INCIDENT INVESTIGATION REPORT IRN000102 Issue 1

This investigation involved the following equipment;

MEGGITT RETURN No	N/A	PART No	DAP00100-07	QTY	1
DESCRIPTION	BCU	SERIAL No	230000159		
DATE OF MANUFACTURE	Aug 2011	MOD. STATE	1		
OPERATOR	Flight Options LLC	REPORTED USAGE	Unknown		
AIRCRAFT	EMB-505	DATE OF INCIDENT	05/08/2013		
CONSTRUCTOR	Embraer	CUSTOMER ORDER	N/A		

1. INTRODUCTION

Event Details as reported by the NTSB:

On August 5, 2013, at 0848 central daylight time, N327FL, an Embraer S.A. EMB-505, multi-engine turbofan airplane, was substantially damaged during landing at Flying Cloud Airport (FCM), Eden Prairie, Minnesota. The two pilots were not injured. The airplane was registered to and operated by Flight Options, LLC; Cleveland, Ohio. Day visual meteorological conditions (VMC) prevailed at the time of the accident and an instrument flight rules flight plan had been filed for the 14 Code of Federal Regulations Part 91 positioning flight. The airplane had departed Pittsburgh International Airport (PIT), Pittsburgh, Pennsylvania, about 0730 eastern daylight time and was destined for FCM.

The pilots reported that the airplane was on a steep visual approach when they landed long and fast. The pilot flying also reported that after touchdown he could feel the pulsing of the anti-skid brakes but was unable to stop on the runway surface. The airplane departed the end of the runway and impacted the airport boundary fence coming to rest on a four-lane highway about 1,000 feet from the runway.

At 0838 the data from FCM revealed that the wind was from 150 degrees at 4 knots, 6 miles visibility in mist, few clouds at 200 feet above ground level (agl), an overcast ceiling at 7,000 feet agl, temperature 18 degrees C, dew point temperature 17 degrees C, with an altimeter setting of 29.89 inches of mercury. Remarks indicated that rain ended at 0819 with a one hour precipitation of 0.01 inches.

For full details see Appendix 1 'National Transportation Safety Board Preliminary Report Aviation CEN13LA462'

2. APPENDICES

Appendix	1	National Transportation Safety Board Preliminary Report Aviation CEN13LA462
Appendix	2	Fault Log Download
Appendix	3	AAIB Field Notes

3. INVESTIGATION MEETING

MABS arranged an investigation meeting which was held on 3rd October 2013, attendees were;

Brian McDermid	AAIB (Attending on behalf of NTSB)
Luis Savio dos Santos	Embraer Aviation Europe
Andy Whittingham	MABS, Chief Project Engineer
John Smith	MABS, Customer Support Engineer
Neil Wann	MABS, Senior Software Engineer

Meeting agenda;

- Review unit history
- Conduct Fault Log download
- Conduct Function Tests
- Analyses of findings and event data

4. UNIT HISTORY

Date of Manufacture 15/08/2011 as -06 Mod 0 standard

Upgraded to -07 standard, (in accordance with Service Information Letter CS-SIL-00039 Issue 2) carried out by MABS tech support field engineer Nov 2011

Returned to MABS following the incident

5. TEST EQUIPMENT UTILISED (FOR FAULT LOG DOWNLOAD AND FUNCTION TESTING)

- BCUTE F2895
- BCU Main Connector Harness F2895_1
- BCU Test Connector Harness F2895_2
- Adaptor Module DAA05451-00
- Adaptor 1 Harness F2907_1
- Adaptor 2 Harness F2907_2

(See Figure 1 below)

Figure1

6. FAULT LOG DOWNLOAD

The BCU's fault logs were read in accordance with Production Acceptance Test Procedure TPDAP00100 Section 3.8 Batch File B00100_05V2.txt.

Overall power up count = 1542 (3 power ups since incident event)

The incident data correlates with the fault records for BCU power up 1539.

Four fault logs associated with this event are listed below;

READ_FAULT_LOG
MODULE : BCU1
FAULT ID : EXT_Pedal_Fail_R1
READING : 0022 0001 0603 0027 6345 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
DECIMAL : 34 1 1539 39 25413 0 0 0 0 0 0 0 0 0 0 0 0

READ_FAULT_LOG
MODULE : BCU1
FAULT ID : EXT_Pedal_Fail_R2
READING : 0023 0002 000E 0007 E302 0603 0027 6345 0000 0000 0000 0000 0000 0000 0000 0000 0000
DECIMAL : 35 2 14 7 58114 1539 39 25413 0 0 0 0 0 0 0 0 0

READ_FAULT_LOG
MODULE : BCU1
FAULT ID : Pedal_Fail_R1
READING : 0033 0001 0603 0027 4AA1 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
DECIMAL : 51 1 1539 39 19105 0 0 0 0 0 0 0 0 0 0 0 0

READ_FAULT_LOG
MODULE : BCU1
FAULT ID : Pedal_Fail_R2
READING : 0034 0002 000E 0007 DD89 0603 0027 4A8C 0000 0000 0000 0000 0000 0000 0000 0000 0000
DECIMAL : 52 2 14 7 56713 1539 39 19084 0 0 0 0 0 0 0 0 0

See appendix 2 for complete fault log download results

7. FUNCTION TESTING

The BCU was then subjected to the following tests in accordance with Production Acceptance Test Procedure TPDAP00100, execution of part B batch files.

