Australian Government

Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY INVESTIGATION REPORT

Aviation Occurrence Investigation – AO-2008-007

Interim Factual

Hard landing – Darwin Airport, NT

7 February 2008

VH-NXE

Boeing Company 717 - 200

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Jeppesen aeronautical charts (Figure 1)
Google Earth (Figure 2)
Boeing Commercial aircraft (Figure 3)
National Jet Systems (Figure 4)

Abstract

On 7 February 2008, a Boeing Company 717–200 aircraft, registered VH-NXE, was being operated on a scheduled passenger service from Cairns, Qld, via Nhulunbuy (Gove) to Darwin, NT, with six crew and 88 passengers. During an ILS approach to runway 29 at Darwin Airport, the aircraft touched down on the runway at a high rate of descent which resulted in a hard landing. The crew completed the landing rollout and taxied the aircraft to the terminal without further incident. The extent of aircraft damage constituted an accident.

The investigation is continuing.

THE AUSTRALIAN TRANSPORT SAFETY BUREAU

The Australian Transport Safety Bureau (ATSB) is an operationally independent multi-modal bureau within the Australian Government Department of Infrastructure, Transport, Regional Development and Local Government. ATSB investigations are independent of regulatory, operator or other external organisations.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within Commonwealth jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to fare-paying passenger operations.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and Regulations and, where applicable, relevant international agreements.

Purpose of safety investigations

The object of a safety investigation is to enhance safety. To reduce safety-related risk, ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated.

It is not the object of an investigation to determine blame or liability. However, an investigation report must include factual material of sufficient weight to support the analysis and findings. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner.

Developing safety action

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. The ATSB prefers to encourage the relevant organisation(s) to proactively initiate safety action rather than release formal recommendations. However, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation, a recommendation may be issued either during or at the end of an investigation.

The ATSB has decided that when safety recommendations are issued, they will focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on the method of corrective action. As with equivalent overseas organisations, the ATSB has no power to implement its recommendations. It is a matter for the body to which an ATSB recommendation is directed (for example the relevant regulator in consultation with industry) to assess the costs and benefits of any particular means of addressing a safety issue.

About ATSB investigation reports: How investigation reports are organised and definitions of terms used in ATSB reports, such as safety factor, contributing safety factor and safety issue, are provided on the ATSB web site www.atsb.gov.au.

FACTUAL INFORMATION

The information contained in this interim factual report is derived from initial investigation of the occurrence. Readers are cautioned that there is the possibility that new evidence may become available that alters the circumstances as depicted in the report.

Sequence of events

On 7 February 2008, a Boeing Company 717–200 (717) aircraft, registered VH-NXE, was being operated on a scheduled passenger service from Cairns, Qld, via Nhulunbuy (Gove) to Darwin, NT, with six crew and 88 passengers. During an ILS[1] approach (Figure 1) and visual landing to runway 29 at Darwin Airport, the aircraft was subjected to a hard landing.

The flight crew consisted of the pilot in command (PIC) and copilot. The copilot was the handling pilot for the descent, approach and landing at Darwin and the PIC was the monitoring pilot. The crew had received a weather briefing prior to the departure from Cairns, informing them that there were showers in the Darwin area for their arrival. Thunderstorms were forecast for the Darwin area shortly after their planned arrival.

Air traffic control (ATC) cleared the flight crew to conduct an approach to Darwin runway 29. The PIC stated that the runway was in sight prior to flying over the Howard Springs non-directional beacon (NDB).

Information from the aircraft's flight data recorder (FDR) indicated that the aircraft flew over the Howard Springs NDB at about 3,000 ft above mean sea level (AMSL), with a computed air speed of 220 knots at 2111:47 Central Standard Time[2] (Appendix A).

The aircraft was above the glideslope at the Howard Springs NDB, where the copilot attempted to place the aircraft on the glideslope by using the vertical speed mode on the autopilot.

The copilot disconnected the autopilot at 2113:00 when the aircraft was at 1,861 ft AMSL, with a descent rate of 2,000 feet per minute (FPM), and from where the remainder of the approach was flown manually by reference to the ILS and visual reference with the runway lighting.

At the outer marker[3], the aircraft was configured for landing with the landing gear selected down and the landing flaps of 40° set. The glideslope was captured at 2113:31 at 1,159 ft AMSL, where the rate of descent was 1,976 FPM.

