Operator Proficiency Check
OSG	Overspeed Governor
P1	Pilot-in-Command
P1/S	Pilot-in-Command, under Supervision
P2	Co-Pilot, Second-in-Command
P/N	Part Number
PANS	Procedures for Air Navigation Services
PAPI	Precision Approach Path Indicators
PF	Pilot Flying
PG	Propeller Governor
PLA	Power Lever Angle
PNF	Pilot Not Flying
P_{T2}/T_{T2}	Pressure/Temperature sensor (engine component)
QNH	Altimeter barometric setting with reference to sea level
RA	Radio Altitude
RBS	Radio Backup System
RFF	Rescue and Fire Fighting appliance
RPL	Repetitive Flight Plan
RPM	Revolutions Per Minute
RVR	Runway Visual range
RVSM	Reduced Vertical Separation Minimum
RWY	Runway
S/N	Serial Number
SAFA	Safety Assessment of Foreign Aircraft
SALS	Simple Approach Lighting System
SANA	Safety Inspection of National Aircraft (Spain)
SARPS	Standards and Recommended Practices
SB	Service Bulletin
SHP	Shaft Horse Power
SMC	Surface Movements Controller (Air Traffic Control)
SMS	Safety Management System
SOP	Standard Operating Procedures
TAF	Terminal Aerodrome Forecast
TAWS	Terrain Awareness Warning System
TRTO	Type Rating Training Organisation
USG	US Gallons
USG	Underspeed Governor

UTC	Coordinated Universal Time
VFR	Visual Flight Rules
VHF	Very High Frequency
VOR	VHF Omnidirectional Radio range
Wf	Fuel flow
WOCL	Window of Circadian Low

AIRPORT DESIGNATORS

ICAO	IATA	Airport	State
DAAG	ALG	Algiers (Houari Boumediene)	Algeria
DAFH	HRM	Tilrempt (Hassi R Mel)	Algeria
DAOO	ORN	Oran (En Sénia)	Algeria
EGAA	BFS	Belfast International (Aldergrove)	United Kingdom
EGAC	BHD	Belfast City (George Best)	United Kingdom
EGNS	IOM	Isle of Man (Ronaldsway)	United Kingdom
EGPE	INV	Inverness	United Kingdom
EGPH	EDI	Edinburgh	United Kingdom
EICK	ORK	Cork	Ireland
EIDW	DUB	Dublin	Ireland
EIKY	KIR	Kerry	Ireland
EINN	SNN	Shannon	Ireland
EIWF	WAT	Waterford	Ireland
EKBI	BLL	Billund	Denmark
LEBL	BCN	Barcelona (El Prat)	Spain
LEPA	PMI	Palma de Mallorca	Spain
LERS	REU	Reus	Spain
LEZL	SVQ	Seville	Spain

- END -

NOTES

NOTES

In accordance with Annex 13 to the Convention on International Civil Aviation, Regulation (EU) No 996/2010, and Statutory Instrument No. 460 of 2009, Air Navigation (Notification and Investigation of Accidents, Serious Incidents and Incidents) Regulations 2009, the sole purpose of this investigation is to prevent aviation accidents and serious incidents. It is not the purpose of any such investigation and the associated investigation report to apportion blame or liability.

A safety recommendation shall in no case create a presumption of blame or liability for an occurrence.

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AAIU Reports are available on the internet www.aaiu.ie

An Roinn Iompair Turasóireachta agus Spóirt

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