Section 3.8 Batch File B00100_05V2.txt Read Fault Log

Section 6.11 Batch File B00100_04.txt Clear Fault Log

Section 6.1 Batch File B00100_17V2.txt Power Supply

Section 6.2 Batch File B00100_18.txt Wheel Speed Transducer Interfaces

Section 6.3 Batch File B00100_19V9A,B,C & D.txt Brake Pedal LVDT Interfaces

Section 6.4 Batch File B00100_20.txt Brake Pressure Interfaces

Section 6.5 Batch File B00100_21V6.txt Discrete Input Interfaces

Section 6.6 Batch File B00100_22V2.txt Discrete Output Interfaces

Section 6.7 Batch File B00100_23V3.txt Brake Control (Servo) Valve Interfaces

Section 6.8 Batch File B00100_24V5.txt Shut Off Valve Interface

Section 6.9 Batch File B00100_25V3.txt Hardware By-Pass

Section 6.10 Batch File B00100_16V3.txt System Tests

Section 6.11 Batch File B00100_04.txt Clear Fault Log

Results

The BCU successfully completed the all tests.

Note

The full set of functional testing results have not been included in this document due to file size, however they would be made available on request.

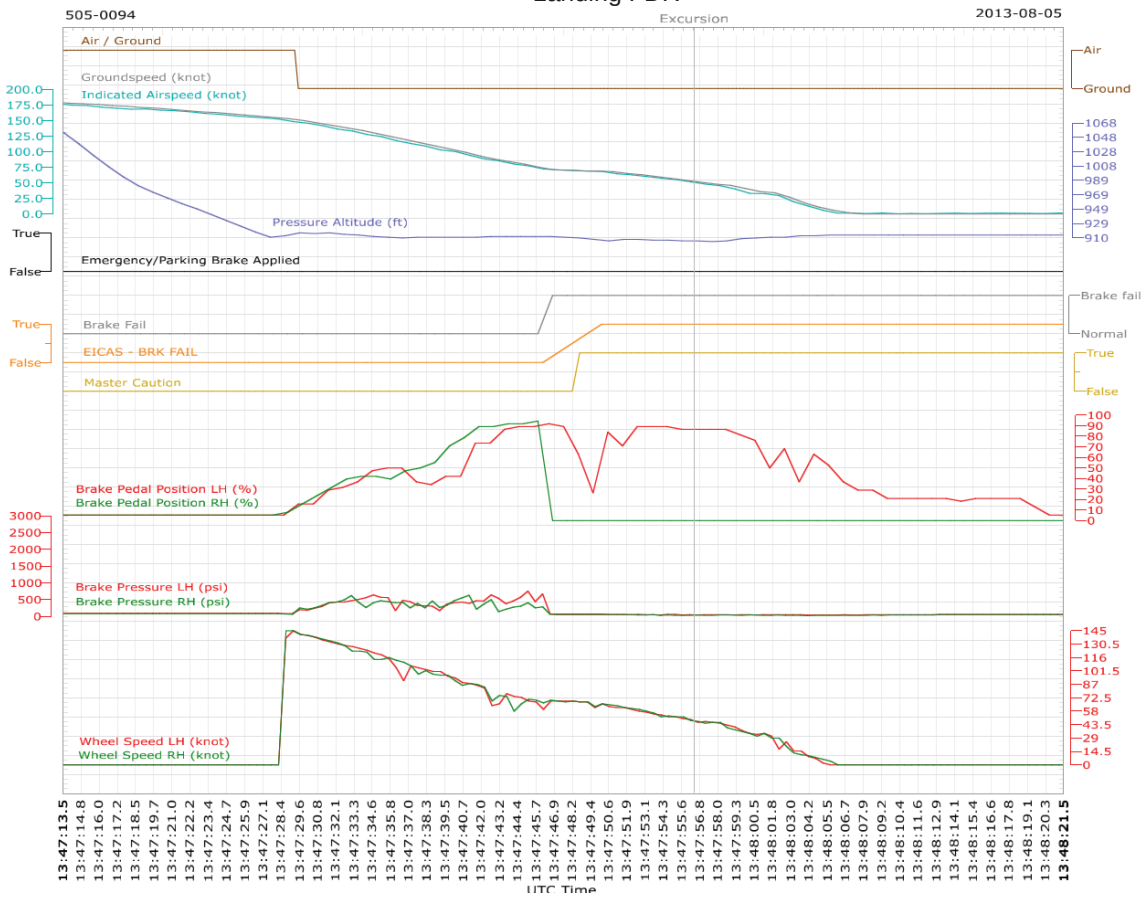
Provided Aircraft Data

Landing CAS/CMC Data

FLIGHT	CAS	A: HIGH SPEED	1464	05/08/2013	13:47:09	CLEAR not inh	0.13897	0.13897	93.50242	0	0.28022	93.50242	
FLIGHT	CAS	A: FLT DIRECTOR	1267	05/08/2013	13:47:29	SET not inh	0	0	0	0	0	6	0
LANDING	CMC	_landing_transition	5	05/08/2013	13:47:30	SET not inh	74.77299	74.67654	0.57703	0.57781	0		
LANDING	CMC	_landing_transition	5	05/08/2013	13:47:30	SET not inh	74.77299	74.67654	0.57703	0.57781	0		
GND	CAS	A: FLT DIRECTOR	1267	05/08/2013	13:47:30	CLEAR not inh	0	0	0	0	0	6	1
GND	CMC	AFCS FD VERTICAL MODE REVERT	732	05/08/2013	13:47:30	SET not inh	0	0	0	7	24	6	
GND	CMC	_gps position	2	05/08/2013	13:47:31	SET not inh	-1115064061	534819755	-1115064061	534819755	-1	-1	1	0
GND	CMC	AFCS FD VERTICAL MODE REVERT	732	05/08/2013	13:47:38	CLEAR not inh	0	0	0	0	0	0	
GND	CAS	BRK FAIL	1567	05/08/2013	13:47:48	SET not inh	0	0	2	2071	1	0	
GND	CMC	_AIRBORNE_INDICATION_GND_30S	98	05/08/2013	13:48:01	SET not inh	0						
GND	CAS	K1	1002	05/08/2013	13:48:01	SET not inh	1	0					
GND	CAS	AP FAIL	1530	05/08/2013	13:48:03	SET not inh	0	0	1	1	1	1	1
GND	CAS	VENTRAL RUD FAIL	1486	05/08/2013	13:48:03	SET not inh	0	31	31	1	31	31	0
GND	CAS	YD FAIL	1240	05/08/2013	13:48:03	SET not inh	0	1	1				
GND	CMC	_afcs_ap_fail	806	05/08/2013	13:48:04	SET not inh	1	1	1				
GND	CMC	_afcs_yd_fail	763	05/08/2013	13:48:04	SET not inh	1	1	1				
GND	CAS	ADS 1 SLIP FAIL	1521	05/08/2013	13:48:04	SET not inh	0	1	4720989				
GND	CAS	ADS 2 HTR FAIL	1553	05/08/2013	13:48:04	SET not inh	0	1	-1895805				
GND	CMC	ADS/SWPS IASP 2 HEATER FAIL	204	05/08/2013	13:48:04	SET not inh	-1895805411						
GND	CMC	_afcs_ap_ahrs1_fail	795	05/08/2013	13:48:05	SET not inh	1	-52436992					
GND	CMC	_afcs_ap_ahrs2_fail	796	05/08/2013	13:48:05	SET not inh	1	-52436992					
GND	CMC	_ahrs1_pitch_fail	787	05/08/2013	13:48:06	SET not inh	-1						
GND	CMC	_ahrs1_roll_fail	789	05/08/2013	13:48:06	SET not inh	-1						
GND	CMC	_ahrs2_pitch_fail	788	05/08/2013	13:48:06	SET not inh	-1						

A BRK_FAIL is set 18 seconds after the transition to ground.

Landing FDR



8. ANALYSIS OF DATA PROVIDED AND INVESTIGATION FINDINGS

Note
Details taken from AAIB Field Notes, for complete document see appendix 3

Touchdown and brake pedals applied at 13.47:29.

Brake pressure shows that approximately 4 seconds after the brakes are applied there is anti-skid activity which occurs until loss of brake pressure.

At approximately 17 seconds, right pedal displacement goes to 94.49% of travel and then goes to zero displacement.

At the same time the main brake pressure drops from 670 psi to 50 psi, and the warning BRKFAIL is generated. Three seconds later the CAS BRKFAIL warning is generated.