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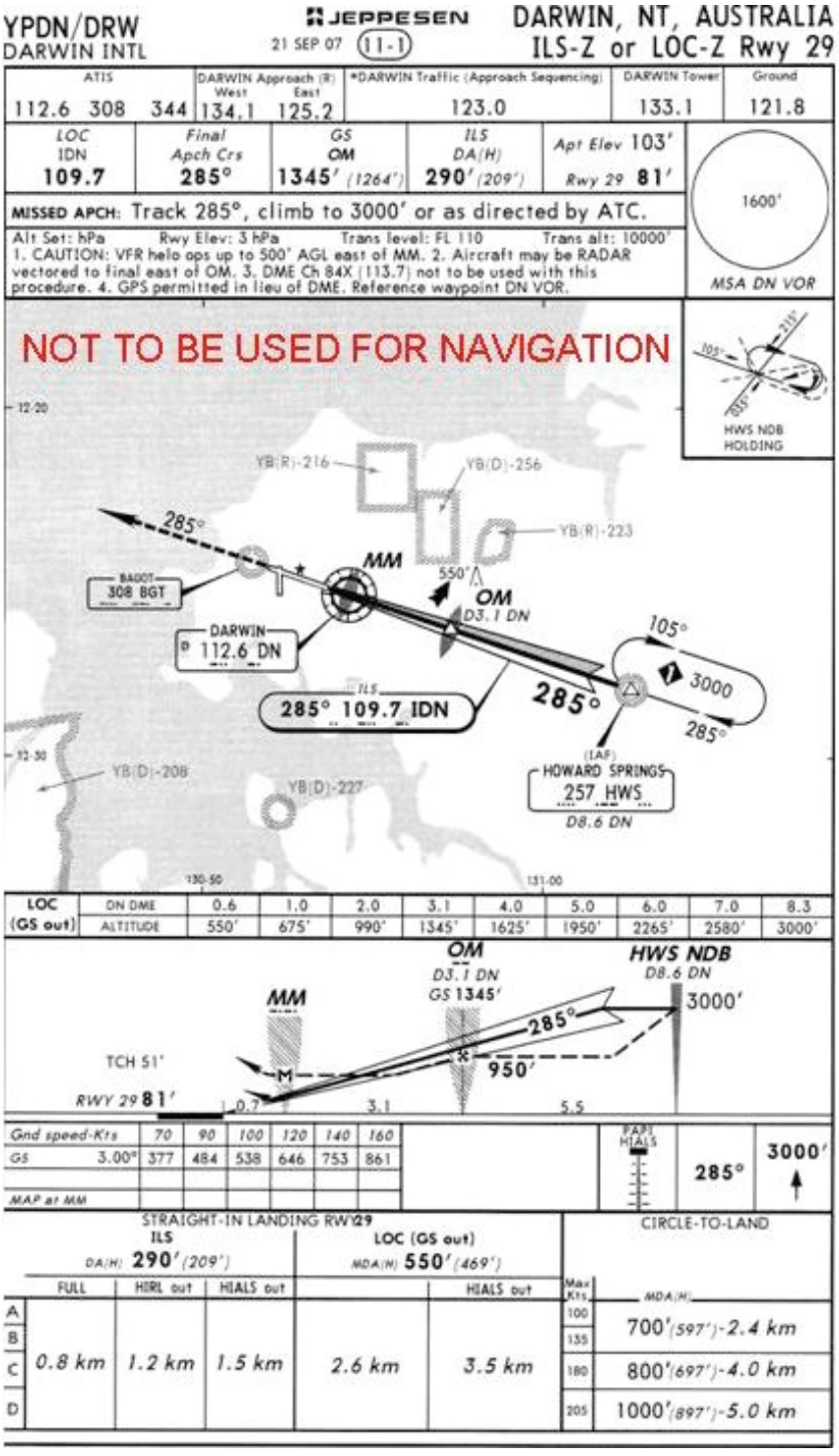
1 The instrument landing system (ILS) is a ground-based navigation aid. An ILS instrument approach provides lateral and vertical guidance to the runway. The aircraft was equipped with two ILS receivers that displayed the deviation from localiser and glideslope radio beams.

2 The 24-hour clock is used in this report to describe the local time of day, Central Standard Time (CST), as particular events occurred. Central Standard Time was Coordinated Universal Time (UTC) + 9.5 hours.

3 The outer marker is a ground based navigation aid associated with the ILS.

Figure 1: Darwin Runway 29 ILS approach chart



At approximately 700 ft AMSL, the flight crew reported passing through a rain shower. The monitoring pilot switched on the windscreen wipers and, as they could see the runway lighting and PAPI[4], the approach was continued.

4 The precision approach path indicator (PAPI) is a ground based light system which provides visual approach slope guidance to the crew during an approach.

At 500 ft above ground level (AGL), the aircraft was established within the company's stable approach criteria descent rate of not more than 1,000 FPM. However, the descent rate increased again at 182 ft AGL to a recorded value of 1,168 FPM. As the deviation from the stable approach criteria was considered momentary by the PIC, and the copilot made a corrective action to reduce the descent rate, the approach was continued.

During the approach and landing, the aircraft's autothrottle remained engaged.

