Australian Government

Australian Transport Safety Bureau

INTERIM FACTUAL
AVIATION SAFETY INVESTIGATION REPORT
200501977

Fairchild Industries
Metro 23
07 May 2005

1 INTERIM FACTUAL INFORMATION

1.1 History of the flight

On 7 May 2005, a Fairchild Metroliner SA227-DC, registered VH-TFU, with two pilots and 13 passengers, was being operated under the instrument flight rules (IFR) on a scheduled passenger service from Bamaga to Cairns via Lockhart River, Qld. The crew was flying the third of four sectors scheduled for the day. They commenced duty in Cairns, departing at about 0830 Eastern Standard Time for Bamaga with an intermediate stop at Lockhart River.

Figure 1: Similar Fairchild Metroliner



The aircraft was refuelled in Bamaga. The copilot reported departure to Brisbane Air Traffic Control (ATC) at 1111. At 1136 he advised ATC that they were on descent passing 9,000 ft with an estimated time of arrival at Lockhart River of 1139.

The crew subsequently reported to ATC that they were conducting the Lockhart River Runway 12 RNAV (GNSS)[1] approach. At 1140, they reported on the Lockhart River common traffic advisory frequency (CTAF) passing waypoint 'Whisky Golf' (LHRWG) tracking for 'Whisky India' (LHRWI). The waypoint LHRWI was located 12 NM[2] prior to the missed approach point of the Lockhart River Runway 12 RNAV (GNSS) approach. (Appendix A)

About thirty seconds later, following a request from a pilot in another aircraft in the Lockhart River area, the copilot reported the weather conditions as 'fairly dismal about 900 ft clearance'.

At 1158, when the crew had not reported having landed at the Lockhart River aerodrome, ATC declared an uncertainty phase[3]. When attempts to contact the aircraft failed, a search was commenced.

At 1625, the burnt wreckage of the aircraft was located in the Iron Range National Park on the north-western slope of 'South Pap', a heavily timbered ridge, approximately 11 km north-west of the Lockhart River aerodrome at an elevation of 1,210 ft. The deceleration forces and the severe impact damage resulted in all occupants being fatally injured. The aircraft was destroyed by the impact forces and an intense, fuel-fed, post-impact fire.

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[1] RNAV (GNSS): Area navigation global navigation satellite system – A method of navigation that permits aircraft operations on any desired course within the coverage of station referenced navigation signals or within the limits of self contained system capability.

[2] NM: A nautical mile is 1.852 kilometres

[3] Uncertainty phase: Situation where uncertainty exists as to the safety of an aircraft and its occupants.

The aircraft had entered the forest canopy at a descent angle of between 3 and 5 degrees. The accident site was located on the published Lockhart River runway 12 RNAV (GNSS) final approach track. At that point in the approach, the minimum obstacle clearance altitude was 2,060 ft AMSL[4].

Figure 2: Accident site and Lockhart River aerodrome



1.2 Personnel information

1.2.1 Pilot in command

At the time of the accident the pilot in command (PIC) had logged a total of 6,071 hours flying experience, of which 3,248 hours were on the Metroliner aircraft type.[5] He held an air transport pilot (aeroplane) licence issued by the Civil Aviation Safety Authority (CASA), which included an

[4] AMSL: Above mean sea level

[5] The pilot in command's log book entries were complete up to 16 April 2005, hours flown since that date were derived from aircraft flight logs and flight data recorder information.

endorsement for command on Metro 3 aircraft (covering all SA227 aircraft types). In addition, he held a command multi-engine instrument rating, which included an approval to conduct RNAV (GNSS) approaches. The PIC's initial command multi-engine instrument rating was issued on 13 November 1993; an approval to conduct RNAV (GNSS) approaches was added on 3 January 2003.

The pilot's first flight with the operator as PIC occurred on 19 February 2001. He had passed a company flight proficiency base check and command multi-engine instrument rating renewal on 28 February 2005.

The pilot's logbook indicated that he had:

- operated as PIC on Metroliner aircraft into Lockhart River on twenty four occasions prior to the accident flight
- completed 16 RNAV (GNSS) approaches at various locations between 3 January 2003 and 16 April 2005 (the date of the last log book entry)
- carried out one Runway 12 RNAV (GNSS) approach at Lockhart River, on 27 September 2002
- logged 8.4 hours flight time under instrument meteorological conditions within the preceding 90 days
- carried out three RNAV (GNSS) type approaches within the preceding 90 days
- completed one NDB type approach within the preceding 90 days.

Prior to commencing duty on the day of the accident the PIC was rostered free of duty for 19 hours and 7 minutes. He had returned from a period of 7 days leave, 3 days before the accident flight. During that 3 day period he had completed 9 hours and 40 minutes of flight time and 12 hours 20 minutes of duty time. The pilot's colleagues reported that he was "quite fit" and was "relaxed due to just having finished a holiday".

1.2.2 Copilot

The copilot had logged a total of 655 hours flying experience, of which 150 hours were as copilot on the Metroliner aircraft type.[6] He was qualified to perform the duties of copilot on the Metroliner aircraft and although he held a Command Instrument rating, it did not include approval to conduct RNAV (GNSS) approaches. His initial command multi-engine instrument rating was issued on 19 March 2004. The rating was renewed on 3 April 2005. The copilot's log book indicated that he had not completed any RNAV (GNSS) type approaches.

The company operations manual included the following requirements that related to the use of GPS for Non Precision Approaches (GPS/NPA)[7], such as the Lockhart River RNAV (GNSS) Runway 12 approach:

> Flight crew are to:
>
> - hold endorsements for GPS Primary means navigation and GPS/NPA
> - have been assessed as proficient
> - meet the GPS recency requirements.

The copilot passed a company flight proficiency base check with the operator on 22 December 2004; he commenced operational duties with the operator on 28 February 2005. His logbook

[6] The copilot's log book entries were complete up to 5 May 2005; hours flown since that date were derived from aircraft flight logs and flight data recorder information.

[7] The terminology GPS/NPA (or global positioning system /non-precision approach) was used in the company's operator's manual, but has been superseded by the term RNAV (GNSS). The term RNAV (GNSS) will be used hereafter.

indicated that he had operated as a crew member into Lockhart River on three occasions before the accident flight. The first occasion was on 13 April 2005.

Prior to commencing duty on the day of the accident, the copilot was rostered free of duty for 19 hours and 7 minutes. The day of the accident was his fifth consecutive duty day, prior to which he had been rostered free of duty for 4 days. During that 5-day period he had completed 19 hours and 32 minutes of flight time and 26 hours and 26 minutes of duty time. The pilot's family and colleagues reported that he was fit. They also reported that he had competed in a triathlon the weekend before the accident.

1.3 Aircraft information

Civil Aviation Order (CAO) 82.3 states in part that aircraft in which more than nine passenger seats may be fitted must be provided with a minimum flight crew of two pilots.

The Metroliner was not fitted with an autopilot, nor was an autopilot required by regulation.

The actual gross weight or load distribution of the aircraft at the time of impact could not be determined as no load sheet could be located.

The aircraft, serial number DC-818 B, was manufactured in December 1992. The aircraft's *Flight/Maintenance Log* dated 6 May 2005 (the day prior to the accident) indicated that the aircraft had completed 26,875.5 hours and 28,527 cycles. Based on the times and cycles recorded by the flight data recorder (FDR)[8], the aircraft had logged 26,877.7 hours and 28,529 cycles. Scheduled maintenance was due at 26,932.0 hours and 28,565 cycles.

1.3.1 Ground Proximity Warning System

The aircraft was fitted with a Honeywell International Inc. (Honeywell) Ground Proximity Warning System (GPWS) MK VI. The GPWS was designed to provide warnings when certain conditions that threatened the safety of flight were encountered. One such warning was designed to alert the crew when an excessive terrain closure rate exists. When there is an excessive terrain closure rate situation, the GPWS generates a caution message "terrain terrain", and if the magnitude of the terrain closure rate is high enough, an aural "pull up" message is heard and the red GPWS warning light will illuminate. The generation of these warnings is influenced by the position of the landing gear and flap, as well as the position of the flap over-ride switch.