As the brake pressure drops, the aircraft stops decelerating for approximately 3 seconds before decelerating at a slightly slower rate.

Emergency / Parking brake lever discrete shows the brake to be on at the start of the flight and moved to the release position for taxing. The discreet remains off for the remainder of the flight.

9. SUMMARY

The data indicates that the brakes initially operated normally with the anti-skid operating; could this be due to a wet runway or the fact the aircraft touched down at a very fast speed and hence relatively little weight on the wheels? The pedal displacement gradually increased over 17 seconds until the brake failure occurs. The displacement of the right pedal suggests that this failure probably occurred as a result of the pedal moving beyond the 93% mechanical stop; or less likely failure of both LVDTs.

Following the brake failure the aircraft stops decelerating for approximately 3 seconds. The pilot would then be expected to apply the emergency / park brake in order to operate the emergency braking system. While the aircraft starts to decelerate the discrete for the park brake remains at off. It may be that the park brake has to be pulled fully on or twisted into a detent for the discrete to activate.

The animation from Embraer, based on the FDR, shows the WOW discrete activating when the speed is at least 140 kt. The right brake pressure is then lost close to the end of the runway. It is possible that the crew never activated the emergency brake system and the deceleration is due to the aircraft running over the grass?

10. CONCLUSIONS

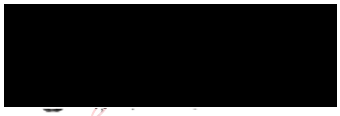
Based on the data provided and the results of the testing performed, there is no evidence to suggest that the BCU did not function as designed.

11. RECOMMENDATIONS

MABS recommend that BCU Part Number DAP00100-07 Mod 1.S/N 230000159 is returned to service.

Signed:  **Date:** 12th February 2016

John Smith
Customer Support Engineer

Signed:  **Date:** 12 February 2016

Gary Percival
Customer Support and Chief Airworthiness Engineer

Appendix 1

National Transportation Safety Board Preliminary Report Aviation CEN13LA462

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Printed on : 8/7/2013 11:22:06 AM

National Transportation Safety Board

PRELIMINARY REPORT AVIATION

NTSB ID: CEN13LA462	Most Critical Injury: None
Occurrence Date: 08/05/2013	Investigated By: NTSB
Occurrence Type: Accident	

Location/Time

Nearest City/Place	State	Zip Code	Local Time	Time Zone	
Eden Prairie	MN	55347	0848	CDT	

Aircraft Information

Registration Number	Aircraft Manufacturer	Model/Series Number
N327FL	EMBRAER	EMB-505

Type of Aircraft: Airplane	Amateur Built Aircraft?	

Injury Summary:	Fatal	Serious	Minor	None	2

Revenue Sightseeing Flight: No Air Medical Transport Flight: No

Narrative

Brief narrative statement of facts, conditions and circumstances pertinent to the accident/incident:

*** Note: NTSB investigators may not have traveled in support of this investigation and used data provided by various sources to prepare this aircraft accident report. ***

On August 5, 2013, at 0848 central daylight time, N327FL, an Embraer S.A. EMB-505, multi-engine turbofan airplane, was substantially damaged during landing at Flying Cloud Airport (FCM), Eden Prairie, Minnesota. The two pilots were not injured. The airplane was registered to and operated by Flight Options, LLC; Cleveland, Ohio. Day visual meteorological conditions (VMC) prevailed at the time of the accident and an instrument flight rules flight plan had been filed for the 14 Code of Federal Regulations Part 91 positioning flight. The airplane had departed Pittsburgh International Airport (PIT), Pittsburgh, Pennsylvania, about 0730 eastern daylight time and was destined for FCM.

