



**REPUBLIC OF NAMIBIA
MINISTRY OF WORKS AND TRANSPORT**

Directorate of Aircraft Accident Investigations

Accident Reference: ACCID/112913/1-12

Aircraft Accident Investigation Interim Report

11/29/2013
Embrear 190
C9-EMC
Bwabwata National park.
NAMIBIA

RELEASE DATE: 1 DEC 2014

Introduction

In view of the sustained interest within the aviation industry, and amongst the travelling public, it is considered appropriate to publish an update on the continuing investigation into this accident. This report is in addition to the Preliminary Report, released on 18 December 2013.

The information contained in this Interim Accident Report is published to inform the aviation Industry and the public of the general circumstances of the accident and that occurred at Bwabwata National park on 29th November 2013

Readers are cautioned that there is the possibility that new information may become available that alters this Interim Accident Report prior to the availability of the Final Accident Report.

The Directorate of Aircraft Accident Investigations (DAAI) as the authority in charge of the investigations is working in close corporation with Accredited representatives from Angola (state with most fatalities as well as the state of intended destination) Mozambique (state of registry and operator), Botswana (state with responsible for Air navigational and traffic services at the time of accident) Brazil (the state of airframe design and manufacture) as well as USA (state of engine manufacture).

In accordance policies of DAAI which are in line with Annex 13 to the Convention of International Civil Aviation the sole objective of the investigation is to determine the probable cause of the accident and to make safety recommendations intended to prevent a reoccurrence.

It is not the purpose of this activity to apportion blame or determine liability but this investigation intends to investigate factual information, analyze the available information and determine probable cause and possibly come up with safety recommendations.

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Note for readers unfamiliar with the ICAO Annex 13 chronological number sequencing for accident report sections.

Sections have been omitted from this report as they are either covered in the Preliminary Report or are not considered relevant to this specific accident Interim Report.

1. FACTUAL INFORMATION

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2. ANALYSIS

SYNOPSIS

Status	:	Preliminary
Date	:	29 November 2013
Time	:	11:16:26 UTC
Type	:	ERJ 190-100 IGW
Operator	:	Mozambique Airlines (LAM)
Registration	:	C9-EMC
Serial number	:	19000581
Engine s/no.	:	424388-LH 424408 RH
Year built	:	2012
Crew	:	Fatalities: 6 Occupants: 6
Passengers	:	Fatalities: 27 Occupants: 27
Total fatalities	:	Crew: 6/ Occupants: 27
Airplane damage	:	Aircraft destroyed
Location	:	Bwabwata National Park, Eastern Kavango - Namibia
Phase	:	Cruise
Nature	:	Scheduled Flight
Departure airport	:	Maputo International Airport, Mozambique
Destination airport	:	Luanda International Airport, Angola

Narrative

On the 29th November 2013 at 09:26 UTC, an Embreair ERJ-190 with registration number C9-EMC departed Maputo International Airport on a scheduled flight to Luanda, Angola. The flight operations were normal and the aircraft was cruising at FL380 (38000 ft).

The flight was in good radio communication with Gaborone Area control on frequency 126.1 MHZ.

The Namibian Radar Data playback revealed that at position EXEDU, which is a mandatory reporting point in the Gaborone FIR (Flight information region) the aircraft commenced a sudden descent from the normal cruising level of FL380.

Radar contact and voice contact was lost with ATS (Air Traffic Services) search and rescue was instituted and thereby located the wreckage the following day in the Bwabwata National park.

A team lead by Namibian Investigators were dispatched immediately, the onsite investigations commenced and were able to retrieve the FDR/CVR recorders. The recorders were sent to the NTSB (National Transportation Safety Board) laboratories in Washington DC for readout.

The flight data and cockpit voice recorders revealed the following:

1. The aircraft was operating at normal conditions and no mechanical faults were detected.
2. Minutes before the crash the F/O (first officer) left the cockpit for the lavatory and only the captain remained in the Flight Deck.
3. The altitude was manually selected three times from 38000ft to the final 592ft (below ground elevation).
4. Auto throttle was manually reengaged and throttle level automatically retarded and set to idle.
5. The Airspeed was manually selected several times until the end of the recording, which remained close to the Vmo (maximum operating limit speed).
6. The speed brake handle parameter indicates it was commanded to open the spoiler panels and remained in this situation until the end of the recording. This was manually commanded as the parameter monitors the handle position.
7. During all this actions there was audible low and high chimes as well as repeated banging an indication for call to enter the cockpit.

