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).*	**<u>Non-compliance No.6</u>** 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;	**<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 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	**<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.
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	**<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.

(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.	**Refer to Non-compliances 2 and 3.**
(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 620 %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

FORM 503 PAGE 4
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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	BC769	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=
```

```
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]

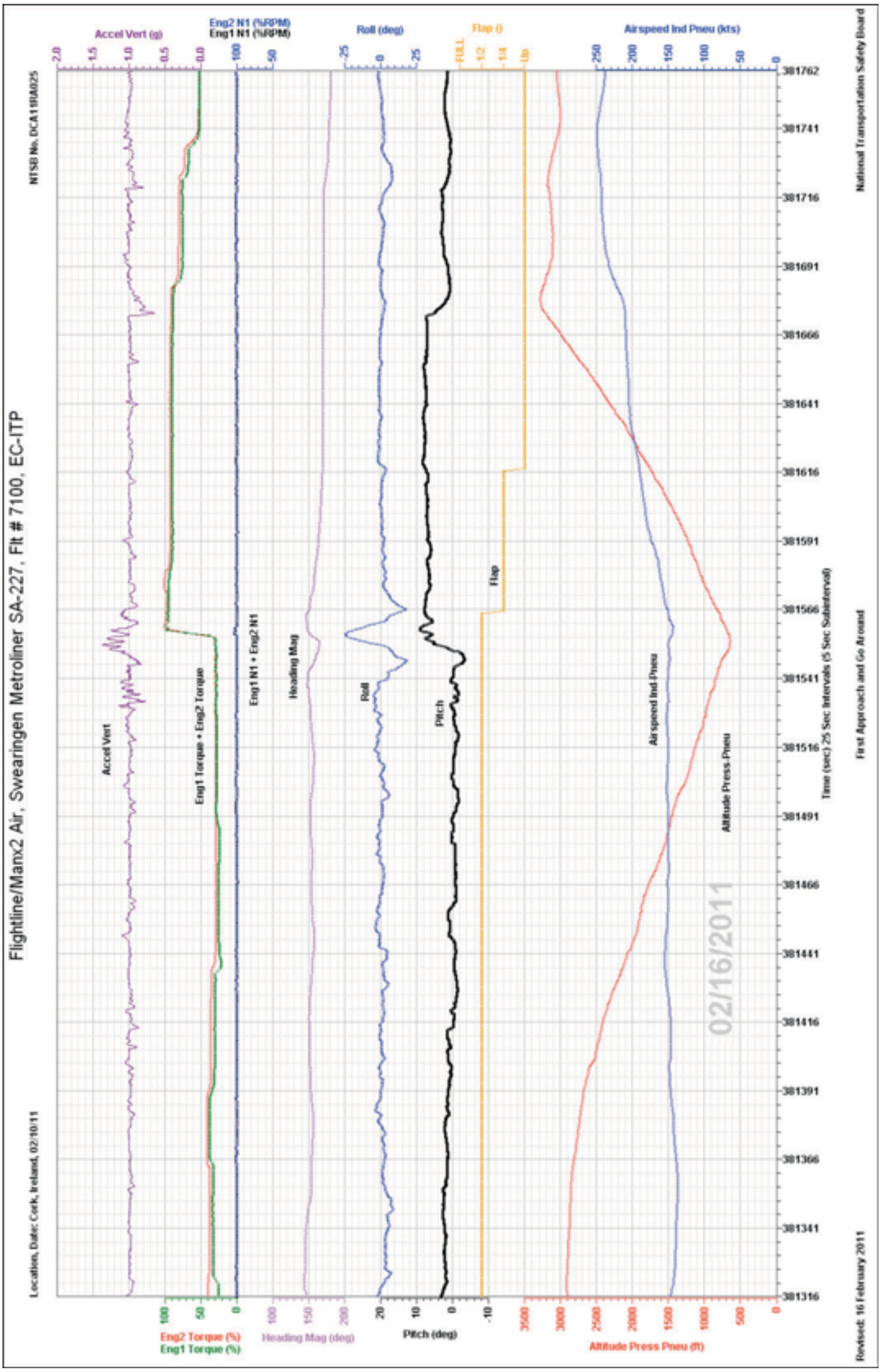
Certified Transcript of Cork Ground (121.850 MHz)
on 10 February 2011