The pilots reported that the airplane was on a steep visual approach when they landed long and fast. The pilot flying also reported that after touchdown he could feel the pulsing of the anti-skid brakes but was unable to stop on the runway surface. The airplane departed the end of the runway and impacted the airport boundary fence coming to rest on a four-lane highway about 1,000 feet from the runway.

At 0838 the data from FCM revealed that the wind was from 150 degrees at 4 knots, 6 miles visibility in mist, few clouds at 200 feet above ground level (agl), an overcast ceiling at 7,000 feet agl, temperature 18 degrees C, dew point temperature 17 degrees C, with an altimeter setting of 29.89 inches of mercury. Remarks indicated that rain ended at 0819 with a one hour precipitation of 0.01 inches.
Updated on Aug 7 2013 11:20AM

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National Transportation Safety Board

PRELIMINARY REPORT AVIATION

NTSB ID: CEN13LA462

Occurrence Date: 08/05/2013

Occurrence Type: Accident

Other Aircraft Involved

Registration Number	Aircraft Manufacturer	Model/Series Number

Accident Information

Aircraft Damage: Substantial

Accident Occurred During: Landing-flare/touchdown

Crew	Name	Certificate No.	Injury
Pilot			
2			
3			
4			
5			
6			

Operator Information

Name	Operator Designator Code	Doing Business As
FLIGHT OPTIONS LLC	DJFA	

Street Address	City	State	Zip Code
26180 CURTISS WRIGHT PARKWAY	CLEVELAND	OH	44143-1453

-Type of Certificate(s) Held:

Air Carrier Operating Certificate(s): On-demand Air Taxi

Operating Certificate:

Operator Certificate:

Regulation Flight Conducted Under: Part 91: General Aviation

Type of Flight Operations Conducted: Positioning

Flight Plan/Itinerary

Type of Flight Plan Filed: IFR

	State	Airport Identifier
Last Departure Point: Pittsburgh	PA	PIT
Destination: Same as Accident/Incident Location		FCM

Weather Information

Investigator's Source: Unknown

Facility ID: FCM

Observation Time (Local): 0838

Sky/Lowest Cloud Condition: Few 200 Ft. AGL

Lowest Ceiling: Overcast 7000 Ft. AGL

Visibility: 6 SM

Altimeter: 29.89 "Hg

National Transportation Safety Board
PRELIMINARY REPORT
AVIATION

NTSB ID: CEN13LA462	
Occurrence Date: 08/05/2013	
Occurrence Type: Accident	

Weather Information

(Continued from page 2)

Temperature:	18 °C	Dew Point:	17 °C	Wind Direction: 150	
Wind Speed: 4	Kts.	Gusts:	Kts.	Weather Conditions at Accident Site: Visual Conditions	

Administration Data

Notification From	Date

FAA District Office/Coordinator FAA Minneapolis St Paul FSDO David R. Nelson	Investigator-In-Charge (IIC) Thomas Latson

Appendix 2

Fault Log Download

Fault Log

SEQUENCE START TIME : 11:03:18

TIME : 11:03:27
NOTE : ## BCUTE IDENTIFICATION

SOFTWARE DESCRIPTION : STTE NEW STYLE, desgined by Ashley .J. Burton
TEST FILE IDENTITY : B00100_05V2.txt
BOX IDENTITY : BCU0159

TIME : 11:03:28
NOTE : ## EMBRAER PHENOM 300 BCU DAP00100

TIME : 11:03:29
NOTE : ## PRODUCTION ACCEPTANCE TEST PROCEDURE

TIME : 11:03:29
NOTE : ## TPDAP00100

TIME : 11:03:29
NOTE : ## RESULTS FILE B00100_05V2.RES

TIME : 11:03:29
NOTE : ## READ FAULT LOG

TIME : 11:03:31
NOTE : ## INITIALISING

TIME : 11:03:40
NOTE : ##

TIME : 11:03:53
RECEIVED FAULT LOG :

0007 FFFF 000D 0004 0606 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0001 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0002 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0003 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0004 0032 0030 0000 014B 0031 0000 014B 0032 0000 014B
0033
0000 014B 0034 0000 014B 0005 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0006 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0007 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0008 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0009 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 000A 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 000B 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 000C 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000