The FDR information at Appendix B displays the aircraft's flight path parameters from a radio altitude of 180 ft to after touchdown.

At approximately 30 ft radio altitude, the FDR recorded a rate of descent of approximately 1,000 FPM at the same time as an abrupt control column nose-up command was applied and the autothrottle retarded the thrust to idle. The copilot recalled hearing the synthesised calls of radio altitude from the aircraft's radar altimeter.

At 2114:51, the aircraft landed heavily on the left main landing gear prior to the 300 m runway markings (Figure 2), to the left of the runway centreline, and with a rate of descent of about 900 FPM (Appendix A).

Figure 2: Darwin Runway 29 touchdown markings and environs

During the landing, the ground spoilers[5] partially extended then retracted. The ground spoilers are automatically deployed by a signal provided from the main wheel spin-up or a ground contact signal from the main gear. If the thrust levers are advanced to a high thrust lever position while the ground spoilers are extended, the spoiler panels automatically retract. The FDR recorded the thrust levers had been advanced after initial touchdown, beyond the position necessary to automatically retract the spoiler panels. The flight crew did not manually extend the ground spoilers (Appendix C).

The FDR data also showed after initial touchdown a forward movement of the control column, which transferred some of the aircraft's weight onto the nosewheel.

The crew then completed the landing roll and taxied the aircraft to the terminal. There were no reported injuries to passengers and crew, however the extent of aircraft damage constituted an accident. (see below)

Aircraft operator's 717 landing history

The aircraft operator subsequently became aware of two previous hard landings by the copilot in the 15-day period prior to this accident. There was no damage to the aircraft on these occasions. The Quick Access Recorder (QAR) data that indicated the aircraft had been subjected to the hard landings was not immediately available to the flight crew or to the aircraft operator.

The aircraft operator's investigation report into the accident indicated that the pilot had raised concerns about difficulties with landings with a Check Captain during a line check on a previous flight, and again with another Check Captain after the Darwin accident. It also noted that the pilot did not report the landing difficulties directly to the aircraft operator training organisation due to a lack of defined procedures for reporting such issues as well as concerns whether the matter would be treated in a non-jeopardy manner.

Further analysis of the QAR data following the accident identified six instances of high vertical acceleration limits[6] being exceeded during the 30 months of operating the aircraft type prior to this occurrence. There were a further 11 instances during February 2008, with 13 instances during the subsequent 4-month period.

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5 Ground spoilers are hinged moveable surfaces on the upper rear surface of the wing which, when extended after landing, reduce lift, increase drag and place the weight of the aircraft on the wheels, thus improving braking efficiency and preventing the aircraft from becoming airborne

6 High vertical acceleration limits are set by the aircraft operator at 1.8G, where the force is 1.8 times the force of gravity. The aircraft manufacturer has identified a vertical acceleration limit of 10 ft/sec which equates to approximately 2.1G, beyond which a hard landing inspection is required.

Aircraft information

Aircraft data

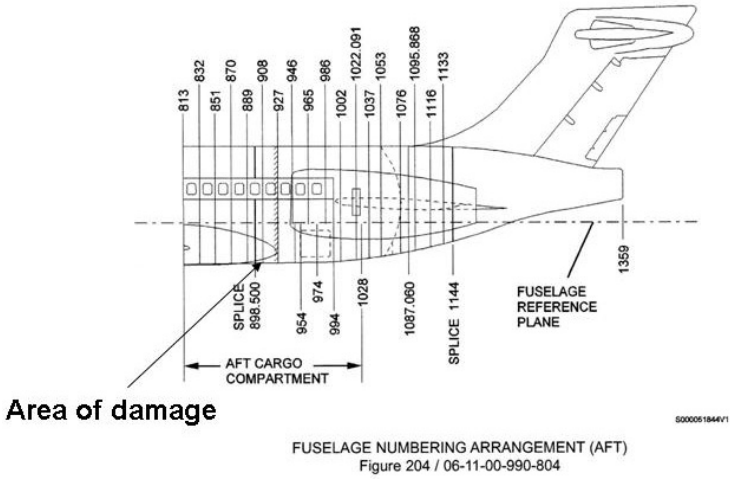
Aircraft model	Boeing 717-200
Serial number	55063
Date of manufacture	September 2000
Certificate of Registration	Valid, issued 20 June 2007
Certificate of Airworthiness	Valid, issued 25 July 2005
Total airframe hours and cycles	19,090.41 hours, 14,560 cycles

Aircraft damage

Damage to the aircraft included several creases to the skin on the fuselage above the wing area and underneath the fuselage behind the wing (Figures 3 and 4). Several longerons[7] in the rear cargo area were damaged. The left main landing gear and the outer left main tyre were also damaged.