BACKGROUND

In accordance with requirements of ICAO Annex 13 the DAAI have issued this Interim Report into the accident which occurred in the Bwabwata national park in Namibia on the 29th November 2013.

The key areas of the accident event sequence have been identified. Further detailed investigation is ongoing to validate the findings and determine the contributing significant factors, the culmination of which will form the basis for determining the probable cause of this accident and the associated recommendations.

The investigation has centered on the actions and inactions on the flight deck in particular but not limited to the operation of the Auto-pilot.

It also reviews various emergency and safety devices at the disposal of the flight crew. Focus is also aimed on reviewing threats emanating from both sides of the cockpit door and the issue of authorized and unauthorized access to the reinforced cockpit door.

Wider systemic issues that emanates from the operations of the aircraft are also explored.

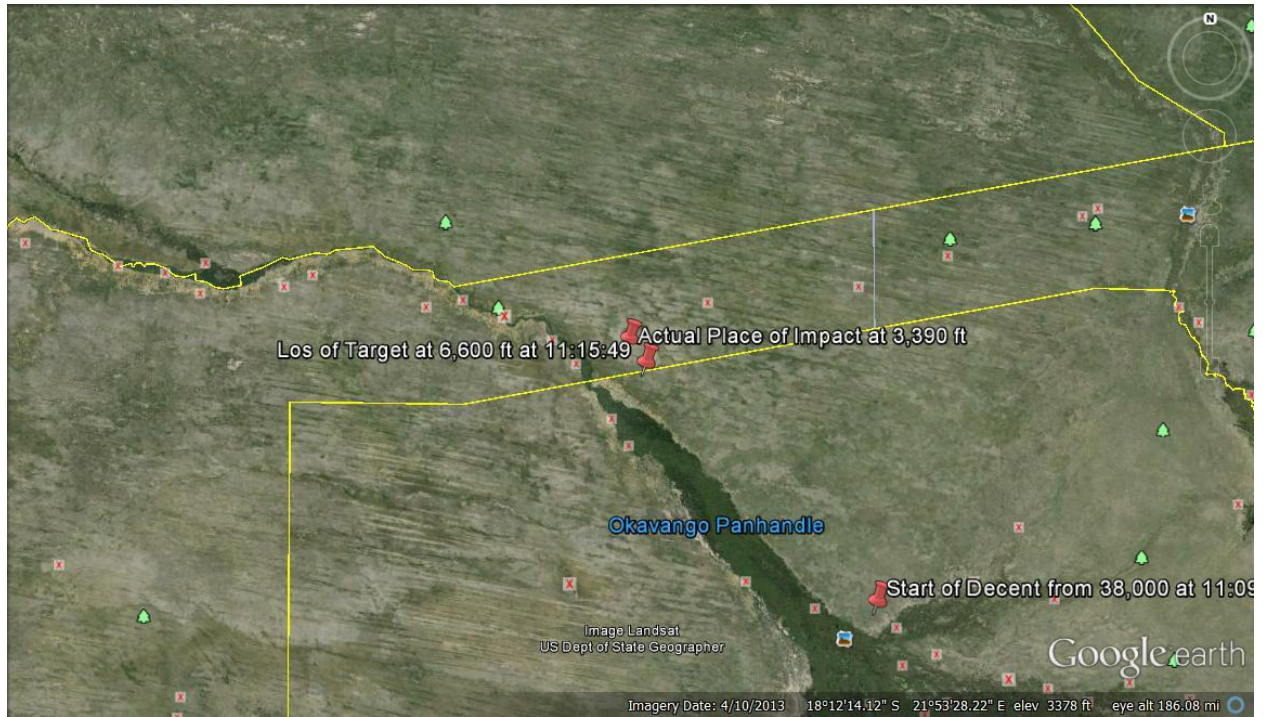
The report tries to also address other non-contributory safety defenses shortcomings.