0000
0000 0000 0000 0000 0000 000D 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000
0000 0000 0000 0000 0000 000E 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000
0000 0000 0000 0000 0000 000F 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000
0000 0000 0000 0000 0000 0010 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000
0000 0000 0000 0000 0000 0011 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000
0000 0000 0000 0000 0000 0012 0001 0600 0000 71F9 0000 0000 0000 0000 0000 0000
0000
0000 0000 0000 0000 0000 0013 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000
0000 0000 0000 0000 0000 0014 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000
0000 0000 0000 0000 0000 0015 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000
0000 0000 0000 0000 0000 0016 0001 0600 0000 2F51 0000 0000 0000 0000 0000 0000
0000
0000 0000 0000 0000 0000 0017 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000
0000 0000 0000 0000 0000 0018 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000
0000 0000 0000 0000 0000 0019 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000
0000 0000 0000 0000 0000 001A 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000
0000 0000 0000 0000 0000 001B 000B 0455 0015 2D27 00F6 0025 75D1 0127 0053 6491
0128
0001 30E1 0129 0000 1EA5 001C 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000
0000 0000 0000 0000 0000 001D 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000
0000 0000 0000 0000 0000 001E 000A 003A 0002 D2E5 003C 0000 183D 003D 0000 920F
0107
0000 1B1F 0108 0002 32B9 001F 001C 0128 0001 5388 01B9 0005 4220 00E3 0000 EFEB
00E4
0000 03C9 0106 0004 B268 0020 0023 0021 0000 0704 0022 0000 0704 0023 0000 0704
0024
0000 0704 0025 0000 0704 0021 0023 0021 0000 0704 0022 0000 0704 0023 0000 0704
0024
0000 0704 0025 0000 0704 0022 0001 0603 0027 6345 0000 0000 0000 0000 0000 0000
0000
0000 0000 0000 0000 0000 0023 0002 000E 0007 E302 0603 0027 6345 0000 0000 0000
0000
0000 0000 0000 0000 0000 0024 0003 002E 0000 5D09 0033 0002 BE44 017A 0000 0448
0000
0000 0000 0000 0000 0000 0025 0003 002E 0000 5D0C 0033 0002 BE41 017A 0000 0448
0000
0000 0000 0000 0000 0000 0026 0003 002E 0000 7045 0033 0002 CD6D 017A 0000 0448
0000
0000 0000 0000 0000 0000 0027 0003 002E 0000 7054 0033 0002 CD7D 017A 0000 0448
0000
0000 0000 0000 0000 0000 0028 0005 0034 0001 0B18 0036 0003 3C43 0037 0001 46C2
0038
0000 515C 0039 0000 FAD7 0029 0006 0108 0002 32B9 003A 0002 D2E5 003C 0000 183D
003D
0000 920F 0107 0000 1B1F 002A 000A 003A 0002 D2E5 003C 0000 183D 003D 0000 920F
0107
0000 1B1F 0108 0002 32B9 002B 0012 051C 0000 018D 05CE 0000 018D 05F3 0000 018D
0427
0000 018D 0463 0000 018D 002C 0014 0427 0000 018D 0463 0000 018D 051C 0000 018D
05CE
0000 018D 05F3 0000 018D 002D 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000
0000 0000 0000 0000 0000 002E 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000

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0000
0000 0000 0000 0000 0000 002F 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000
0000 0000 0000 0000 0000 0030 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000
0000 0000 0000 0000 0000 0031 0023 0021 0000 018B 0022 0000 018B 0023 0000 018B
0024
0000 018B 0025 0000 018B 0032 0023 0021 0000 018B 0022 0000 018B 0023 0000 018B
0024
0000 018B 0025 0000 018B 0033 0001 0603 0027 4AA1 0000 0000 0000 0000 0000 0000
0000
0000 0000 0000 0000 0000 0034 0002 000E 0007 DD89 0603 0027 4A8C 0000 0000 0000
0000
0000 0000 0000 0000 0000
```

```
TIME :  11:03:55
READ_FAULT_LOG
MODULE  :  BCU1
FAULT ID  :  BCU_ID
READING :    0007
DECIMAL :    7
```

```
TIME :  11:03:56
READ_FAULT_LOG
MODULE  :  BCU1
FAULT ID  :  SER_ID
READING :    FFFF
DECIMAL :    65535
```

```
TIME :  11:03:57
READ_FAULT_LOG
MODULE  :  BCU1
FAULT ID  :  SW_ID
READING :    000D
DECIMAL :    13
```

```
TIME :  11:03:57
READ_FAULT_LOG
MODULE  :  BCU1
FAULT ID  :  FPGA_ID
READING :    0004
DECIMAL :    4
```

```
TIME :  11:03:58
READ_FAULT_LOG
MODULE  :  BCU1
FAULT ID  :  POWERUP_CNT
READING :    0606
DECIMAL :    1542
```

```
TIME :  11:03:59
READ_FAULT_LOG
MODULE  :  BCU1
FAULT ID  :  Hardware_Monitor_PBIT_Fail
READING :    0000  0000  0000  0000  0000  0000  0000  0000  0000  0000  0000  0000
0000  0000  0000  0000  0000  0000
DECIMAL :    0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
```