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*

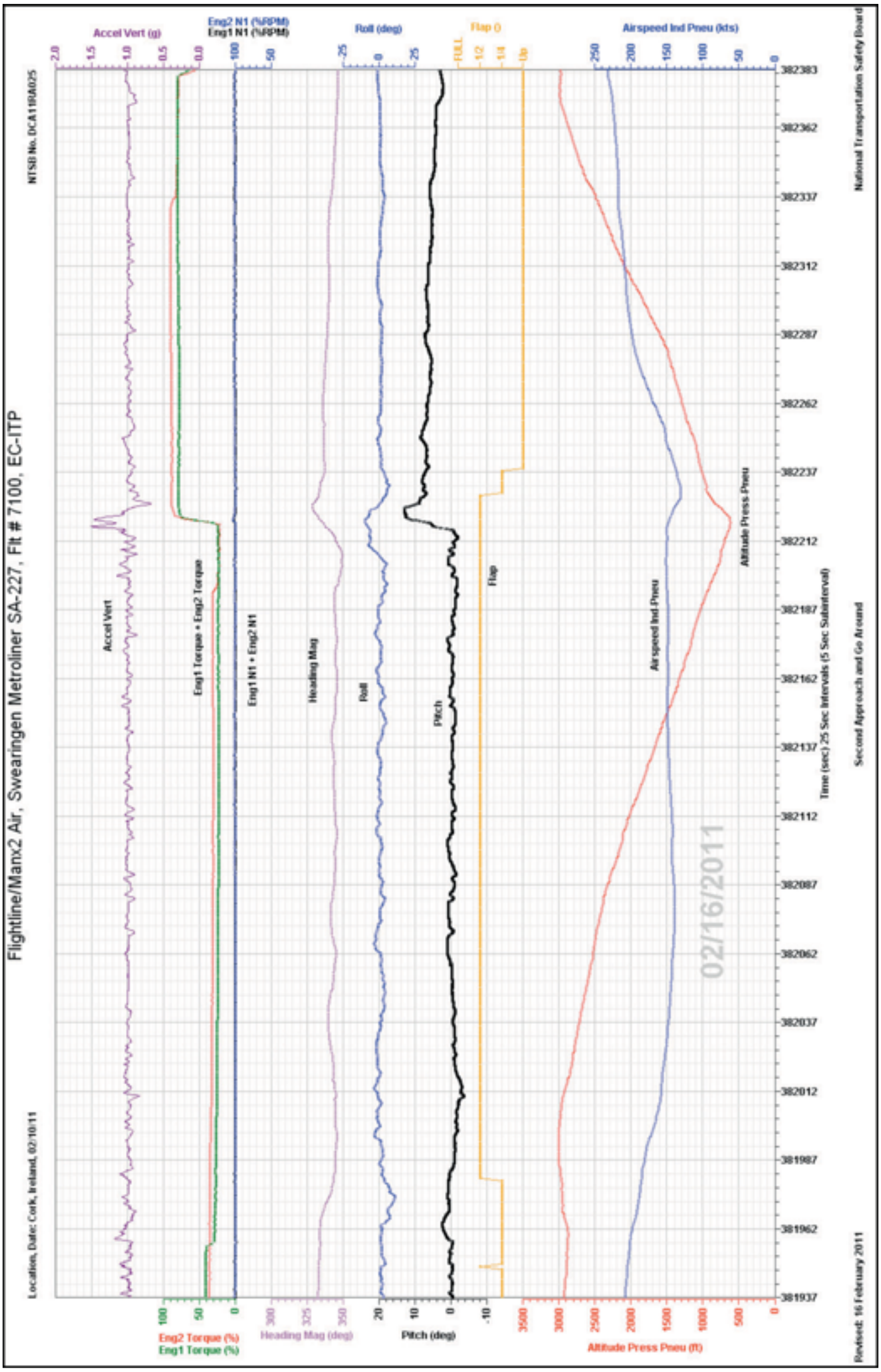
09.57:15	Police 1	*Proceeding via Charlie on to 17-35*
09.57:20	Police 2	*Tower, Police 2 proceeding with Police 1*
09.57:22	Ground	*Police 2 roger, thank you*
09.57:43	AFO	*Ground AFO*
09.57:44	Ground	*AFO Ground*
09.57:47	AFO	*For information, there is some debris on the runway between Taxiway Alpha 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

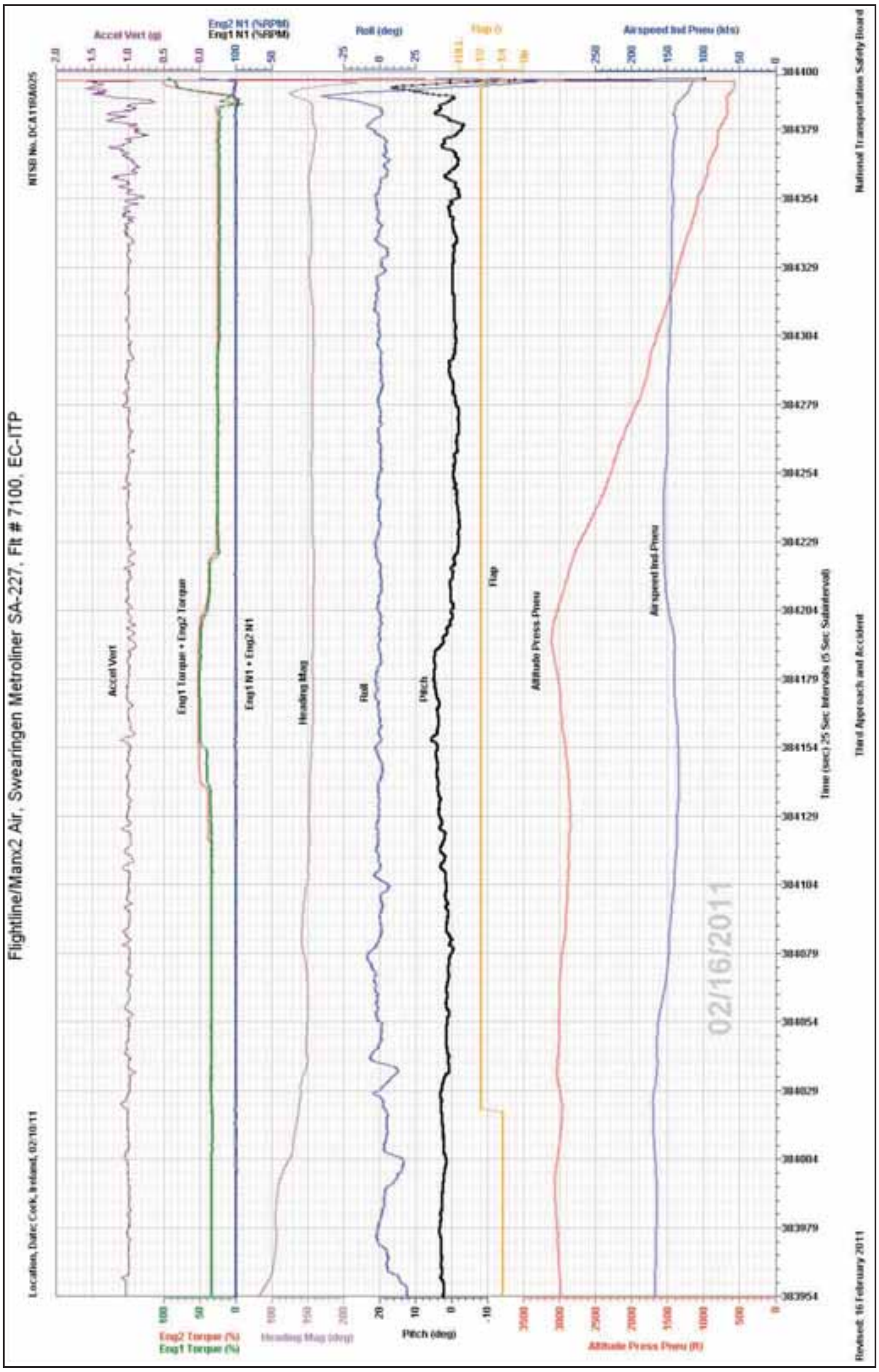
FDR data for first approach and go-around



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.