ABBREVIATION

ATC	Air Traffic Control
ATPL	Airline Transport Pilot License
AFCS	Automatic Flight Control System
ATNS	Air Traffic and Navigation Service
CVR	Cockpit Voice Recorder
CENIPA	Centro de Investigação e Prevenção de Acidentes Aeronáuticos (Aeronautical Accidents Investigation and Prevention Center) BRAZIL
DAAI	Directorate of Aircraft Accident Investigations (Namibian AIB)
DFDR	Digital Flight Data Recorder
GPWS	ground proximity warning system
ELT	Emergency Locator Transmitter
ICAO	International Civil Aviation Organization
LNAV	Lateral navigation
UTC	Coordinated Universal Time (Universal Time Co-ordinate)
VMO	Maximum Operating Speed

1. FACTUAL INFORMATION

Map1 : Estimates from descent point to Radar loss Gaborone Airspace by the Namibian radar



Horizontal distance from top of descent to loss of radar 87.4 Km

Vertical distance from top of descent to radar loss 9 571m

Time taken from the descent till loss of Radar 6 min 43 sec

1.1 HISTORY OF FLIGHT

This is an updated brief chronological description of the flight. Which has been complied utilizing an event timeline generated from analysis the DFDR data, ATC Transcripts and Namibian Radar footage.

- 1.1.1 On the 29th November 2013 at 09:26 UTC, an Embreair ERJ 190-100 IGW aircraft with registration number C9-EMC departed Maputo International Airport on a scheduled flight to Luanda Angola. On board the aircraft were a total of 33 people comprised of the following: Six (6) crew members (two pilots, one engineer and three flight attendants) plus 27 passengers. The flight operations were normal and the aircraft was in radio communication with Gaborone Area Control Centre on frequency 126.1 MHZ and was cruising at FL380 (38000 FT).
- 1.1.2 At position EXEDU, a mandatory reporting point in the Gaborone FIR (Flight Information Region) which is at 72 nautical miles (nm) south of the point AGRAM which is the boundary position between Gaborone FIR and Luanda FIR (18° 56S 02° 228E), the Namibian Radar Data revealed that the aircraft commenced a sudden descent from the normal cruising level of FL380 at 11:09:07 UTC. Radar and voice contact were lost with air traffic services at 11:15:49 UTC at an altitude of 6 600 ft AMSL while on its abrupt descent. The aircraft impacted the ground at 11:16:04 UTC at an altitude of 3 390 ft Above Mean Sea Level (AMSL).
- 1.1.3 There were no distress call made by the crew to declare an emergency nor was there any signal transmitted from the ELT (Emergency Locator Transmitter) after the crash.
- 1.1.4 Namibian authorities (police) at the Eastern Kavango and Zambezi regions were informed about the crash at around 12:00 UTC.
- 1.1.5 Search and rescue operation was immediately instituted but could not locate the accident site the same day. The accident site was located the following day (30 November 2013) at around 9h00 AM, in Bwabwata National Park (Namibia). The Namibian Investigators responded immediately after the crash site was located.
- 1.1.6 Eyewitnesses from villagers on the Botswana side near the border heard explosions and observed smoke coming from the Namibian territory then informed the Namibian Authorities.
- 1.1.7 The Government of Mozambique and the Mozambique Airline were informed by the Namibian Government on Saturday 30 November 2013 that the wreckage has been located and identified as that of C9-EMC, an Embreair ERJ and that there were no survivors. Both CVR/FDR recorders were retrieved from the accident site on Saturday 30th November 2013 the day after the crash.

DAAI lead a team of accredited representatives from Mozambique state of registry and operator, Brazil, state of manufacturer and design, Botswana, the state that was

controlling the accident aircraft, Angola the state of final destination and USA, state of power plant manufacturer.