```
TIME :  11:04:00
READ_FAULT_LOG
MODULE  :  BCU1
```

FAULT ID : Manual_Braking_Select_PBIT_Fail
READING : 0001 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000
DECIMAL : 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

TIME : 11:04:00
READ_FAULT_LOG
MODULE : BCU1
FAULT ID : Hardware_By_Pass_PBIT_Fail
READING : 0002 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000
DECIMAL : 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

TIME : 11:04:01
READ_FAULT_LOG
MODULE : BCU1
FAULT ID : Wheel_Speed_Interface_BITE_Fail
READING : 0003 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000
DECIMAL : 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

TIME : 11:04:02
READ_FAULT_LOG
MODULE : BCU1
FAULT ID : Pressure_Interface_BITE_Fail
READING : 0004 0032 0030 0000 014B 0031 0000 014B 0032 0000 014B
0033 0000 014B 0034 0000 014B
DECIMAL : 4 50 48 0 331 49 0 331 50 0 331 51 0 331 52 0 331

TIME : 11:04:03
READ_FAULT_LOG
MODULE : BCU1
FAULT ID : Discrete_Interface_BITE_Fail
READING : 0005 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000
DECIMAL : 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

TIME : 11:04:04
READ_FAULT_LOG
MODULE : BCU1
FAULT ID : OFP_Enable_Fail
READING : 0006 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000
DECIMAL : 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

TIME : 11:04:05
READ_FAULT_LOG
MODULE : BCU1
FAULT ID : Fault_Log_Enable_Fail
READING : 0007 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000
DECIMAL : 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

TIME : 11:04:06
READ_FAULT_LOG
MODULE : BCU1
FAULT ID : Initial_Pedal_Fail_L1
READING : 0008 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000
DECIMAL : 8 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

TIME : 11:04:06
READ_FAULT_LOG
MODULE : BCU1
FAULT ID : Initial_Pedal_Fail_L2
READING : 0009 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000
DECIMAL : 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

TIME : 11:04:07
READ_FAULT_LOG
MODULE : BCU1
FAULT ID : Initial_Pedal_Fail_R1
READING : 000A 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000
DECIMAL : 10 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

TIME : 11:04:08
READ_FAULT_LOG
MODULE : BCU1
FAULT ID : Initial_Pedal_Fail_R2
READING : 000B 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000
DECIMAL : 11 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

TIME : 11:04:09
READ_FAULT_LOG
MODULE : BCU1
FAULT ID : Wheel_Speed_Fail_L1
READING : 000C 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000
DECIMAL : 12 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

TIME : 11:04:10
READ_FAULT_LOG
MODULE : BCU1
FAULT ID : Wheel_Speed_Fail_L2
READING : 000D 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000
DECIMAL : 13 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

TIME : 11:04:11
READ_FAULT_LOG
MODULE : BCU1
FAULT ID : Wheel_Speed_Fail_R1
READING : 000E 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000
DECIMAL : 14 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

TIME : 11:04:12
READ_FAULT_LOG
MODULE : BCU1
FAULT ID : Wheel_Speed_Fail_R2
READING : 000F 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000
DECIMAL : 15 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

TIME : 11:04:12
READ_FAULT_LOG
MODULE : BCU1
FAULT ID : Pressure_Fail_Left

READING : 0010 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000
DECIMAL : 16 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

TIME : 11:04:13
READ_FAULT_LOG
MODULE : BCU1
FAULT ID : Pressure_Fail_Right
READING : 0011 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000
DECIMAL : 17 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

TIME : 11:04:14
READ_FAULT_LOG
MODULE : BCU1
FAULT ID : SOV_Fail
READING : 0012 0001 0600 0000 71F9 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000
DECIMAL : 18 1 1536 0 29177 0 0 0 0 0 0 0 0 0 0 0 0

TIME : 11:04:15
READ_FAULT_LOG
MODULE : BCU1
FAULT ID : Brake_Control_Valve_Fail_Left
READING : 0013 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000
DECIMAL : 19 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

TIME : 11:04:16
READ_FAULT_LOG
MODULE : BCU1
FAULT ID : Brake_Control_Valve_Fail_Right
READING : 0014 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000
DECIMAL : 20 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

TIME : 11:04:17
READ_FAULT_LOG
MODULE : BCU1
FAULT ID : Hardware_Monitor_Fail
READING : 0015 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000
DECIMAL : 21 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

TIME : 11:04:18
READ_FAULT_LOG
MODULE : BCU1
FAULT ID : Hardware_Manual_Brake_Select_Fail
READING : 0016 0001 0600 0000 2F51 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000
DECIMAL : 22 1 1536 0 12113 0 0 0 0 0 0 0 0 0 0 0 0

TIME : 11:04:18
READ_FAULT_LOG
MODULE : BCU1
FAULT ID : 15V_Power_Fail
READING : 0017 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000
DECIMAL : 23 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

TIME : 11:04:19
READ_FAULT_LOG
MODULE : BCU1
FAULT ID : Hardware_By_Pass_Fail
READING : 0018 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000
DECIMAL : 24 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

TIME : 11:04:20
READ_FAULT_LOG
MODULE : BCU1
FAULT ID : PFD_Fail_Left
READING : 0019 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000
DECIMAL : 25 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

TIME : 11:04:21
READ_FAULT_LOG
MODULE : BCU1
FAULT ID : PFD_Fail_Right
READING : 001A 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000
DECIMAL : 26 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

TIME : 11:04:22
READ_FAULT_LOG
MODULE : BCU1
FAULT ID : EXT_WOW_Dissimilarity_Fail
READING : 001B 000B 0455 0015 2D27 00F6 0025 75D1 0127 0053 6491
0128 0001 30E1 0129 0000 1EA5
DECIMAL : 27 11 1109 21 11559 246 37 30161 295 83 25745 296 1
12513 297 0 7845

TIME : 11:04:23
READ_FAULT_LOG
MODULE : BCU1
FAULT ID : EXT_WOW_Fail_To_Air_Fail
READING : 001C 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000
DECIMAL : 28 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

TIME : 11:04:24
READ_FAULT_LOG
MODULE : BCU1
FAULT ID : EXT_Uncommanded_Braking_Fail
READING : 001D 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000
DECIMAL : 29 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

TIME : 11:04:24
READ_FAULT_LOG
MODULE : BCU1
FAULT ID : EXT_Loss_Braking_Fail
READING : 001E 000A 003A 0002 D2E5 003C 0000 183D 003D 0000 920F
0107 0000 1B1F 0108 0002 32B9
DECIMAL : 30 10 58 2 53989 60 0 6205 61 0 37391 263 0 6943 264
2 12985

TIME : 11:04:25
READ_FAULT_LOG
MODULE : BCU1

FAULT ID : EXT_Gear_Select_Fail
READING : 001F 001C 0128 0001 5388 01B9 0005 4220 00E3 0000 EFEB
00E4 0000 03C9 0106 0004 B268
DECIMAL : 31 28 296 1 21384 441 5 16928 227 0 61419 228 0 969
262 4 45672

TIME : 11:04:26
READ_FAULT_LOG
MODULE : BCU1
FAULT ID : EXT_Pedal_Fail_L1
READING : 0020 0023 0021 0000 0704 0022 0000 0704 0023 0000 0704
0024 0000 0704 0025 0000 0704
DECIMAL : 32 35 33 0 1796 34 0 1796 35 0 1796 36 0 1796 37 0
1796

TIME : 11:04:27
READ_FAULT_LOG
MODULE : BCU1
FAULT ID : EXT_Pedal_Fail_L2
READING : 0021 0023 0021 0000 0704 0022 0000 0704 0023 0000 0704
0024 0000 0704 0025 0000 0704
DECIMAL : 33 35 33 0 1796 34 0 1796 35 0 1796 36 0 1796 37 0
1796

TIME : 11:04:28
READ_FAULT_LOG
MODULE : BCU1
FAULT ID : EXT_Pedal_Fail_R1
READING : 0022 0001 0603 0027 6345 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000
DECIMAL : 34 1 1539 39 25413 0 0 0 0 0 0 0 0 0 0 0 0

TIME : 11:04:29
READ_FAULT_LOG
MODULE : BCU1
FAULT ID : EXT_Pedal_Fail_R2
READING : 0023 0002 000E 0007 E302 0603 0027 6345 0000 0000 0000
0000 0000 0000 0000 0000 0000
DECIMAL : 35 2 14 7 58114 1539 39 25413 0 0 0 0 0 0 0 0 0

TIME : 11:04:30
READ_FAULT_LOG
MODULE : BCU1
FAULT ID : EXT_Wheel_Speed_Fail_L1
READING : 0024 0003 002E 0000 5D09 0033 0002 BE44 017A 0000 0448
0000 0000 0000 0000 0000 0000
DECIMAL : 36 3 46 0 23817 51 2 48708 378 0 1096 0 0 0 0 0 0

TIME : 11:04:30
READ_FAULT_LOG
MODULE : BCU1
FAULT ID : EXT_Wheel_Speed_Fail_L2
READING : 0025 0003 002E 0000 5D0C 0033 0002 BE41 017A 0000 0448
0000 0000 0000 0000 0000 0000
DECIMAL : 37 3 46 0 23820 51 2 48705 378 0 1096 0 0 0 0 0 0

TIME : 11:04:31
READ_FAULT_LOG
MODULE : BCU1
FAULT ID : EXT_Wheel_Speed_Fail_R1
READING : 0026 0003 002E 0000 7045 0033 0002 CD6D 017A 0000 0448