<u>Propeller No. 2</u> (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

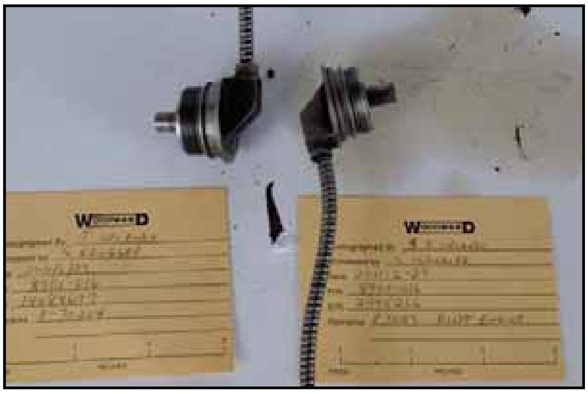


Photo No. 2:
Bellows height comparison

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**).

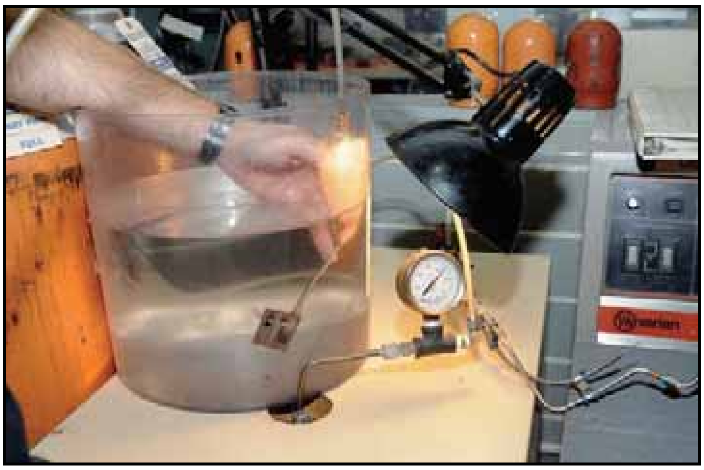


Photo No. 3: P_{T2}/T_{T2} leak check test

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**).

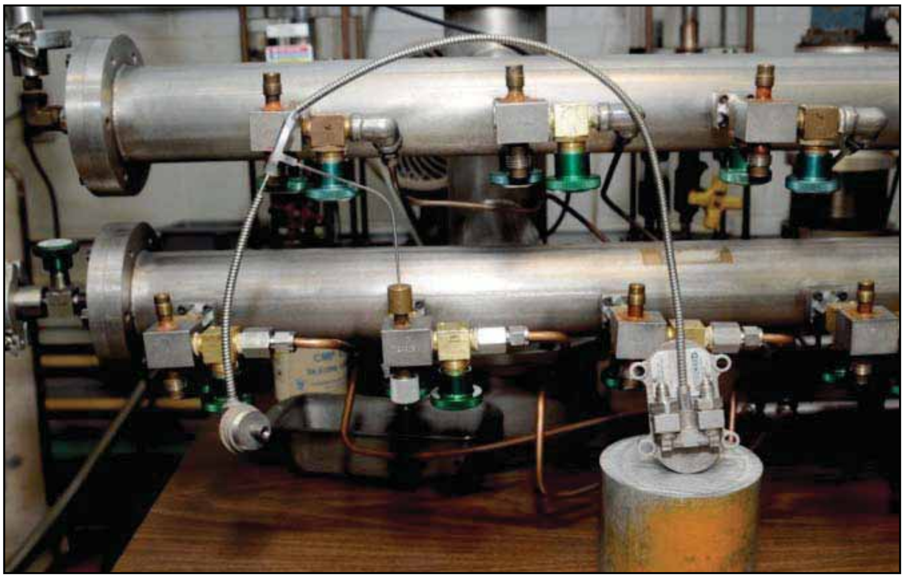
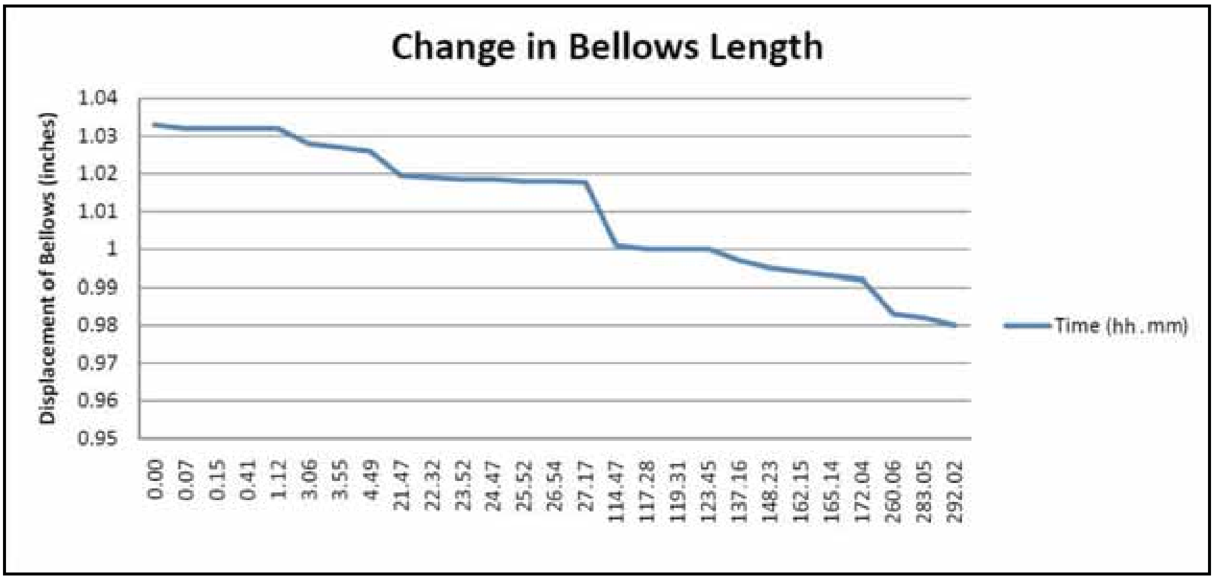