1.5 PERSONNEL INFORMATION

The captain was a holder of an Airline Transport Pilot License (ATPL) while the first officer was a holder of a Commercial Pilot License (CPL). Their Medical Certificates Category I were valid. The aircraft type was also endorsed into their licenses

1.5.1 Captain

Nationality		Mozambican			
Licence No	451/ PLAA/169	Gender	Male	Age	49
Licence Valid		Yes	Type Endorsed	Yes	
Ratings		ATPL			
Medical Expiry Date		02 September 2014			
Restrictions		None			
Previous Accidents		None			

Flying Experience:

Total Hours	9052.87
Total Past 90 Days	239.73
Total on Type Past 90 Days	239.73
Total on Type	2519.83

1.5.2 First Officer

Nationality		Mozambican			
Licence No	485/PCA/457	Gender	Male	Age	24
Licence Valid		Yes	Type Endorsed	Yes	
Ratings		CPL (with Instrument Ratings)			
Medical Expiry Date		17 November 2014			
Restrictions		None			

Flying Experience :

Total Hours	1183.25
Total Past 90 days	101.26
Total on Type Past 90 Days	101.26

1.11 FLIGHT RECORDERS

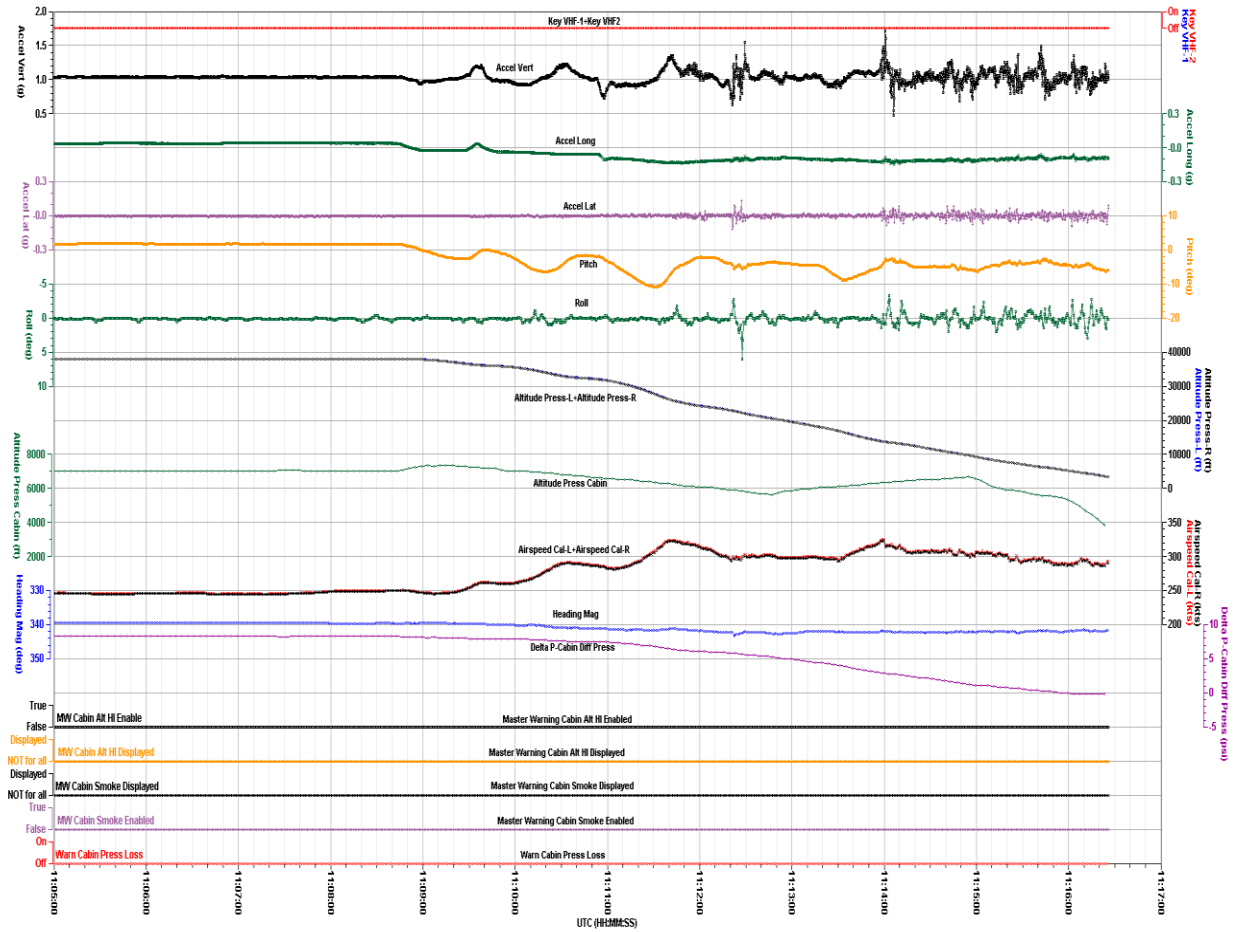
- 1.11.1 The aircraft was equipped with two black boxes (CVFDR), each being a combined Cockpit voice recorder and Flight Data Recorder.