Data derived from the FDR was analysed by Honeywell to determine if the conditions, which would cause the GPWS computer to generate an excessive terrain closure rate alert should have been satisfied in the period preceding the collision with terrain.

Honeywell engineers determined that the flight profile of the Metroliner was such that the GPWS unit fitted to the aircraft should have generated a number of warnings of the terrain closure rate. The Honeywell assessment relied heavily on an estimation of radio altitude, because radio altitude was not one of the parameters recorded by the FDR. Honeywell determined that from approximately 29 seconds before impact, the terrain closure rate was such as to normally generate both warning "pull up" and caution "terrain terrain" messages. (See Appendix C for a Honeywell chart depicting the warnings that would be generated by the system if operating normally.)

The investigation has not been able to determine if the GPWS unit functioned as designed. (See 1.8 regarding the lack of cockpit voice recorder (CVR[9]) data.)

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[8] A flight data recorder is a device for automatically recording information on aircraft operation, colloquially referred to as a "black box".

[9] A cockpit voice recorder is a device for automatically recording all crew radio and inter-crew communications, plus background sounds and is also like the FDR, colloquially referred to as a "black box".

1.4 Meteorology

The Bureau of Meteorology (BoM**)** issued the following Terminal Area Forecast (TAF) for Lockhart River aerodrome at 0416 on 7 May 2005. This TAF was available to the crew of the Metroliner prior to departure from Cairns.

TAF YLHR 061816Z 2008 12014KT 9999 - SHRA SCT030

T 24 26 28 28 Q 1011 1013 1013 1011

TAF Interpretation

Terminal Area Forecast for Lockhart River Aerodrome, issued on 7 May 2005 at 0416 local time, with a validity period from 0600 to 1800 local time. Wind 120 degrees true at 14 knots; Visibility 10 km or greater; Light rain showers; Cloud, three to four eighths sky coverage, with a cloud base of 3,000 ft above aerodrome elevation.

Temperature and QNH (altimeter barometric setting required for the approach) at the commencement of the validity period, 0600 will be 24 degrees C and 1011 hectopascals (hPa); at 0900 will be 26 degrees C and 1013 hPa; at 1200 will be 28 degrees C and 1013 hPa; at 1500 will be 28 degrees C and 1011 hPa.

The BoM issued the following amended TAF at 0922 on 7 May 2005.

TAF AMD YLHR 062321Z 2308 13015G25KT 9999 – SHRA FEW010 BKN025

TEMPO 2302 4000 SHRA BKN010

INTER 0208 4000 SHRA BKN010

T 25 27 27 25 Q 1013 1012 1011 1012

Amended TAF Interpretation

Terminal Area Forecast amended for Lockhart River Aerodrome, issued on 7 May 2005 at 0921 local time, with a validity period from 0900 to 1800 local time. Wind 130 degrees True at 15 knots, gusting to 25 knots; Visibility 10 km or greater; Light rain showers; Cloud of one to two eighths coverage with a base of 1,000 ft and five to seven eighths coverage with a base of 2,500 ft above aerodrome elevation.

Temporarily between 0900 and 1200, conditions will be visibility 4,000 m in moderate rain showers; and cloud cover broken[10] with a base of 1,000 ft above aerodrome elevation.

Intermittently between 1200 and 1800, conditions will be visibility 4000 metres in moderate rain showers, cloud broken coverage with a cloud base of 1,000 ft above aerodrome elevation.

Temperature and QNH at the commencement of the validity period ie, 0900 will be 25 degrees C and 1013 hPa; at 1200 will be 27 degrees C and 1012 hPa; at 1500 will be 27 degrees C and 1011 hPa; at 1800 will be 25 degrees C and 1012 hPa.

[10] Broken: 5 to 7 eighths of the sky obscured by cloud.

At 0932, Brisbane ATC advised the crew of the Metroliner:

> Tango foxtrot uniform…hazard alert for you. An amended aerodrome forecast has just come out on Lockhart River. It now has a tempo period from two three zero zero till zero two zero zero. Visibility four thousand metres, moderate rain, cloud broken one thousand, and it also shows wind gusts in the main body of the TAF. Wind one three zero degrees, one five, gusting two five knots.[11]

The crew acknowledged and requested the QNH. The controller advised that the QNH from 2300 UTC was 1013 hPa.

The BoM Automatic Weather Station (AWS) located at the Lockhart River aerodrome was configured to record data at 10 minute intervals. It recorded wind, temperature and rainfall data. In the period from 1140 until 1150, which encompasses the estimated time at which the Metroliner collided with the terrain, the AWS recorded the following:

> Average wind direction 136 degrees; Average wind speed 9kt, Maximum wind speed 14 kt; Air temperature from 24.6°C to 26.0 degrees C and QNH 1013.1 hPa.

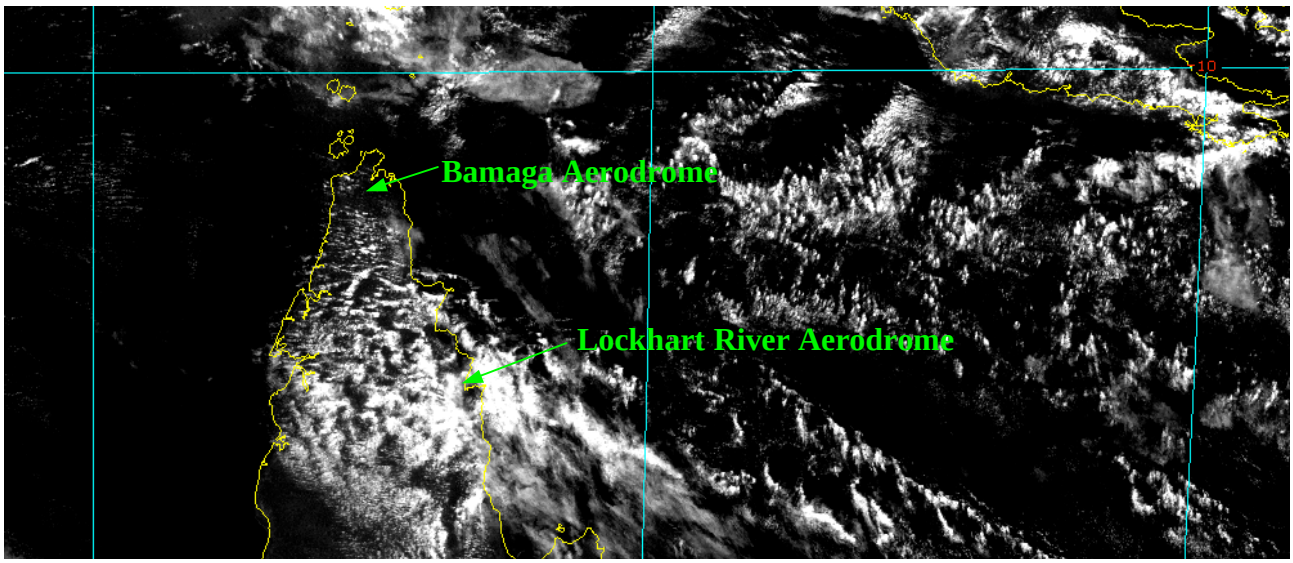
Observations were made at the aerodrome at 0900; 1200 and 1500 on the day of the accident. The 1200 synoptic observation was recorded as:

> Temperature 25.4 degrees C; Dew Point[12] temperature 23.5 degrees C; Mean Sea Level Pressure 1012.8 hPa; Wind from the South East at 8 knots; Rainfall 0.4mm; Present weather, rain within past hour; Past weather, moderate intermittent rain.

The visible satellite imagery covering the Cape York region at 1130 on the day of the accident is shown in Figure 3.

Prior to departing from Bamaga for Lockhart River, the PIC commented to the agent that the weather was 'bad' in Lockhart River, and that due to the weather conditions it may not be possible to land at Lockhart River.