Photo No. 7: pressurizing the P_{T2}/T_{T2} sensor to determine leak rate

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.

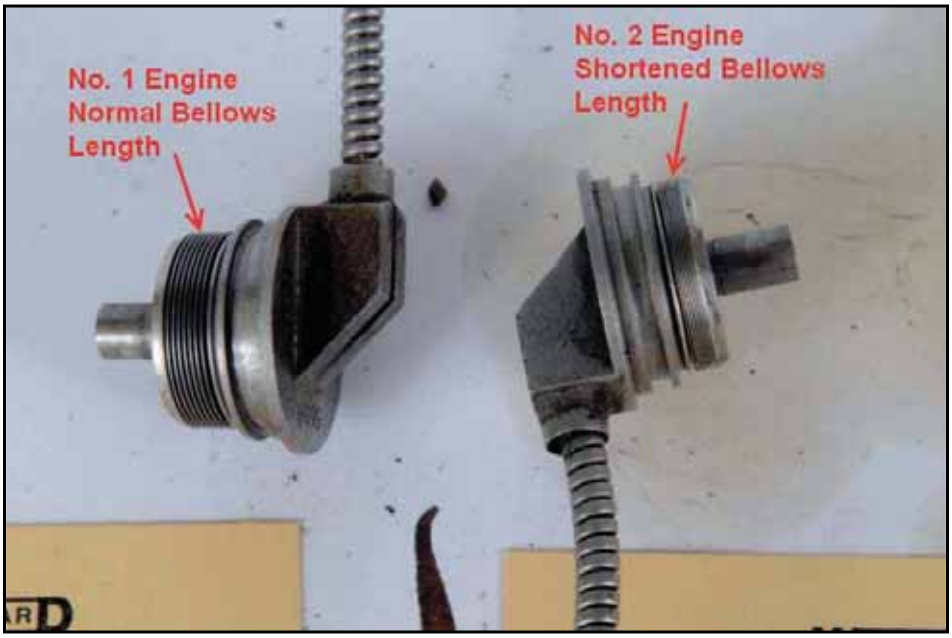


Photo No. 1: P_{T2}/T_{T2} sensor bellows from No. 1 and No. 2 Engines

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.

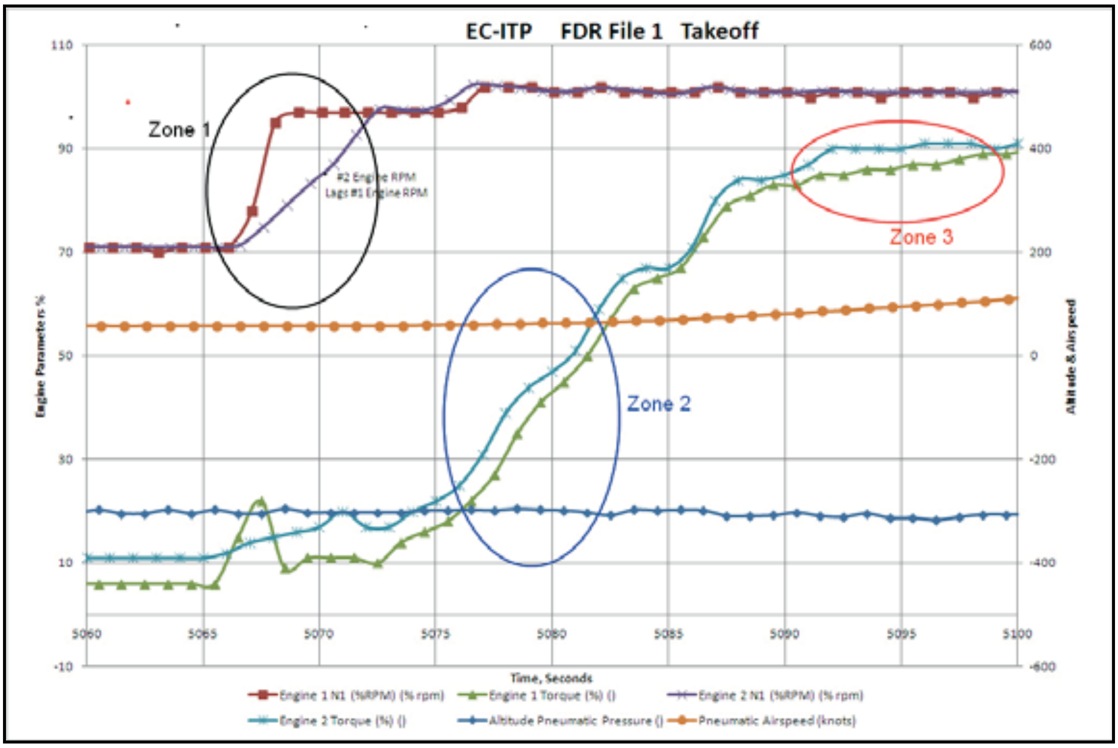


Figure No. 1: Previous Take-off FDR Parameters

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.