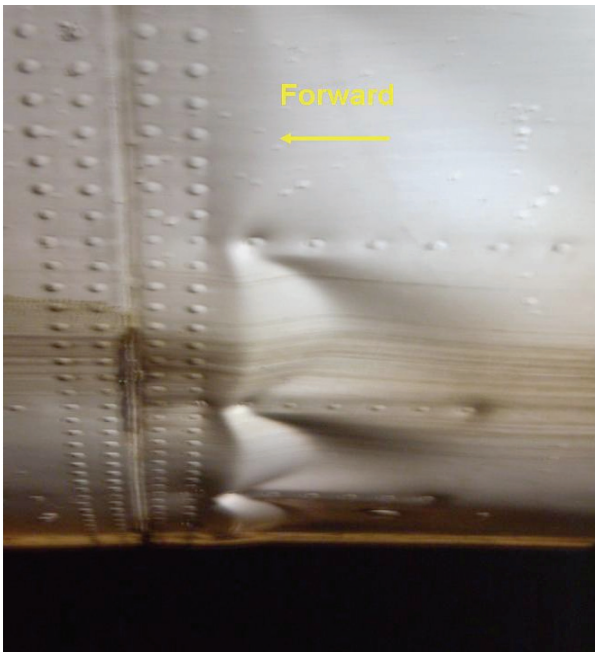
Annex 13 to the convention on international Civil Aviation titled *Aircraft accident and incident investigation* - published by International Civil Aviation Organization (ICAO) defined the damage to the aircraft as meeting the criteria of an accident.

Figure 3: Aircraft dimensions showing area of damage



7 Longerons are longitudinal members which give the airframe its shape and provide a basis for the skin.

Figure 4: Damage on the underside of aircraft



Flight recorders

The aircraft's flight data recorder (FDR), cockpit voice recorder (CVR) and quick access recorder (QAR) were recovered and sent to the Australian Transport Safety Bureau's (ATSB) recorder facility in Canberra for downloading and data analysis. Data from the cockpit voice recorder for the accident flight had been over-written and therefore was not available to the investigation.

Personnel information

The PIC held an airline transport pilot licence, was type rated on the 717 aircraft, held a current medical certificate, and had 8,466 hours total flight experience, including 1,947 hours on the 717 aircraft.

The copilot held an airline transport pilot licence, was type rated on the 717 aircraft, held a current medical certificate, and had 7,500 hours total flight experience, including 400 hours on the 717 aircraft.

Meteorological information

Aerodrome forecasts

The Bureau of Meteorology (BoM) issued an amended terminal aerodrome forecast (TAF) for Darwin Airport at 1801 on 7 February 2008. The forecast indicated light showers in a prevailing westerly flow of 12 kts with 1 to 3 oktas[8] of cloud at 1,500 ft above the aerodrome level.

8 Unit of sky area equal to one-eighth of total sky visible to celestial horizon.

The Darwin TAF was further amended at 2057 to indicate the probability of thunderstorms from 2130, with visibility reducing to 1,000 m and wind gusting to 35 kts from the north-east.

The Darwin trend type forecast (TTF) issued at 2102 indicated that, at the aircraft's estimated time of arrival, the wind would be 210 degrees true at 7 kts, the visibility would be greater than 10 km, with 3 to 4 oktas of cloud at 1,600 ft. The TTF also forecast thunderstorms from 2130.

A special aerodrome weather report (SPECI) issued at 2115 reported a heavy shower at Darwin Airport, reducing visibility to 5,000 m, with wind from the south-south-west at 7 kts. A further SPECI at 2119 reported visibility further reduced to 1,000 m in a heavy shower and wind from the southwest at 7 kts. A subsequent SPECI issued at 2124 reported a thunderstorm at the airport, with 1,000 m visibility and wind from the south at 7 kts.

Actual weather information

The BoM automatic weather station data for Darwin Airport provided weather information every 1 minute. Figure 5 provides the wind direction and speed immediately prior to and after the time of landing.

Figure 5: Tabular wind data

Time	Wind direction degrees true	Wind speed Kts	Comment
21:12	211	7	
21:13	216	8	
21:14	216	9	
21:15	213	8	Time of landing
21:16	191	8	
21:17	184	7	
21:18	188	8	

The FDR recorded a wind of 168 to 183 degrees magnetic at 9 to 11 kts from a radio altitude of 180 ft to landing.

Bureau of Meteorology weather summary

A review of radar and surface wind data from Darwin Airport was consistent with the aircraft landing in the region immediately behind the leading edge of a gust front. The aircraft experienced an increasing tail wind and heavy rain on the approach and thus would have been in a region of higher sink rate. However, the available data indicated that the sink rate would not be excessive.