The FDR component records airplane flight information in digital coded data format. Both recorders were manufactured by Universal Avionics Systems Corporations and had recorded approximately 141 hours of Data. The event flight was the last flight on the recording and its duration was approximately 1 hour and 50 minutes.

The CVR component of the CVFDR records two hours of digital audio to solid state memory in a four channel format, one channel for captain one for first officer, one for third crew member and/or passenger address system and one channel for the cockpit area microphone. When CVR is removed from the aircraft it retains only the last 2 hours Audio.

Due to heat and structural damage, the serial number were not evident, however, the downloading was conducted successfully. The recorders were disassembled and downloaded in accordance with procedures defined by Universal Avionics Systems Corporation, the recorder manufacturer. The download procedures included the use of a Universal Data Recovery Unit (DRU), Universal part number 1605-75.

GRAPH 1 Basic parameter of the last 12 minutes of descent.



Revised: 13 December 2013

Basic Parameters - Last 12 Minutes

National Transportation Safety Board

1.16 TESTS AND RESEARCH.

LEVEL D EMREAR 190 SIMULATOR FLIGHT TEST

1.16.1 The FDR/CVR recorders were sent to the National Transport Safety Board (NTSB) laboratories in Washington DC, USA (NTSB) for readout. Engineering Data taken from the FDR analysis at NTSB containing various commands inputs of the flights controls as well as Auto-Pilot were plotted against the time frame analysis of the last 12 minutes of the flight.

Level D¹ flight simulator investigations² were conducted at the Azul Flight Training Centre in Brazil in coordination with CENIPA (accredited representative from state of manufacturer) and Embreair (manufacturer) as well as the accredited representative and advisors from Mozambique. The investigations flights on the simulator were performed by manufacturer's test pilots. The objective of the simulator investigation was to reproduce the accident sequence, observe the pilots inputs to the aircraft controls against the autopilot and the reaction of the aircraft and determine if consistent with the outputs as seen on the FDR Data, as well to determine existence of any system deficiencies for the sole purpose of improvement to safety.

The last 12 minutes of the flight was replicated on a simulator as from **11:04:04** UTC to **11:16:25** UTC.

The behaviour of the simulator was very close to the parameters recorded of the occurrence on the FDR.

¹ There are currently four levels of full flight simulator, levels A - D, level D being the highest standard. A Level D/Type 7 FFS also provides motion feedback to the crew through a motion platform upon which the simulator cabin is mounted. The motion platform must produce accelerations in all of the six degrees of freedom (6-DoF) that can be experienced by a body that is free to move in space

² Detailed flight simulator tests and analysis were conducted and are completed and will be included in the final report

2. ANALYSIS

2.1.6 DIGITAL FLIGHT DATA RECORDER FACTUAL ANALYSIS (DFDR)

The following data is a factual DFDR report of the accident flight with factual statements to support the recorded data

SUMMARY:

DFDR Data show the aircraft performing a normal take-off, climb and cruise. Only after approximately 1h 39m was there any anomaly as per flight plan. At this time 11:04 UTC The aircraft was flying at FL380, with ALTITUDE PRESELECTOR set to 38000 ft. Autopilot was engaged (and remained engaged until the end of recording) with flight director vertical mode VALT (FMS altitude hold).

Two minutes later at around 11:06:36 -the altitude preselect adjustment (from FL380 to 4,288 ft,) which is also consistent with clicks picked up by the CVR of the altitude preselect rolling. At **11:06:52** the altitude preselect is adjusted from 4,288 to 1,888 ft, and finally from 1,888 ft to 592 ft.