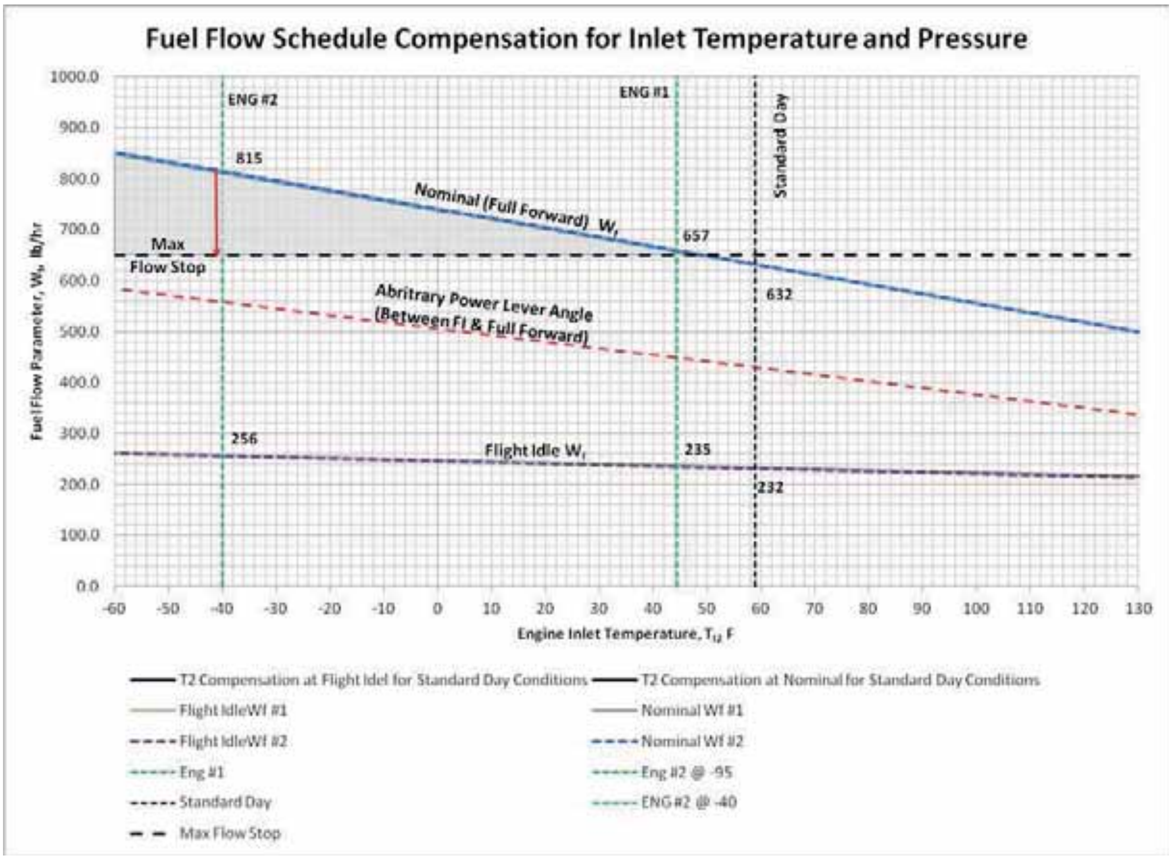


Figure No. 2: Fuel Flow Schedule Compensation (Source Honeywell)

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.

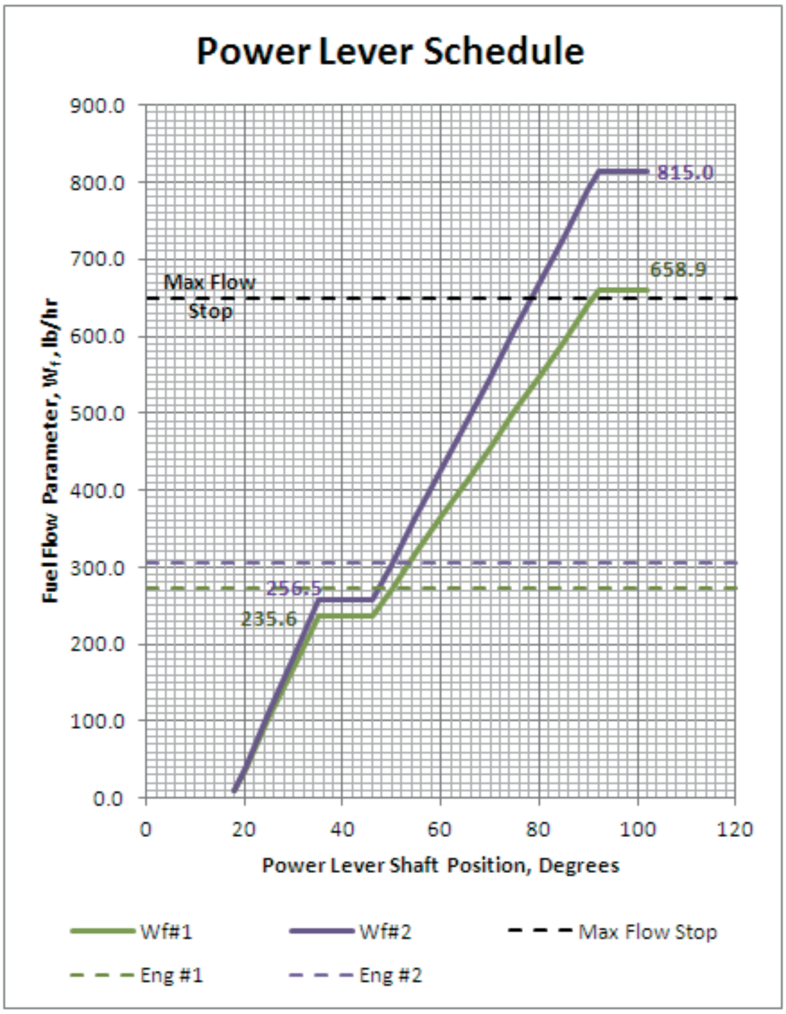


Figure No. 3: Power Lever Schedule for EC-ITP Engines (*Honeywell*)

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.