Provision of weather information to the flight crew

At the time the aircraft was approaching Darwin, the Darwin Airport automatic terminal information service (ATIS), identified as 'KILO' advised pilots to expect a visual approach for runway 29, the wind being 210 degrees magnetic at 10 kts, visibility greater than 10 km, and cloud 1 to 2 oktas at 2,000 ft.

When the aircraft was approximately 8 NM from the runway threshold, ATC advised the crew that the cloud base was 1,000 ft, with the visibility being reduced by rain.

ATC cleared the crew to land on runway 29 when the aircraft was approximately 2 NM from the runway 29 threshold. ATC also advised the flight crew that the crew of a previous aircraft had reported the runway threshold was wet.

Communications

The transmissions between the air traffic controllers and the flight crew during the aircraft's descent and approach to Darwin Airport were recorded by ground-based automatic voice-recording equipment. The quality of those recorded transmissions was good.

Aircraft operator information

Aircraft operator certificate holder responsibilities

The Air Operator's Certificate (AOC) holder is responsible for all activities conducted and are listed in the *Civil Aviation Act 1988. Section 28BE* included the following provisions:

> (1) The holder of an AOC must at all times take all reasonable steps to ensure that every activity covered by the AOC, and everything done in connection with such an activity, is done with a reasonable degree of care and diligence.
>
> (2) If the holder is a body having legal personality, each of its directors must also take the steps specified in subsection (1).
>
> (3) It is evidence of a failure by a body and its directors to comply with this section if an act covered by this section is done without a reasonable degree of care and diligence mainly because of:
>
> (a) inadequate corporate management, control or supervision of the conduct of any of the body's directors, servants or agents; or
>
> (b) failure to provide adequate systems for communicating relevant information to relevant people in the body.

Aircraft operator management

The aircraft operator's investigation report identified issues that included:

> Since the introduction of the 717 fleet, the Manager Pilot Training and Checking has also been fulfilling the role of Head of Pilot Training 717. Not having a separate Head of Pilot training 717 has been a factor in the flight crew not having

> confidence in the training organisation to satisfactorily manage information. This situation has been aggravated by the irregularity of check and training meetings.
>
> Flight crew have reportedly been reluctant to identify training issues directly with management. Lack of defined procedures for reporting such concerns as well as consternation about it being treated in a non-jeopardy manner were the main reasons.
>
> There is currently no detailed briefing in the correct landing technique provided to pilots undergoing conversion training.

Aircraft operator stabilised approach criteria

The aircraft operator's stabilised approach criteria identifies that a missed approach must be executed if the aircraft is not established within the stabilised criteria below 400 ft AGL. However, the procedure permits the flight crew to continue the approach if an exceedence is momentary. When the rate of descent exceeded 1,000 FPM below 400 ft AGL, the approach was continued as the flight crew considered the exceedence to be momentary.

A review of stabilised approach criteria for three other major Australian operators revealed essentially consistent procedures, which require an immediate missed approach to be executed if the approach is not stable by 1,000 ft AGL in instrument meteorological conditions and 500 ft AGL in visual meteorological conditions. There is no consideration by any of those operators of a momentary exceedence in this procedure.

Aircraft operator certificate training organisation responsibilities

The *Civil Aviation Regulations 1988 (CAR) 217* require the AOC holder to be responsible for all training activities conducted, and included the following provisions:

> (1) An operator of a regular public transport service, an operator of any aircraft the maximum take-off weight of which exceeds 5,700 kilograms and any other operator that CASA specifies shall provide a training and checking organisation so as to ensure that members of the operator's operating crews maintain their competency.

There are currently no CASA Regulations or Orders identifying the activities of third party training providers. Therefore the AOC holder is responsible of all training being conducted on their behalf. The proposed Civil Aviation Safety Regulation (CASR) Part 142, identifying requirements for third party training providers, has not as yet been passed into law.

Aircraft operator training organisation

The aircraft operator's investigation report into the accident identified training issues that included:

> The current shortage of experienced flight crew has necessitated employing pilots with less total aeronautical experience than they would have previously. This increases the demand for a greater flexibility in the training organisation by

ensuring that if necessary, extra training be given to those individuals who have lesser aeronautical experience than others.

While the Route Manual does provide some details regarding Darwin aerodrome, it is minimal and there is no mention of the possibility of experiencing visual illusions when landing on runway 29. Absence of more aerodrome information in the Route Manual, together with the unavailability of aerodrome audio-visual presentations, limits the ability of company pilots to familiarise themselves with aerodromes.

During the hard landing at Darwin the thrust reduced at 30 feet in the autothrottle retard mode and was not overridden to reduce this rate of descent. The handling pilot did not attempt to manually override the autothrottles when the rate of descent increased.