Figure 3: Cape York satellite image at 1125 (about 18 minutes prior to the aircraft's collision with terrain)



[11] Hazard alerts relating to weather are issued when observations, pilot reports, or amended forecasts at the destination have unexpectedly deteriorated below the instrument flight rules or visual flight rules alternate minima. Tempo period refers to temporary fluctuations in meteorological conditions, lasting for periods of less than one hour in each instance. This covered the period when the Metroliner was making the approach to land.

[12] Dewpoint: Temperature at which, under ordinary conditions, condensation begins in cooling mass of air.

Based on the 0900 observer's report, the AWS recordings between 1100 and 1200 and the visible satellite image of 1125, the BoM estimated that the weather conditions in the Lockhart River area at the time of the accident were overcast, with broken low cloud, with a cloud base between 500 ft and 1,000 ft above mean sea level (AMSL). The wind was from the south east at between 10 and 15 knots, with occasional squally rain showers and intermittent drizzle. Those general conditions were confirmed by persons at Lockhart River.

1.5 Aids to Navigation

1.5.1 Global Navigation Satellite System

The term Global Navigation Satellite System (GNSS) has recently been adopted by ICAO to describe the constellation of satellites that is capable of providing accurate position information to appropriately equipped aircraft. GNSS navigation and position determination is based on measuring the distance from the receiver to satellites. By measuring the distance to four satellites, the system is able to establish three coordinates of a user's position: latitude, longitude, and altitude, as well as GNSS time.

The global positioning system (GPS) was originally developed by the United States Department of Defence to meet military requirements, and has been adapted for civilian use. In 1992, the US Federal Aviation Administration (FAA) issued performance standards for GPS receivers in the form of Technical Standard Order[13] C129 (TSO C129). The issuing of this TSO allowed manufacturers to build satellite receivers for use as supplementary navigation aids for aircraft. The Metroliner was fitted with a Garmin 'GPS 155XL' GNSS navigation unit. That unit, when installed appropriately, was certified to TSO C129.

In Australia, CASA is the organisation responsible for promulgating the criteria for using GNSS. Civil Aviation Advisory Publications (CAAP) are issued by CASA and although advisory only, they detail the CASA preferred method for complying with the Civil Aviation Regulations. CAAP 179A-1(0) *Guidelines for Navigation using GNSS* issued on December 2002 included the following information:

> Human factors issues for the appropriate use of GNSS involve the user having an awareness of the equipment limitations of design, controls, displays and software logic in order to avoid making errors that could lead to undesired aircraft states or accidents. These errors include entry of information into the machine, interpretation of information from the machine, inadequate cross-checking from alternative sources and inappropriate decision-making based on GNSS output.

The Lockhart River Runway 12 RNAV (GNSS) approach procedure referenced satellites to locate the position of the aircraft relative to the published approach waypoints.

Factors for a crew to consider when using GNSS to conduct a non-precision approach such as the Lockhart River 12 RNAV approach were provided in the company operations manual. This guidance included the following:

> Activation of the GPS NPA will cancel the active flight plan and tracking guidance will be to the Initial Approach Fix selected.
>
> Note: Distance information will be to the next position in the approach not the destination.

The pilot of an aircraft engaged on an unrelated search and rescue mission approximately 200 NM east of Lockhart River aerodrome reported a 'RAIM[14] failure' between 1120 and 1150 which lasted for between 10 and 50 seconds. There were no difficulties reported in the Lockhart River area at the

[13] Establishes quality control for avionics and other equipment.

[14] RAIM: Receiver autonomous integrity monitoring. Can be related to receiving unit or GNSS.

time the Metroliner was conducting the approach. The operational status of the Garmin 'GPS 155XL' unit fitted to the aircraft could not be determined.

1.5.2 Non-directional beacon

A non-directional beacon (NDB) was located at the Lockhart River aerodrome. Airservices Australia published an approach procedure for the Lockhart River aerodrome that utilised the NDB to facilitate descent during periods of poor visibility. No reports were received to indicate any failure or malfunction of the NDB at Lockhart River on the day of the occurrence.

1.6 Communications

Recordings of the radio communications from the aircraft during the latter stages of the flight from Bamaga to Lockhart River were identified as having been made by the copilot. It was normal company practice that the pilot not flying assumed responsibility for radio transmissions during flight.

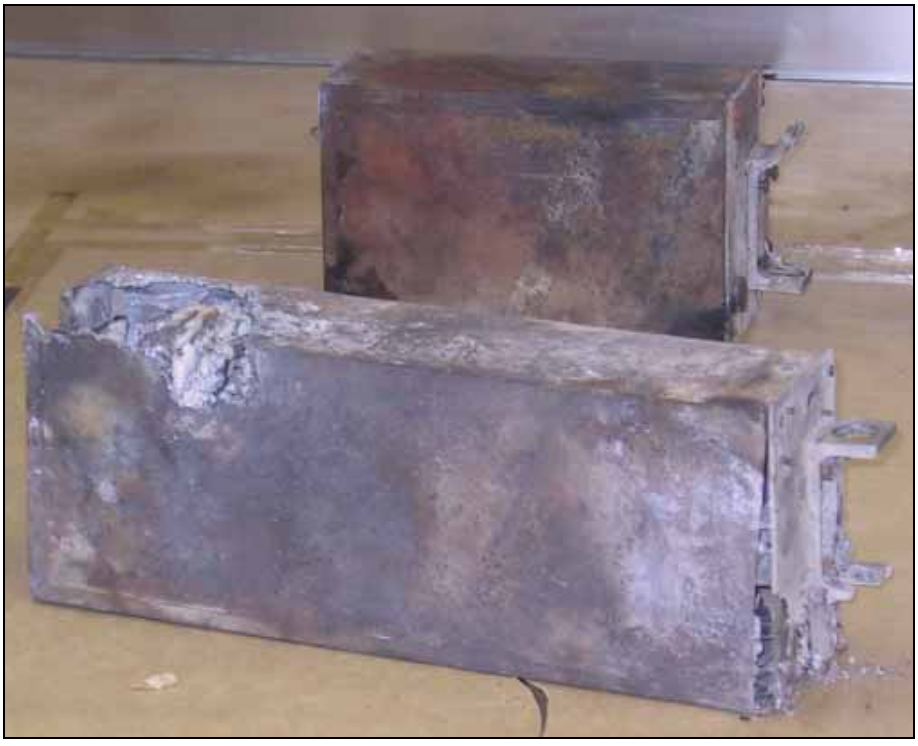
1.7 Aerodrome information

The bearing and distance of the runway 12 threshold from the impact site was 123.5 degrees Magnetic and 10.75 kilometres. The aerodrome elevation was 77 ft.

1.8 Flight recorders

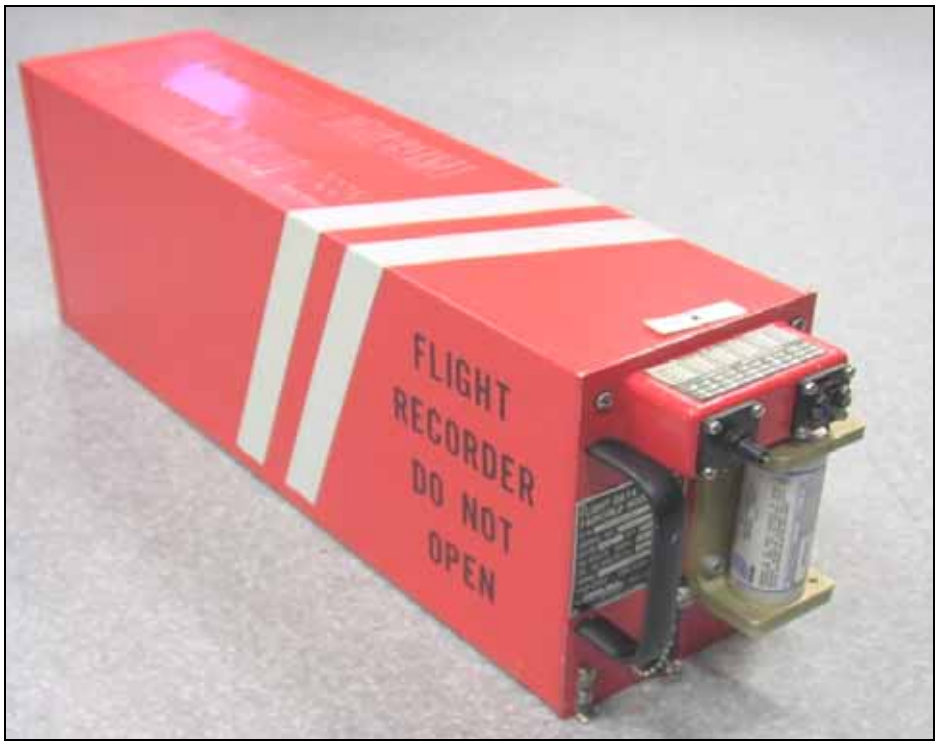
The aircraft's CVR and FDR (see figures 4 and 5) were examined at the Australian Transport Safety Bureau (ATSB) laboratory.