```
0000  0000  0000  0000  0000  0000
DECIMAL :    38  3  46  0  28741  51  2  52589  378  0  1096  0  0  0  0  0  0


TIME :  11:04:32
READ_FAULT_LOG
MODULE  :  BCU1
FAULT ID  :  EXT_Wheel_Speed_Fail_R2
READING :    0027  0003  002E  0000  7054  0033  0002  CD7D  017A  0000  0448
0000  0000  0000  0000  0000  0000
DECIMAL :    39  3  46  0  28756  51  2  52605  378  0  1096  0  0  0  0  0  0


TIME :  11:04:33
READ_FAULT_LOG
MODULE  :  BCU1
FAULT ID  :  EXT_Pressure_Fail_Left
READING :    0028  0005  0034  0001  0B18  0036  0003  3C43  0037  0001  46C2
0038  0000  515C  0039  0000  FAD7
DECIMAL :    40  5  52  1  2840  54  3  15427  55  1  18114  56  0  20828  57  0
 64215


TIME :  11:04:34
READ_FAULT_LOG
MODULE  :  BCU1
FAULT ID  :  EXT_Pressure_Fail_Right
READING :    0029  0006  0108  0002  32B9  003A  0002  D2E5  003C  0000  183D
003D  0000  920F  0107  0000  1B1F
DECIMAL :    41  6  264  2  12985  58  2  53989  60  0  6205  61  0  37391  263
0  6943


TIME :  11:04:35
READ_FAULT_LOG
MODULE  :  BCU1
FAULT ID  :  EXT_SOV_Fail
READING :    002A  000A  003A  0002  D2E5  003C  0000  183D  003D  0000  920F
0107  0000  1B1F  0108  0002  32B9
DECIMAL :    42  10  58  2  53989  60  0  6205  61  0  37391  263  0  6943  264
2  12985


TIME :  11:04:36
READ_FAULT_LOG
MODULE  :  BCU1
FAULT ID  :  EXT_Brake_Control_Valve_Fail_Left
READING :    002B  0012  051C  0000  018D  05CE  0000  018D  05F3  0000  018D
0427  0000  018D  0463  0000  018D
DECIMAL :    43  18  1308  0  397  1486  0  397  1523  0  397  1063  0  397
1123  0  397


TIME :  11:04:36
READ_FAULT_LOG
MODULE  :  BCU1
FAULT ID  :  EXT_Brake_Control_Valve_Fail_Right
READING :    002C  0014  0427  0000  018D  0463  0000  018D  051C  0000  018D
05CE  0000  018D  05F3  0000  018D
DECIMAL :    44  20  1063  0  397  1123  0  397  1308  0  397  1486  0  397
1523  0  397