Aerodrome information

The aircraft operator's investigation report into the accident also identified aerodrome issues. The report stated:

> The approach to runway 29 at Darwin at night is conducive to a degree of black hole phenomenon as it is predominantly over an area with poor ambient lighting. This is a condition that can create visual illusions and was a factor in this event. There were runway environment factors that augmented the visual illusions and were also considered major factors. Runway 29 at Darwin is 60 meters wide and has no centerline lighting. The extra width and lack of lighting are not conducive to reducing visual illusions.
>
> Lack of centerline lighting was cited as a factor in a serious event involving a Boeing 737.

The issue of no centreline lighting on runway 29 has previously been identified in an ATSB report *200300418, VH-TJB* and associated safety recommendation *R20040090* issued on 4 March 2005.

Darwin runway 29 ILS Chart

The profile diagram on the Jeppesen Darwin ILS-Z or LOC-Z Rwy 29 chart dated 21 SEP 07 (Figure 1) identifies an incorrect level segment after passing Howard Springs Non-Directional Beacon (NDB).

Further investigation

The investigation is continuing and will include examination of:

- flight crew operating procedures
- aircraft operator crew training
- Darwin runway lighting
- operator stabilised approach criteria.

SAFETY ACTION

As a result of this accident and investigations to date, the following safety actions have been taken by the relevant organisations.

Aircraft operator

Management responsibilities with 717 training

Action taken by the aircraft operator

The position of Head of Pilot Training 717 has been filled with an experienced 717 Check Captain.

Reporting of training issues

Action taken by the aircraft operator

Flight Operations will consider the introduction of a position of Fleet Captain for the 717. All 717 flight crew could then report recurring inconsistencies in flight standards by individual crew in a non-jeopardy manner to the Fleet Captain. He/she would be in a position to liaise with the company CAR 217 training organisation about the extent of these inconsistencies including what extra training should be provided if necessary. Also that Flight Operations will reiterate the 'Just Culture' policy to all company flight crew.

Current shortage of experienced flightcrew

Action taken by the aircraft operator

The aircraft operator's training organisation is tasked with conducting a review of the 717 technical training provided by the third party training provider. This review will specifically ensure that the syllabus adequately meets company requirements and that there is sufficient flexibility in the syllabus to make extra time allowances for pilots with less aeronautical experience.

Also, the air operator's training organisation is tasked with producing a company 717 Flight Training Manual.

Landing technique training

Action taken by the aircraft operator

A landing technique PowerPoint is under development and will be provided to all company flight crew as well as trainee pilots undergoing 717 conversion training.

The company CAR 217 organisation will increase check and training meetings to regular quarterly meetings to discuss flight standard and standardisation matters.

The visual circuit practice simulator session, currently conducted after the completion of the training provider simulator sessions, will be expanded to a session with flexibility for increased time for individual pilots on a level of performance basis.

On the commencement of copilots' line training, they may be the monitoring pilot for a number of sectors to allow the Training Captain to demonstrate the landing techniques on the line.

Aerodrome familiarisation information

Action taken by the aircraft operator

The company Route Manual Domestic Operations will be expanded to provide more specific information on runway approaches to all aerodromes used by company aircraft.

Flight Operations will consider an audio-visual presentation for all company aerodromes to meet not only CAR 218 Route Qualification Requirements but also to enable flight crew operating to new aerodromes to familiarise themselves with these aerodromes.

Use of autothrottle

Action taken by the aircraft operator

The Head of Pilot Training 717 will ensure that all flight crew are aware that under certain final approach conditions it may be necessary to manually apply thrust during the autothrottle retard mode.

Quick access recorders

Action taken by the aircraft operator

The company currently operates a comprehensive 717 Flight Operations Quality Assurance (FOQA) Program, with the Group Safety Department providing feedback to Flight Operations in relation to any adverse flight trends observed. The company has identified the need to more expeditiously obtain information as to whether a hard landing check is required or not. As a consequence a database change by the component manufacturer is underway, which will allow the Flight Data Acquisition and Management System (FDAMS) to trigger a hard landing report. This will be sent by Aircraft Communication Addressing and Reporting System (ACARS) to the data collection organisation, and will allow company Licensed Aircraft Maintenance Engineers' (LAME) to print out a report and instigate any required action at the daily terminating checks.

Darwin runway lighting

Safety issue

The lack of runway centreline lighting on runway 11/29 at Darwin significantly reduces the visual cues available to flight crew during landing at night.

Action taken by the aircraft operator

The aircraft operator is reviewing the written procedures to flight crew with the emphasis on the transition from either visual slope guidance or the ILS glidepath to the aiming point, and with the lack of surface definition in the touchdown zone.

The aircraft operator has mandated the use of autopilot coupled approaches to runway 29 at Darwin at night.

The aircraft operator intends to approach the aerodrome owner to discuss the installation of centreline lighting on runway 11/29 at Darwin.