Figure 4: FDR (foreground) and CVR recovered from VH-TFU



Under direct ATSB supervision the FDR memory board was transported to the manufacturer's authorised repair facility where, in accordance with the manufacturer's instructions, the data was downloaded using a standard data retrieval unit. The downloaded file was decompressed using the manufacturer's readout support equipment software.

Figure 5: Example of undamaged FDR



The FDR contained approximately 100 hours of data, including data relating to the entire accident flight. The analysis of the data provided valuable information about the aircraft flight profile leading up to the accident (see Appendix B for details).

FDR data indicated that both engines were delivering between 30% and 35% torque at a propeller RPM of between 98.1% and 100.7%. After passing waypoint LHRWI, the aircraft descent rate was greater than required to achieve the recommended descent profile for the published approach procedure. The aircraft descended at an average rate of 1,600 ft/min[15], with some turbulence evident, over the 50 seconds prior to the impact. Indicated airspeed (IAS) averaged 174 kts[16] over this period. When the recording ceased the flaps were at the 18° position.

[15] Pressure altitude data derived from the FDR is accurate to ±100 ft below 3,000 ft

[16] Calculated airspeed data derived from the FDR is accurate to ±15 kts above 150 kts

Figure 6: Approach profile (in red) derived from FDR data overlayed on the Airservices Australia published approach chart

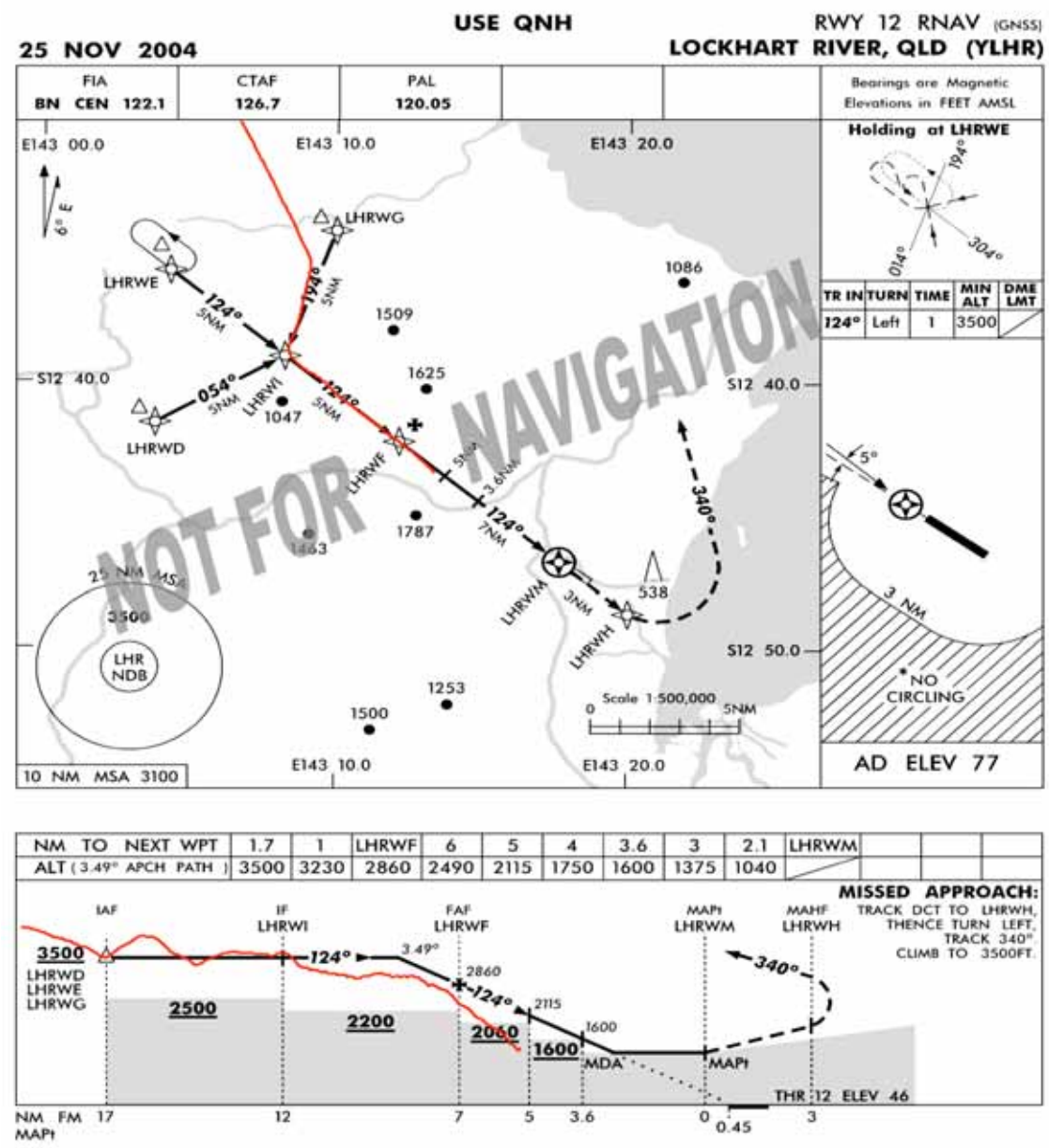


Figure 6 shows an Airservices Australia Runway 12 RNAV (GNSS) instrument approach chart for Lockhart River overlayed with the FDR derived flight profile of the Metroliner. It is apparent that the crew was accurately tracking after the waypoint LHRWG. Some excursions from the recommended vertical profile can be seen after passing LHRWG. After passing waypoint LHRWF, the aircraft descended below the segment minimum safe altitude of 2060 ft.

Analysis of the 30 minute CVR tape indicated that it contained a mixture of electrical pulses and fragments of conversations, some identified from previous flights. The ATSB's flight recorder investigators determined that data from the CVR could not be recovered using current technology. Additional technical advice was sought from the US National Transportation Safety Board and the UK Air Accidents Investigation Branch. Recorder specialists from both organisations verified that recovery of useable data was not possible.

1.9 Wreckage and impact information

Figure 7: Damage to vegetation due to impact and substantial fuel discharge



The destruction of the aircraft was consistent with massive overload as a consequence of collision with trees and large boulders during the impact sequence. The aircraft had cut a swath of less than 100 m length through heavy timber on the steep slope and came to rest about 90 ft below the top of the ridge.

The only major aircraft components not accounted for at the accident site were the outboard section of the right aileron, left front baggage compartment door and one propeller blade. It is likely that those missing components were either thrown well clear of the main wreckage site and lost in the thick vegetation, or had been consumed by the intense post-impact fire. No evidence was identified to suggest that those items had become detached from the aircraft prior to the impact sequence. The dynamics of the collision with the terrain, and the damage to the propellers and engines, was consistent with both engines producing significant power at impact.

Figure 8: Wing section showing deformation caused by collision with a tree



Figure 9: The boulder-strewn site just below the main wreckage covered by shattered pieces of the left wing



The area where the wing tips were found indicated that they were torn off early in the impact sequence. The wing spars were bent backward to between 50 and 55 degrees from their normal position, indicating the degree of disruption sustained by the wings.