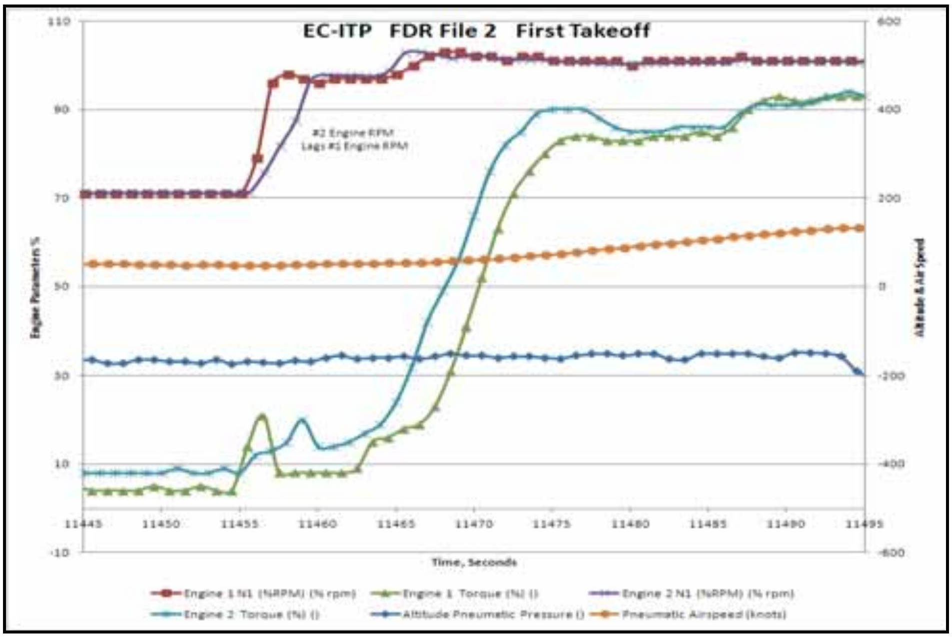


Figure No. 4: Sample of take-off FDR parameters weeks prior to accident

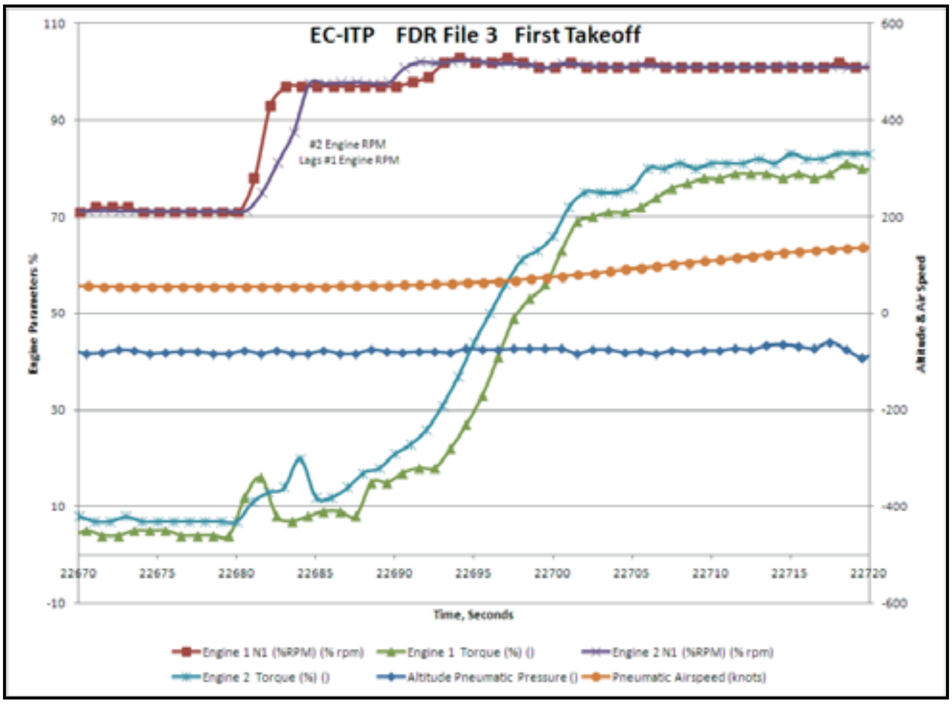


Figure No. 5: Additional sample of take-off FDR parameters weeks prior to accident

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.