ATSB assessment of action

The issue of the lack of centreline lighting on runway 11/29 at Darwin has previously been identified in ATSB report *200300418, VH-TJB and safety recommendation R20040090.*

The safety recommendation stated:

> The Australian Transport Safety Bureau recommends that the Department of Defence (airport infrastructure owner) and Darwin International Airport Pty Ltd (civilian facilities operator) consider installation of centreline lighting and touchdown zone lighting, consistent with CASA recommended practices on runways wider than 50 m.

A response received from the Department of Defence on 16 March 2005 stated:

> Thankyou for a copy of the subject report in your letter at Reference A. The Deputy Chief of the Air Force has been briefed on the report and has requested the Directorate of Capability Management to consider your recommendation and provide feedback through DFS. When this becomes available it will be forwarded to you.
>
> ATSB Status:
>
> As at 27 March 2008, no further advice had been received from the ADF on their consideration of the recommendation and the ATSB reclassifies it as Closed – Partially Accepted.

The ATSB will be discussing the issue of runway lighting with the relevant parties as part of this ongoing investigation.

Civil Aviation Safety Authority

Operator responsibilities with third party training organisations

Action taken by CASA

The air operator is responsible for all activities conducted under their AOC, including contracted training. CASA will review with operators their oversight responsibilities.

CASR Part 142 Training and Checking Operators

Action taken by CASA

The proposed CASR Part 142 is currently being reviewed as a matter of priority.