The landing gear hydraulic actuators were found with their piston shafts bent in the extended position, indicating that the landing gear assemblies were down at the time of impact.

The quantity of fuel on board the aircraft at the time of impact could not be determined. However, the intensity of the post impact fire and the effect of fuel damage to the surrounding foliage indicated that a significant quantity of fuel was onboard.

Figure 10: Accident site looking along the direction of travel



1.10 Medical and pathological information

There was no post-mortem evidence to suggest that either crew member suffered any incapacitation before the collision, nor was there any evidence to suggest an on-board fire prior to impact. Toxicology examination of both pilots did not detect the presence of any drugs.

1.11 Organisational and management information

Pilots employed by the operator were expected to use maps and charts produced by Jeppesen Sanderson Inc. (Jeppesen) and both pilots held current subscriptions to the Jeppesen chart amendment service. Although those charts were produced by Jeppesen, they were developed from data published by Airservices Australia. The Lockhart River, Qld - Runway 12 RNAV (GNSS) approach chart produced by Jeppesen is included at Appendix A.

The company operations manual included the following statement:

> The PIC shall:
>
> - ensure that a load sheet is completed prior to departure of the aircraft on each stage of every flight
> - ensure the load sheet is carried in the aircraft and that a copy is retained on the ground at the aerodrome of departure.

No load sheet relating to the accident flight could be located at Bamaga. Current and former employees of the operator reported that it was not routine practice for the load sheet to be left at Bamaga.

The company operations manual included the following statements:

> All new company pilots shall complete the Human Factors Management (HFM) induction course…within 6 months of joining the company; and
>
> All company pilots shall complete a recurrent HFM course…every 15 months.

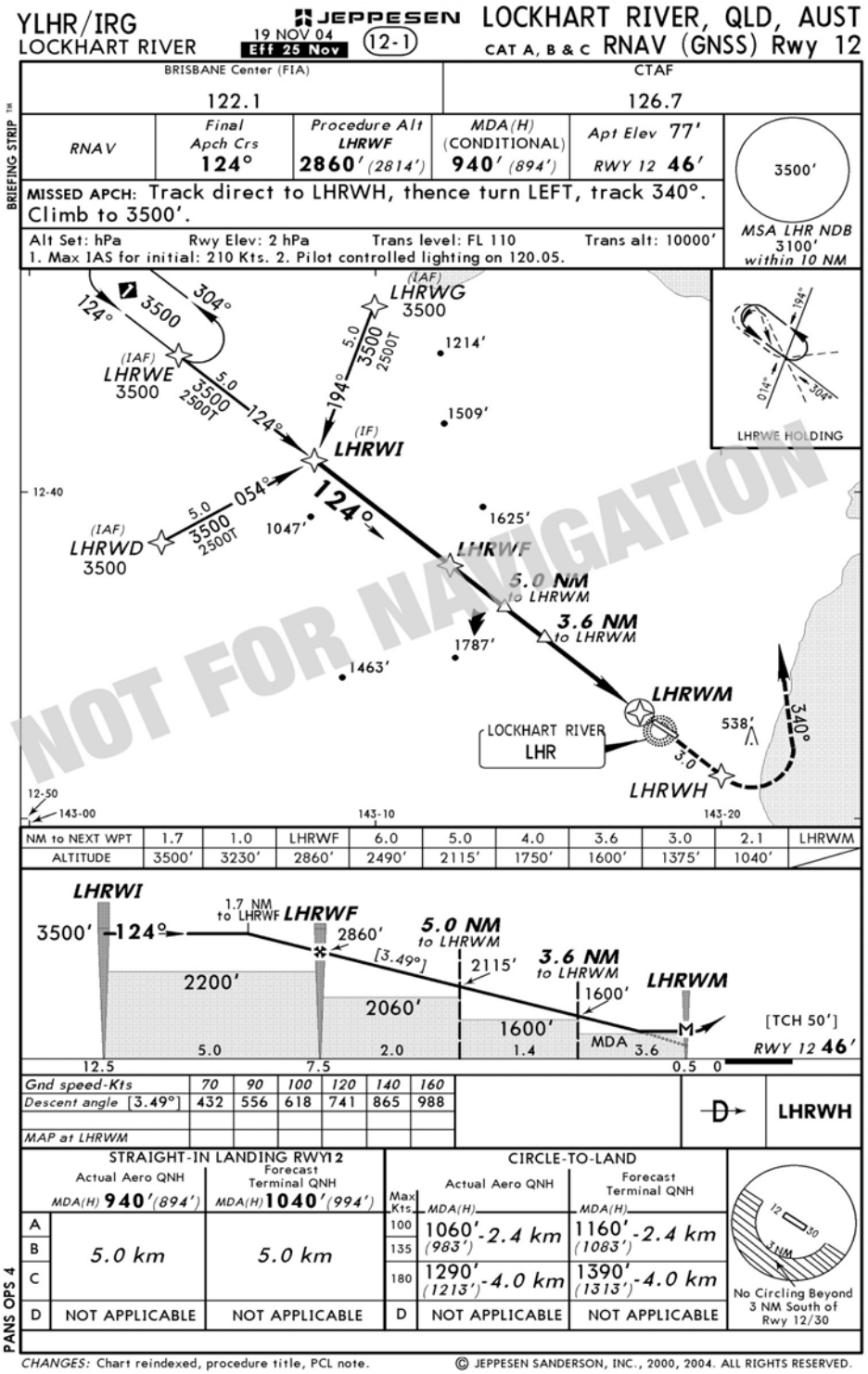
Human factors management courses are designed to teach flight crew the non-technical skills essential for operating in a multi-pilot team in a complex time-critical environment. No record could be located to indicate that the PIC had completed the Human Factors Management Induction Course or any Human Factors Management recurrent training course since appointment.

Documents from the company that refuelled the Metroliner prior to departure from Bamaga indicated that 800 litres of Jet A-1 fuel was supplied to the aircraft.

The continuing investigation is examining and analysing operational, airworthiness and regulatory issues.

Appendix A

Jeppesen Lockhart River Runway 12 RNAV (GNSS) approach chart



Reproduced with the permission of Jeppesen Sanderson, Inc.

Appendix B

Flight Data Recorder Details

Data from the flight data recorder (FDR) fitted to VH-TFU on 7 May 2005 was successfully recovered. The recovered data included the accident flight and 59 previous flights giving a total recording duration of 100 hours 2 minutes and 16 seconds.

Examination of the data showed that the following parameters were serviceable during the accident flight:

- Pressure Altitude
- Indicated Airspeed
- Magnetic Heading
- Roll Attitude
- Horizontal Stabiliser Position
- Flap Position
- Elevator Position
- Rudder Position
- Aileron Position
- Right Engine Propeller percentage RPM
- Left Engine Propeller percentage RPM
- Right Engine Torque
- Left Engine Torque
- Vertical Acceleration
- Longitudinal Acceleration
- Microphone Keying - Pilot
- Microphone Keying – Copilot.

Examination of the data showed that the Pitch Attitude parameter had not been correctly recorded during the accident flight or any of the previous flights recorded by the FDR.

Timing correlation

Co-ordinated universal time (UTC) was not recorded by the FDR; however the FDR did record elapsed time, which began when power was applied to the recorder. When power was removed and later re-applied, this counter was automatically reset to zero.

UTC was matched with the recorded FDR elapsed time[17] by correlating microphone keying with the UTC time stamp from the ATC air/ground voice recording. Using this technique the radio transmission from VH-TFU ("*Brisbane centre tango foxtrot uniform*") which was recorded on the ground at 0114:29 UTC was correlated with the FDR microphone keying parameter at an elapsed time of 1281 seconds.

Results

The F1000 model FDR compresses the flight data before it is recorded and as a result the recording duration exceeds the minimum requirement of retaining the most recent 25 hours. In this case 100 hours 2 minutes and 16 seconds of data was recorded, covering the accident flight and 59 previous flights. The oldest data recorded was from the cruise and descent portion of the Lockhart River to Cairns flight on 13 April 2005.