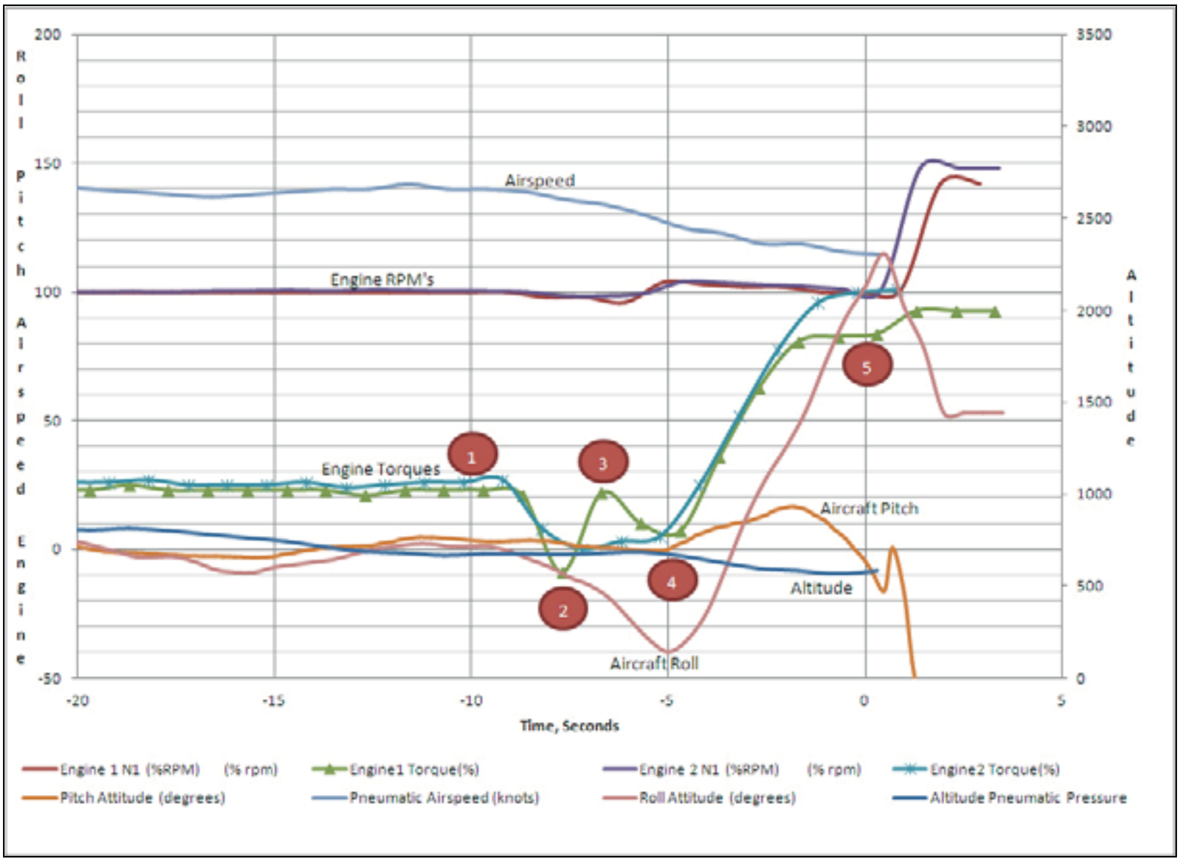


Figure No. 6: FDR Parameters during final approach (accident flight)

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.

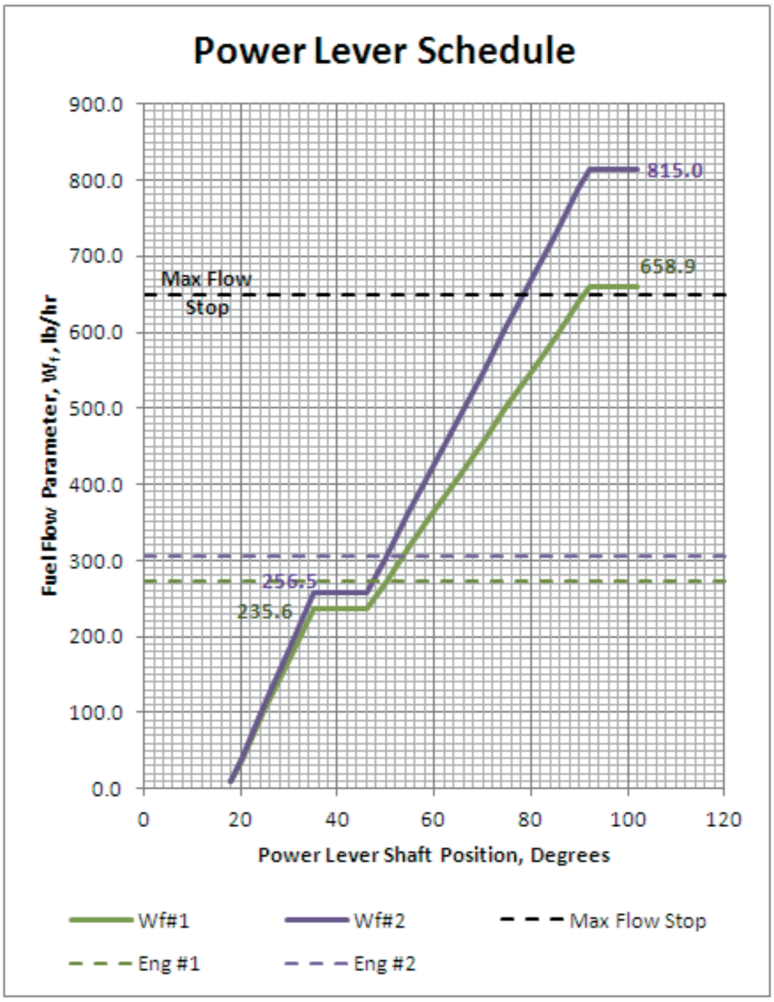


Figure No. 7: Fuel Flow/Power Lever Angle (PLA) Curves

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.