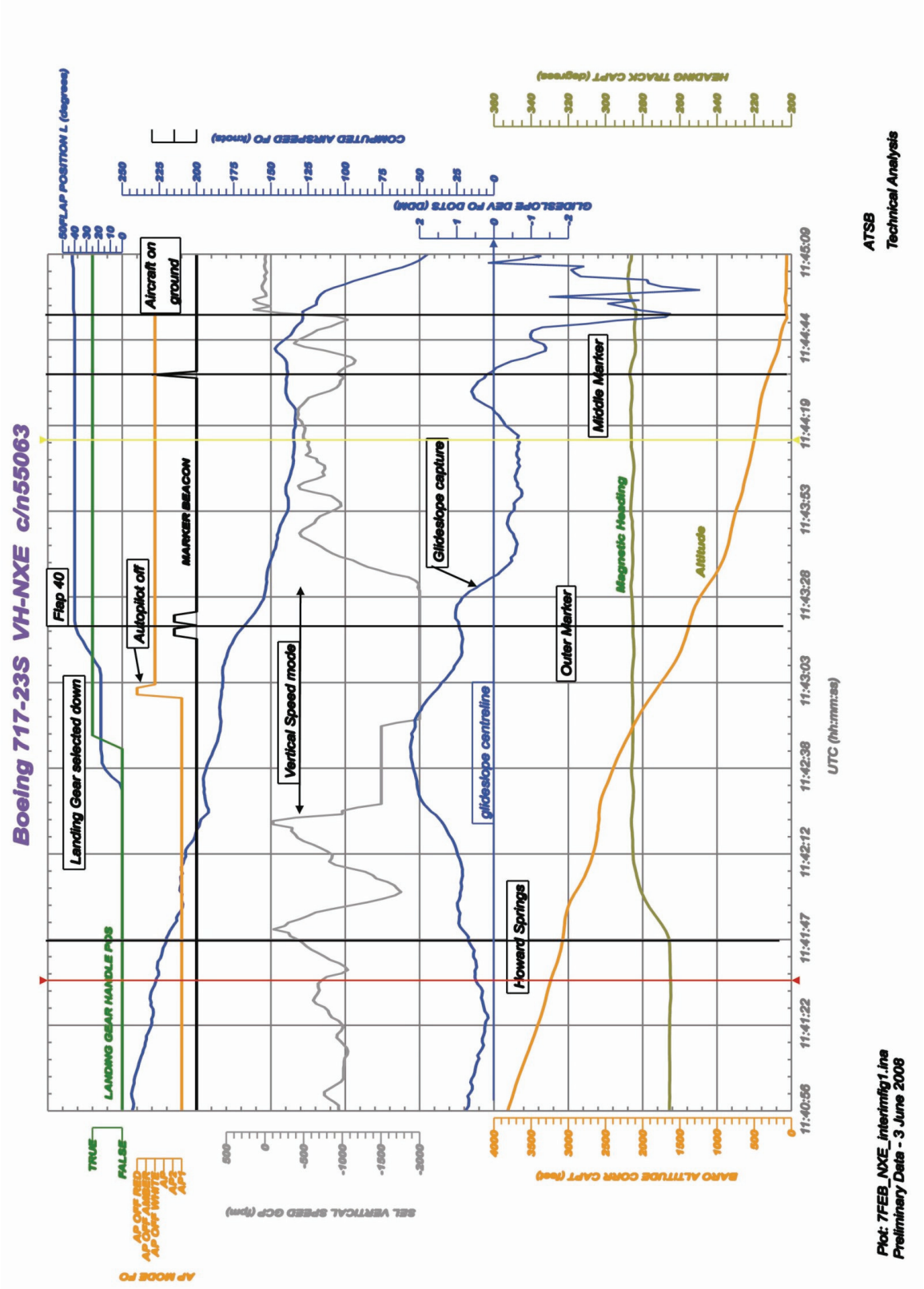
Jeppesen Australia

Darwin runway 29 ILS Chart

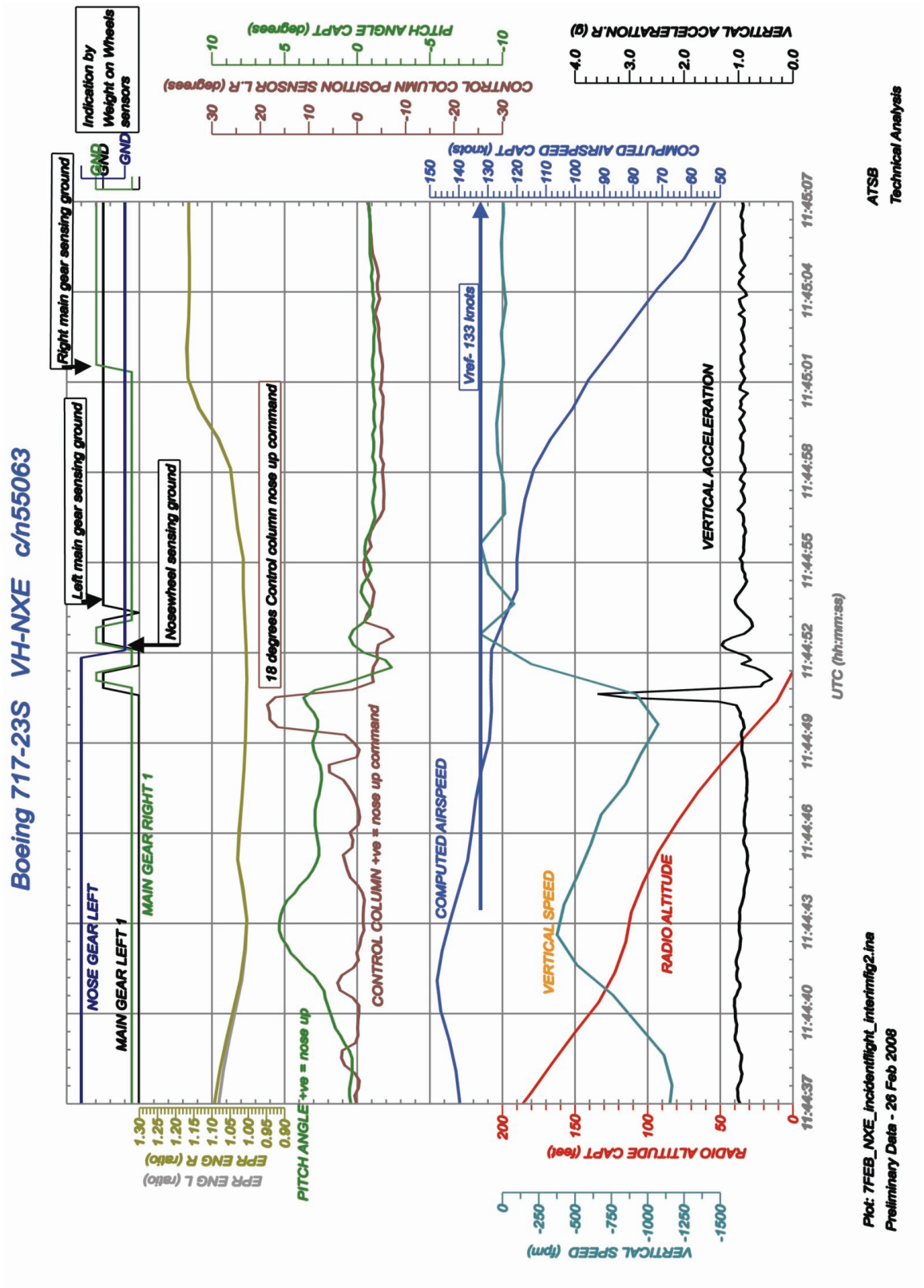
Action taken by Jeppesen

The 27 JUN 08 revision will show the descent starting at Howard Springs NDB.

APPENDIX A: FLIGHT RECORDER DATA - APPROACH



APPENDIX B: FLIGHT RECORDER DATA – SHORT FINAL



APPENDIX C: FLIGHT RECORDER DATA – SPOILERS