[17] FDR does not have a time referenced input. It records elapsed time in seconds.

Flights that landed at the Lockhart River aerodrome (YLHR) are tabulated below:

Flight Sequence: (before accident flight)	Sector:	Date:	Landing Runway:
2	YBCS-YLHR	7 May	12
9	YBCS-YLHR	4 May	12
17	YBAM-YLHR	30 April	12
19	YBCS-YLHR	30 April	12
28	YBAM-YLHR	27 April	12
30	YBCS-YLHR	27 April	12
34	YBCS-YLHR	25 April	12
36	YBAM-YLHR	23 April	12
50	YBCS-YLHR	20 April	12

The accident flight was examined in detail. The FDR sequence of events for the accident flight and plots showing parameters for both the entire flight and the final five minutes (in greater detail) are shown below.

Parameter accuracies

The accuracy of the corrected IAS values was:

IAS	**Accuracy**
60 kts to 150 kts	± 10 kts
> 150kts	± 15 kts

The accuracy of the corrected altitude values was:

Altitude	**Accuracy**
3,000 feet	± 100 feet
18,000 feet	± 300 feet
22,000 feet	± 400 feet

A reasonableness check of magnetic heading was performed by examining recorded magnetic heading during takeoff and landing versus known magnetic heading obtained from the Airservices Australia publication *En Route Supplement Australia.*

Location	**Runway Directions**	**Landing**	**Takeoff**
(7 May 2005)	**(ºM)**	**(ºM)**	**(ºM)**
Cairns	149/329	150.0	151.6
Lockhart River	119/299	119.9	120.8
Bamaga	131/311	129.2	133.3

The recorded headings were obtained at times when the IAS was between 80 and 100 kts. The comparison showed that recorded magnetic heading agreed with documented magnetic heading within an accuracy of ± 5º.