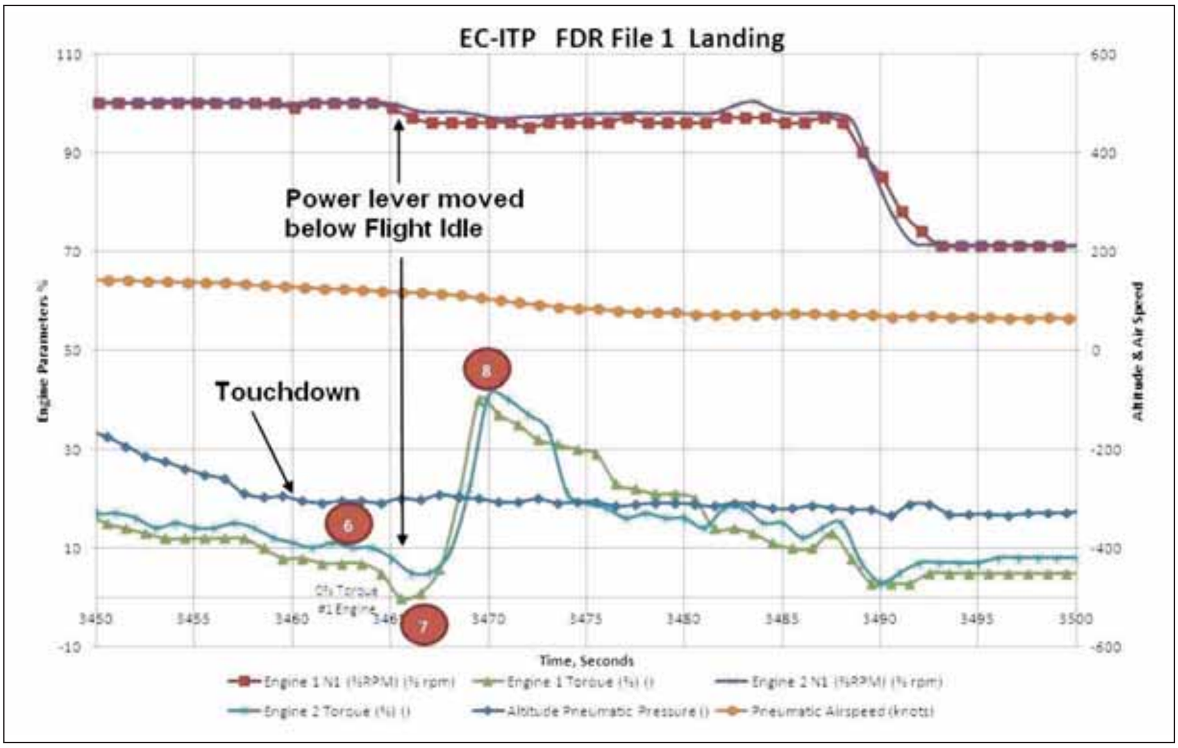


Figure No. 8: FDR Data from Previous Landing

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**.

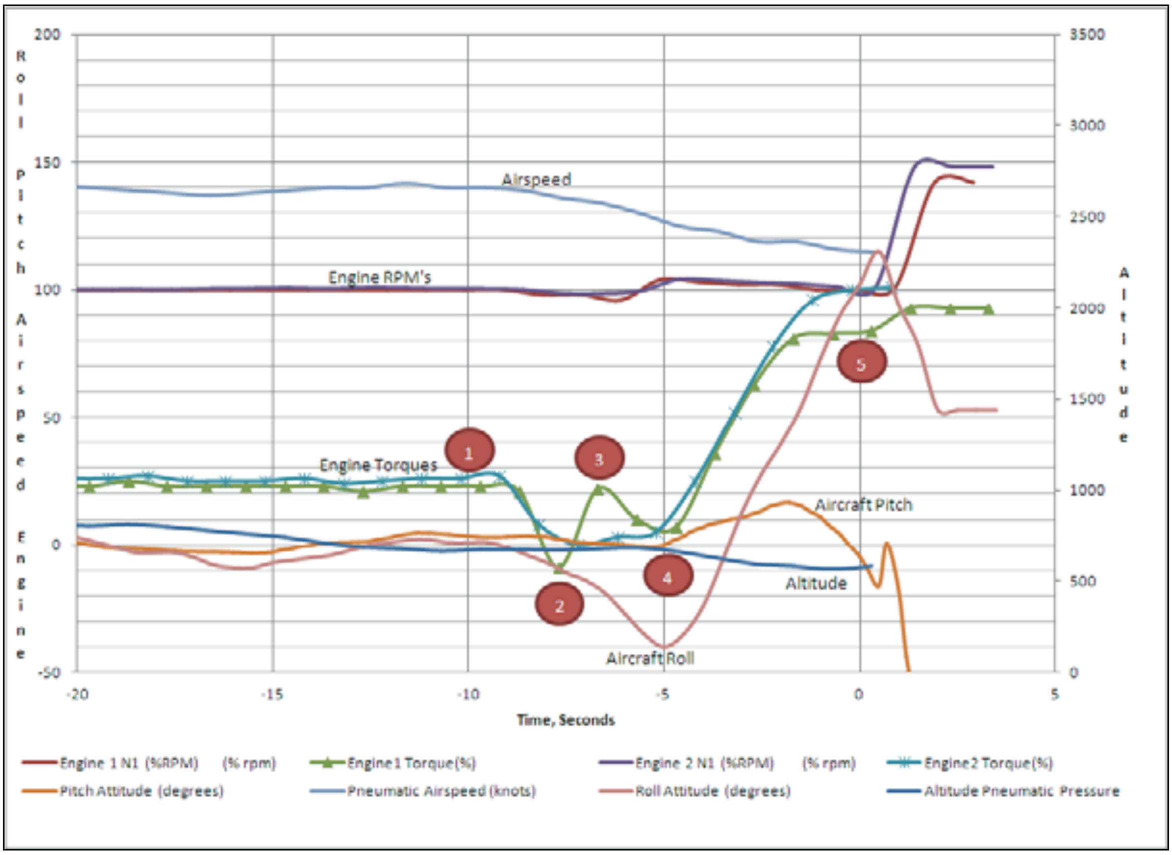


Figure No. 9: FDR Parameters during final approach (accident flight)

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. PROGRAMME

1) Flight Training

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 Revision 8 Page. 20

4. <u>CRM TRAINING</u>

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) <u>Line Check.</u>

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. <u>Qualification of Competency en Route and at the Airport</u>

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.

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.

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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

ANALYSIS OF THE ACCIDENT AND THE MEASURES TAKEN Page18

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.

Produced by the Air Accident Investigation Unit

AAIU Reports are available on the internet **www.aaiu.ie**

An Roinn Iompair Turasóireachta agus Spóirt

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