11:07:41 - AUTOTHROTTLE ENGAGED parameter transitioned from ENGAGED to NOT-ENGAGED³.

11:07:25 - 11:08:41 - During this 1 minute and 16 seconds period, the parameter PACK 2 FLOW drops to near zero with no associated CAS message⁴. Also during this period, the PACK 1 FLOW parameter assumes higher values

11:08:31 - The engaged autopilot vertical mode transitioned from FMS altitude hold (VALT) to FMS flight level change (VFLCH) and subsequently to flight level change (FLCH).⁵

³ In case of an auto-throttle failure, a caution CAS message would be displayed to the crew and would be recorded in the DFDR. As the parameter MASTER CAUTION remained not active by the time of the disengagement, it is possible to infer that this action was manually performed.

⁴ The fact that the MASTER CAUTION parameter does not activate during this time suggests that the pack 2 was intentionally deactivated. This was replicated on the LEVEL –D simulator .

⁵ There are two conditions to consider: a FMS failure or a manual selection. In a FMS failure, the vertical mode would drop to the AFCS basic mode (FPA), which was not observed. Moreover, the lateral mode remained engaged in the LNAV, what indicates that the FMS was available along the whole descent. Therefore it is possible to infer that these transitions were manually commanded by pressing the FLCH pushbutton and subsequently the VNAV pushbutton on the guidance panel

11:08:42 – The autothrottle was manually reengaged and the throttle levers were automatically retarded. This is the expected behavior as the FLCH mode was engaged and the desired altitude (altitude preselector) was below the current aircraft altitude.

11:09:01 - After the throttle levers were reduced, the auto-throttle was disengaged. The MASTER CAUTION parameter remains off, indicating that this disengagement was manually performed.

11:09:26 - The TLA (throttle lever angle) parameters indicate an advance and subsequent retard back to IDLE at **11:09:35**. This action was manually accomplished as the auto-throttle was disengaged.

11:09:52 - The parameter SELECTED AIRSPEED AUTO transitioned from ACTIVE to INACTIVE at the same time that the SELECTED AIRSPEED MANUAL transitioned from INACTIVE to ACTIVE⁶

11:10:54 - The SPEED BRAKE HANDLE parameter indicates that it was commanded to open the spoiler panels and remained in this position until the end of recording. This was manually commanded as the parameter monitors the handle position.

After the speed brakes were commanded open, the vertical speed rises reaching a maximum value of 10560 fpm at **11:11:34**. Also, the indicated airspeed rises, leading to the automatic transition of the flight director vertical mode from FLCH to OVSP (over-speed) at **11:11:34; 11:13:57; 11:15:01; 11:15:08 and 11:15:15**.

At **11:12:52**, the BLEED 1 PRESS and BLEED 2 PRESS drop simultaneously to near zero. The fact that there is no MASTER CAUTION parameter activation indicates that both bleeds were intentionally deactivated.

Between **11:13:27 and 11:13:33**, while the aircraft was crossing 17,000 ft, the parameter MASTER CAUTION was activated. It was not yet possible to correlate this message with any abnormal system behavior.