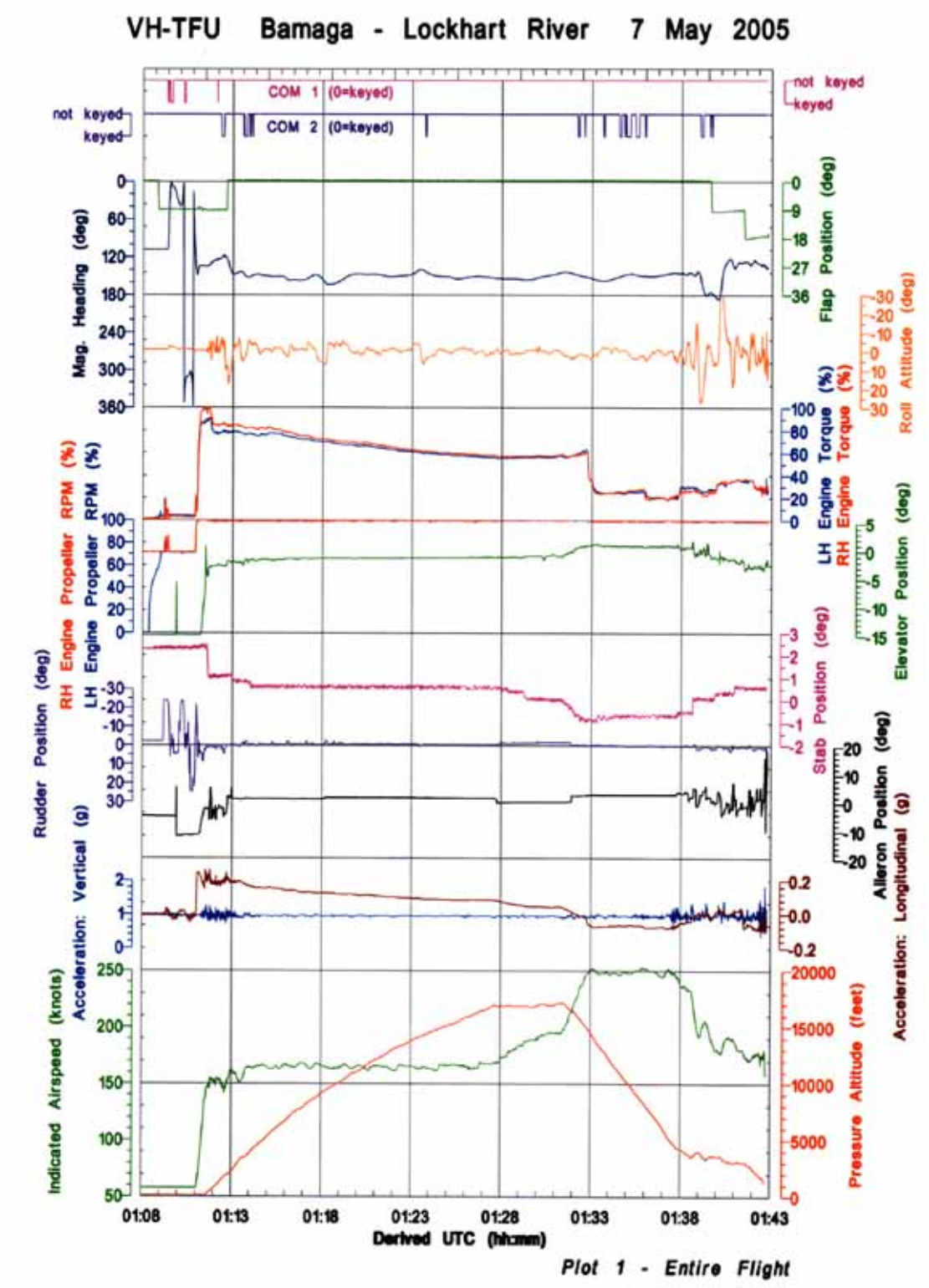
FDR sequence of events

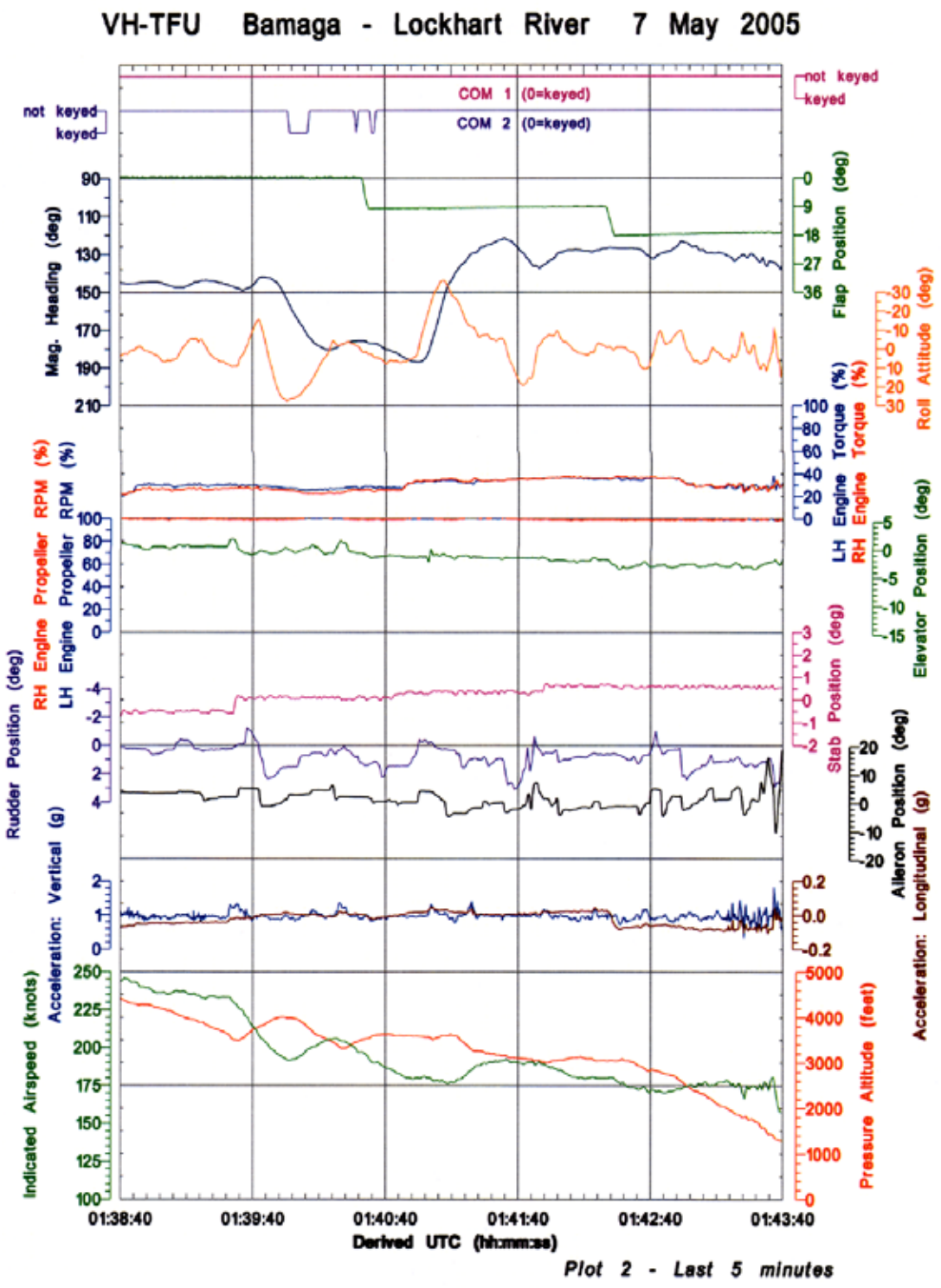
UTC (from ATC recordings) (hh:mm:ss)	FDR Elapsed Time (hh:mm:ss)	Pressure Altitude (feet)	Mag. Heading (degrees)	Indicated Airspeed (knots)	Event
00:53:08	00:00:00	80	N/A	N/A	FDR power-up. Aircraft was stationary at Bamaga.
01:07:33	00:14:25	80	N/A	N/A	Right engine start.
01:09:16	00:16:08	80	N/A	N/A	Left engine start.
01:09:43	00:16:35	80	N/A	N/A	Takeoff flap selected.
01:10:15	00:17:07	80	107.5	N/A	Microphone keyed - COM1[18]. Aircraft began to taxi.
01:10:24	00:17:16	80	6.8	N/A	Microphone keyed - COM1.
01:10:46	00:17:38	80	25.0	N/A	Control checks: aileron and elevator.
01:11:10	00:18:02	80	343.3	N/A	Microphone keyed - COM1.
01:11:55	00:18:47	80	147.4	N/A	Power applied for takeoff on runway 13 at Bamaga.
01:12:20	00:19:12	110	134.3	119	Lift off.
01:12:40	00:19:32	380	131.0	149	Torque reduced on both engines after takeoff.
01:13:02	00:19:54	870	124.6	147	Microphone keyed - COM1.
01:13:15	00:20:07	1250	121.4	154	Microphone keyed - COM2[19].
01:13:32	00:20:24	1770	120.4	146	Flap selected up.
01:14:29	00:21:21	3360	145.8	153	Microphone keyed - COM2.
01:14:34	00:21:26	3440	149.2	155	Microphone keyed - COM2.
01:14:50	00:21:42	3670	151.0	165	Microphone keyed - COM2.
01:14:59	00:21:51	3920	149.7	163	Microphone keyed - COM2.
01:24:37	00:31:29	14280	142.8	165	Microphone keyed - COM2.
01:28:33	00:35:25	16980	153.1	169	Top of climb (FL170).
01:32:27	00:39:19	17120	143.3	201	Top of descent.
01:33:07	00:39:59	16130	147.9	226	Microphone keyed - COM2.
01:33:29	00:40:21	15410	150.5	239	Microphone keyed - COM2.
01:33:38	00:40:30	15130	150.9	246	Torque reduced on both engines.
01:33:55	00:40:47	14530	153.7	252	Further reduction in torque on both engines.

[18] COM 1 refers to the pilot in command's transmitter

[19] COM 2 refers to the copilot's transmitter

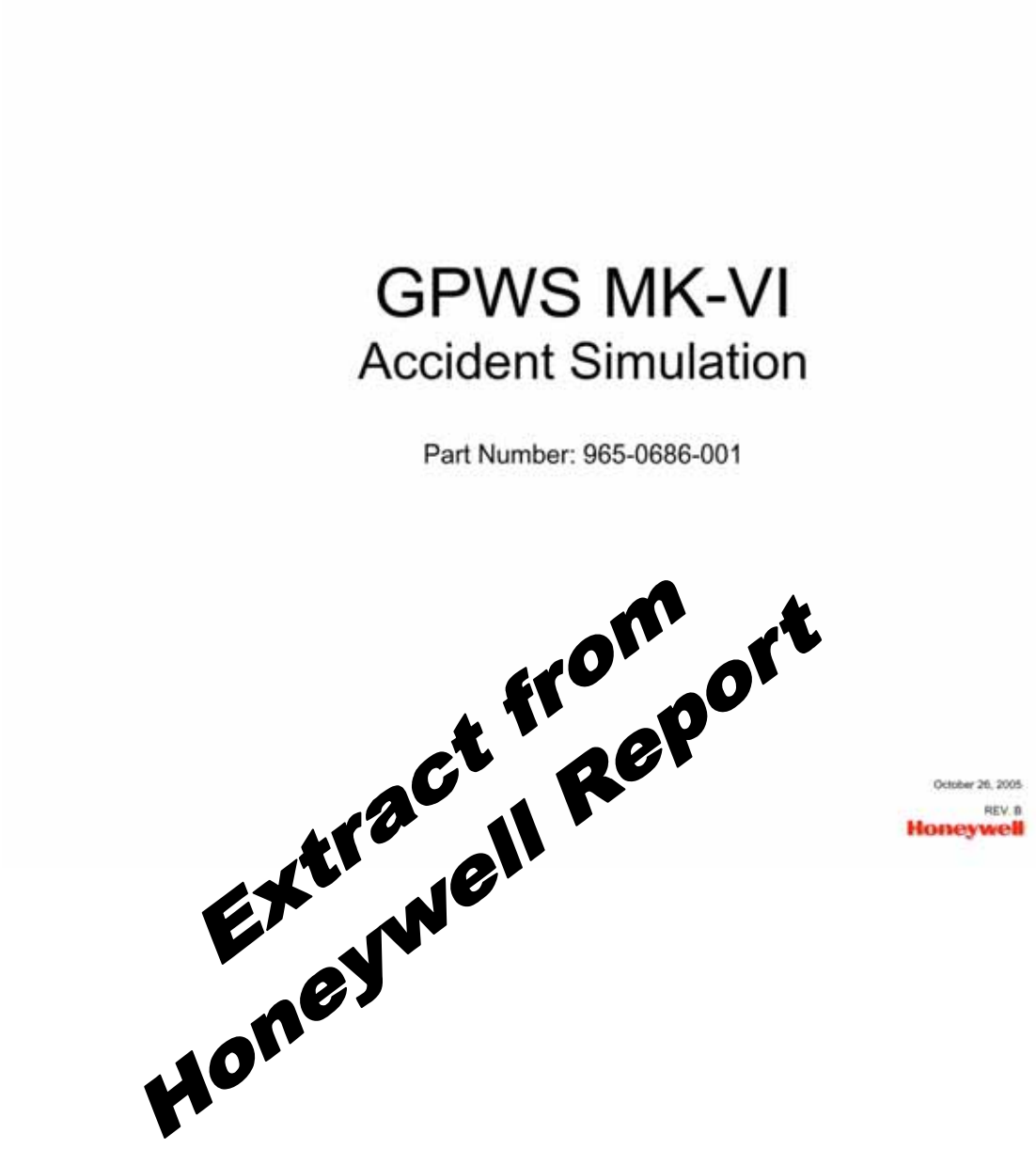
UTC (from ATC recordings) (hh:mm:ss)	FDR Elapsed Time (hh:mm:ss)	Pressure Altitude (feet)	Mag. Heading (degrees)	Indicated Airspeed (knots)	Event
01:34:32	00:41:24	13070	157.1	248	Microphone keyed - COM2.
01:35:25	00:42:17	11200	150.7	247	Microphone keyed - COM2.
01:35:43	00:42:35	10580	147.3	249	Microphone keyed - COM2.
01:35:49	00:42:41	10380	146.9	250	Microphone keyed - COM2.
01:36:19	00:43:11	9370	147.6	250	Microphone keyed - COM2.
01:36:50	00:43:42	8360	149.4	253	Microphone keyed - COM2.
01:38:45	00:45:37	4310	145.3	243	Torque increased on both engines.
01:39:31	00:46:23	3510	146.8	229	Aircraft reached 3,500 feet and began to climb.
01:39:51	00:46:43	3990	144.6	195	Aircraft levelled at 4,000 feet.
01:39:57	00:46:49	3990	157.1	192	Aircraft began to descend. Microphone keyed - COM2.
01:40:20	00:47:12	3320	177.7	204	Altitude 3,300 feet.
01:40:27	00:47:19	3460	175.7	197	Microphone keyed - COM2.
01:40:29	00:47:21	3510	175.7	197	First stage of flap selected.
01:40:34	00:47:26	3600	177.0	190	Aircraft levelled at 3,600 feet. Microphone keyed – COM2
01:40:47	00:47:39	3600	183.6	181	Torque increased on both engines.
01:41:09	00:48:01	3620	145.2	178	Aircraft overflew LHRWI.
01:41:12	00:48:04	3590	139.4	179	Aircraft left 3,600 feet.
01:41:53	00:48:45	3000	134.8	188	Aircraft levelled at 3,000 feet.
01:42:20	00:49:12	3040	127.0	180	Second stage of flap selected.
01:42:30	00:49:22	3040	126.9	174	Aircraft left 3,000 feet on descent.
01:42:40	00:49:32	2860	131.5	173	One minute before the end of the recorded data.
01:42:50	00:49:42	2720	127.5	172	50 seconds before the end of the recorded data.
01:42:59	00:49:51	2400	126.3	174	Aircraft overflew LHRWF.
01:43:00	00:49:52	2380	126.0	174	40 seconds before the end of the recorded data.
01:43:10	00:50:02	2100	129.4	177	30 seconds before the end of the recorded data.
01:43:20	00:50:12	1860	131.9	176	20 seconds before the end of the recorded data.
01:43:30	00:50:22	1560	134.2	172	10 seconds before the end of the recorded data.
01:43:40	00:50:32	1370	136.0	157	End of recorded data.