TIME :  11:04:37
READ_FAULT_LOG
MODULE  :  BCU1
FAULT ID  :  RAM_FAIL
READING :    002D  0000  0000  0000  0000  0000  0000  0000  0000  0000  0000
```

0000 0000 0000 0000 0000 0000
DECIMAL : 45 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

TIME : 11:04:38
READ_FAULT_LOG
MODULE : BCU1
FAULT ID : NVM_FAIL
READING : 002E 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000
DECIMAL : 46 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

TIME : 11:04:39
READ_FAULT_LOG
MODULE : BCU1
FAULT ID : ROM_FAIL
READING : 002F 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000
DECIMAL : 47 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

TIME : 11:04:40
READ_FAULT_LOG
MODULE : BCU1
FAULT ID : CPU_FAIL
READING : 0030 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000
DECIMAL : 48 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

TIME : 11:04:41
READ_FAULT_LOG
MODULE : BCU1
FAULT ID : Pedal_Fail_L1
READING : 0031 0023 0021 0000 018B 0022 0000 018B 0023 0000 018B
0024 0000 018B 0025 0000 018B
DECIMAL : 49 35 33 0 395 34 0 395 35 0 395 36 0 395 37 0 395

TIME : 11:04:42
READ_FAULT_LOG
MODULE : BCU1
FAULT ID : Pedal_Fail_L2
READING : 0032 0023 0021 0000 018B 0022 0000 018B 0023 0000 018B
0024 0000 018B 0025 0000 018B
DECIMAL : 50 35 33 0 395 34 0 395 35 0 395 36 0 395 37 0 395

TIME : 11:04:43
READ_FAULT_LOG
MODULE : BCU1
FAULT ID : Pedal_Fail_R1
READING : 0033 0001 0603 0027 4AA1 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000
DECIMAL : 51 1 1539 39 19105 0 0 0 0 0 0 0 0 0 0 0 0

TIME : 11:04:43
READ_FAULT_LOG
MODULE : BCU1
FAULT ID : Pedal_Fail_R2
READING : 0034 0002 000E 0007 DD89 0603 0027 4A8C 0000 0000 0000
0000 0000 0000 0000 0000 0000
DECIMAL : 52 2 14 7 56713 1539 39 19084 0 0 0 0 0 0 0 0 0 0

TIME : 11:04:44

NOTE : ## CHECK COMPLETE

SEQUENCE END TIME : 11:04:45

Appendix 3

AAIB Field Notes

FIELD NOTES - TEST OF BCU FROM N327FL AT MEGGITT COVENTRY 3 OCTOBER 2013

Present

Brian McDermid	AAIB
Luis Savio dos Santos	Embraer Aviation Europe
Andy Whittingham	MEGGITT, Chief Project Engineer
John Smith	MEGGITT, Customer Support Engineer
Neil Wann	MEGGITT, Senior Software Engineer

Preparation

Unit serial number 230000159.

Unit visually inspected and undamaged.

Essential system description

The normal braking system is brake by wire. The brake pedals operate a left and right brake transducer, each of which contains two LVDTs. Each LVDT consists of a secondary and primary coil. The pedals should be rigged so the maximum mechanical displacement of the pedal is 93%. See pedal design characteristics below.

Download of fault codes

Fault codes downloaded via BCU Test Equipment (F2895). Last calibrated 9/4/13 due next calibration 9/4/14.

Full report will be prepared by MEGGITT. Significant fault CODES are as follows:

Code	Fault	Time from power up
51	Pedal Fail R1	2 hr 51 min 40.036 seconds
52	Pedal Fail R2	2 hr 51 min 39.952 seconds
34	External Pedal Fail R1	2 hr 52 min 5.268 seconds
35	External Pedal Fail R2	2 hr 52 min 5.268 seconds

Production acceptance test

Full functional test carried out on manufacturers test rig; execution of part B batch files. BCU passed test.

Review of FDR data

Touchdown and brake pedals applied at 13.47:29. Brake pressure shows that approximately 4 seconds after the brakes are applied there is anti-skid activity which occurs until loss of brake pressure. At approximately 17 seconds, right pedal displacement goes to 94.49% of travel and then goes to zero displacement. At the same time the main brake pressure drops from 670 psi to 50 psi, and the warning BRKFAIL is generated. Three seconds later the CAS BRKFAIL warning is generated. As the brake pressure drops, the aircraft stops decelerating for approximately 3 seconds before decelerating at a slightly slower rate.

Emergency / Parking brake lever discrete shows the brake to be on at the start of the flight and moved to the release position for taxing. The discreet remains off for the remainder of the flight.

Discussion

The fault codes Pedal Fail R1 and R2 means that the BCU has detected a failure of the secondary coil in the LVDT for both coils in the right hand pedal transducer. The software in the BCU waits until the wheels have stopped rotating for 5 seconds before running a diagnostic routine. It was this routine that generated External Failure R1 and R2. The combination of these fault codes indicates that there has been a simultaneous fault in the secondary coils, or the interface circuitry in both LVDTs in the right pedal transducer; it could also be caused by over-travel of the right pedal which contains the LVDTs.

The system is designed such that if a failure occurs in both LVDTs, in either pedal transducer, then the system will declare a brake failure and close the main brake system shut-off valve. The brakes are then controlled by the emergency brake system via the emergency / park brake handle; there is no anti skid with this system.

The data indicates that the brakes initially operated normally with the anti-skid operating; could this be due to a wet runway or the fact the aircraft touched down at a very fast speed and hence relatively little weight on the wheels? The pedal displacement gradually increased over 17 seconds until the brake failure occurs. The displacement of the right pedal suggests that this failure probably occurred as a result of the pedal moving beyond the 93% mechanical stop; or less likely failure of both LVDTs.

Following the brake failure the aircraft stops decelerating for approximately 3 seconds. The pilot would then be expected to apply the emergency / park brake in order to operate

the emergency braking system. While the aircraft starts to decelerate the discrete for the park brake remains at off. It may be that the park brake has to be pulled fully on or twisted into a detent for the discrete to activate.

The animation from Embraer, based on the FDR, shows the WOW discrete activating when the speed is at least 140 kt. The right brake pressure is then lost close to the end of the runway. It is possible that the crew never activated the emergency brake system and the deceleration is due to the aircraft running over the grass?

Follow-up action

The following action should be considered:

- Test of the right brake pedal transducer, particularly with regard to the condition of the secondary coils in the LVDTs.
- Check the rigging of the brake pedals and their transducers. Can the pedal assembly distort under heavy braking action?
- Establish if the crew operated the emergency / park brake.
- Determine if the partial operation of the emergency / park brake generates a discrete on the FDR.
- Review the deceleration before and after the loss of brake pressure to explain the change in deceleration. Did the crew activate the emergency brake, or was the deceleration due to running over the grass?

Signed

Brian McDermid
Senior Inspector (Engineering)
Air Accidents Investigation Branch