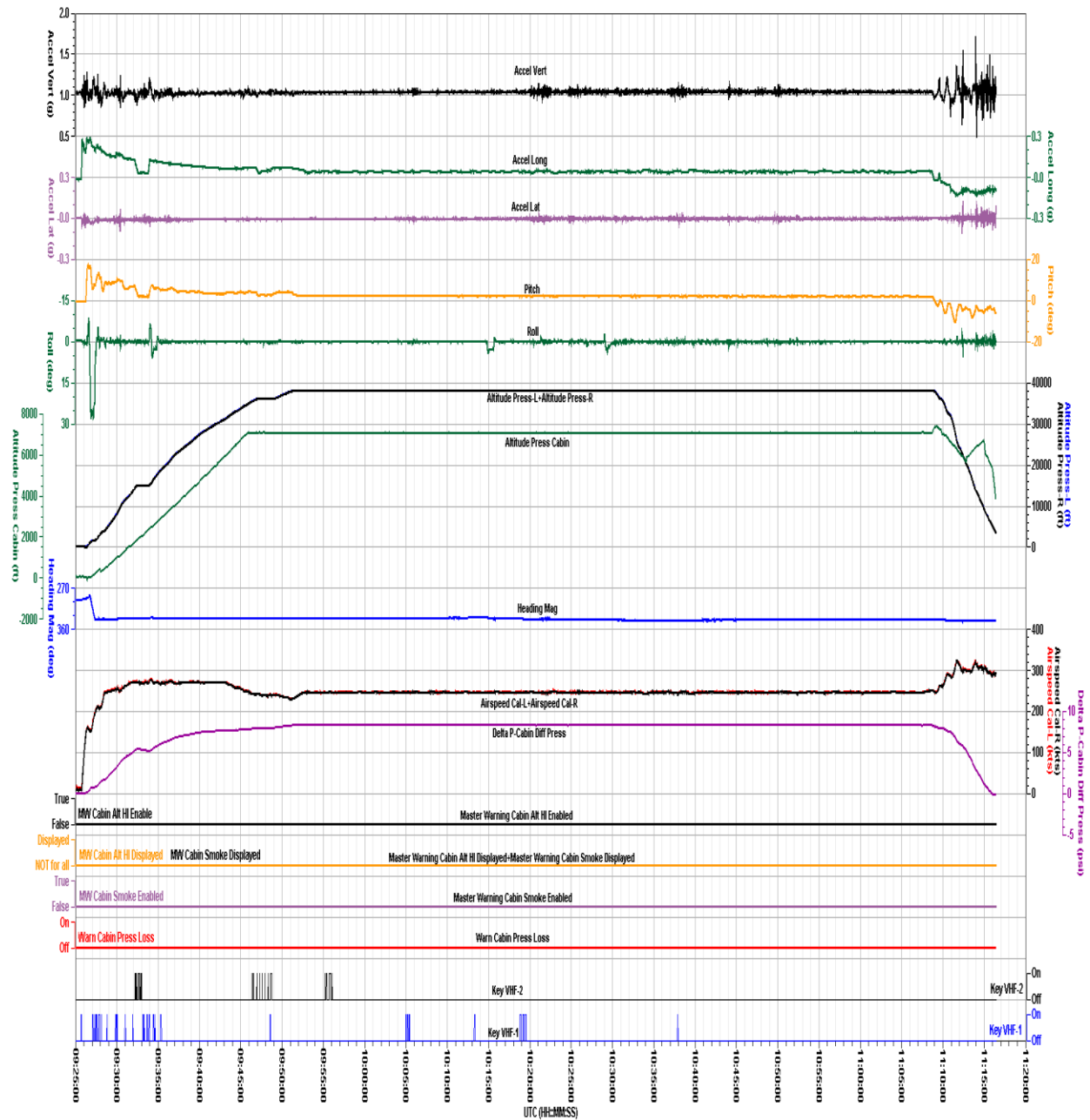
At **11:16:01** (25 seconds before the end of recording), the GPWS CAUTION parameter indicates that the first GPWS alert was triggered as the aircraft crossed 2,010ft AGL (5,150ft ASL) followed by a second activation at **11:16:06**.

At **11:16:14**, the parameter GPWS WARNING was activated and at **11:16:24** the GPWS TERRAIN PULL UP parameter was activated.

⁶ This was accomplished by switching the SPEED outer knob from AUTO to MAN in the guidance panel and rotating the inner knob to the desired airspeed (SELECTED AIRSPEED). The SELECTED AIRSPEED parameter indicates that the desired speed was manually adjusted several times until the end of the recording, being the last time at **11:16:01** (25 seconds from the impact).

The SELECTED AIRSPEED parameter remained close to the VMO throughout the remaining portion of the descent. The AFCS automatically limits the manually selected speed target to VMO

Graph 2 Basic parameters of the entire flight



3. PROGRESS UPDATE

This Interim Accident Report has been made available as an update on the progress of this investigation

The DAAI will provide updates on the investigation and safety recommendations as they become available until completion of the final report, this is in line with DAAI policies and procedures which are in accordance with the provisions of ICAO Annex 13.

The investigation is continuing into wider areas on which some may not be causal or contributory nevertheless worth investigating, all safety issues identified during the course of the investigation will be advised to all relevant parties.

The investigation into the cause of this accident continues.