VH-TFU Bamaga - Lockhart River 7 May 2005
COM 1 (0=keyed)
COM 2 (0=keyed)
not keyed
keyed
Mag. Heading (deg)
Flap Position (deg)
Roll Attitude (deg)
LH Engine Torque (%)
RH Engine Torque (%)
LH Engine Propeller RPM (%)
RH Engine Propeller RPM (%)
Elevator Position (deg)
Stab Position (deg)
Aileron Position (deg)
Rudder Position (deg)
Acceleration: Vertical (g)
Acceleration: Longitudinal (g)
Indicated Airspeed (knots)
Pressure Altitude (feet)
01:08
01:13
01:18
01:23
01:28
01:33
01:38
01:43
Derived UTC (hh:mm)
Plot 1 - Entire Flight


VH-TFU Bamaga - Lockhart River 7 May 2005
COM 1 (0=keyed)
COM 2 (0=keyed)
not keyed
keyed
Mag. Heading (deg)
Flap Position (deg)
Roll Attitude (deg)
LH Engine Torque (%)
RH Engine Torque (%)
LH Engine Propeller RPM (%)
RH Engine Propeller RPM (%)
Elevator Position (deg)
Rudder Position (deg)
Stab Position (deg)
Aileron Position (deg)
Acceleration: Vertical (g)
Acceleration: Longitudinal (g)
Indicated Airspeed (knots)
Pressure Altitude (feet)
01:38:40
01:39:40
01:40:40
01:41:40
01:42:40
01:43:40
Derived UTC (hh:mm:ss)
Plot 2 - Last 5 minutes

Appendix C

Honeywell GPWS MK-VI Simulation



The following simulation of the classic MKVI GPWS computer relies heavily on an estimated radio altitude value. The actual radio altitude value was not recorded on the flight recorder. The estimated radio altitude value is derived by using the estimated 3D flight path of the aircraft and the best available digital elevation model (DEM). Because of this the results must be used with caution as the actual radio altitude values as seen by the GPWS computer could be quite different.

The simulation assumes that the flaps were not in landing configuration and that the landing gear was down. Also the simulation assumes that the cockpit GPWS DESENS or Flap Override switch was not activated. If the GPWS DESENS or Flap Override switch was activated NO GPWS alerts would be issued.

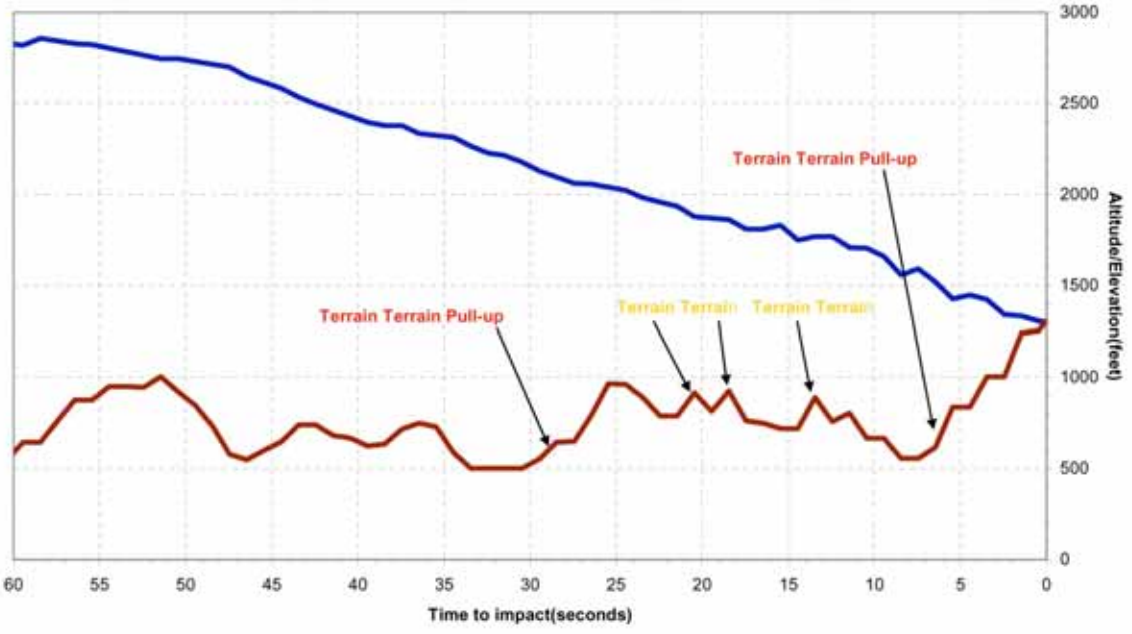
The following table shows the results of the GPWS simulation.

Time to impact	Voice message - event
29.4	"TERRAIN-TERRAIN PULL UP"
27.4	"PULL UP"
25.4	"PULL UP"
24.0	Voice off. GPWS alert lamp remains on
20.65	"TERRAIN-TERRAIN"
18.4	"TERRAIN-TERRAIN"
13.9	"TERRAIN-TERRAIN"
6.35	"TERRAIN-TERRAIN PULL UP"

Extract from Honeywell Report

October 26, 2005
REV. B
Honeywell

Lockhart River, QLD, Australia (YLHR)
Accident: May 07, 2005
Metroliner



October 26, 2005
REV. B
Honeywell