Australian Government
Australian Transport Safety Bureau

Publication Date: June 2010 ISBN 978-1-74251-059-0

ATSB TRANSPORT SAFETY REPORT
Aviation Occurrence Investigation AO-2009-001
Final

Unstable approach, VH-TQL Sydney Aerodrome, New South Wales 26 December 2008

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May10/ATSB89

Released in accordance with section 25 of the *Transport Safety Investigation Act 2003*

Abstract

On 26 December 2008, a Bombardier Inc DHC-8-315 (DHC8), registered VH-TQL, was conducting a regular public transport flight from Moree to Sydney Aerodrome, New South Wales. While on final approach, and after capturing the glideslope for the runway 34 Left (34L) instrument landing system approach, the autopilot commanded the aircraft to descend. This prompted the crew to make a number of configuration changes in an effort to continue the approach. Those changes destabilised the aircraft and diminished its performance, which lead to the activation of the aircraft's stickshaker. Shortly after, a missed approach was commenced by the flight crew.

In this occurrence, the crew continued the approach despite becoming aware of the unstable aircraft state. Positive action to avoid a stickshaker event could have been taken if the crew communicated to each other the inappropriate aircraft configuration as it progressed along the approach.

As a result of this occurrence, the operator has proactively implemented changes to its DHC-8 training syllabus, highlighted to its crews the destabilising effects of changes to an aircraft's configuration during an approach and emphasised to crews the importance of good communication in a multi-crew environment.

FACTUAL INFORMATION

Sequence of events

At about 2220 Eastern Daylight-saving Time[1] on 26 December 2008, the flight crew of a Bombardier Inc DHC-8-315 (DHC8), registered VH-TQL, was conducting a regular public transport flight from Moree to Sydney Aerodrome, New South Wales. The pilot in command (PIC), who was the pilot not flying (PNF), and the copilot, who was the pilot flying (PF) conducted an approach to land at Sydney in instrument meteorological conditions (IMC) using the runway 34 Left (34L) instrument landing system (ILS).

The PF reported that, prior to commencing the approach, an approach brief was completed. That brief included an overview of the approach chart procedure, the missed approach procedure and the identification of any additional restrictions or requirements.

During the approach, which was reported to be in IMC, the crew were given heading and altitude clearances by Air Traffic Control. Those instructions enabled the flight crew to better position the aircraft for an intercept of the runway 34L localiser[2]. During the intercept of the localiser, the PF reduced power and commanded

1 The 24-hour clock is used in this report to describe the local time of day, Eastern Daylight-saving Time (EDT), as particular events occurred. Eastern Daylight-saving Time was Coordinated Universal Time (UTC) + 11 hours.

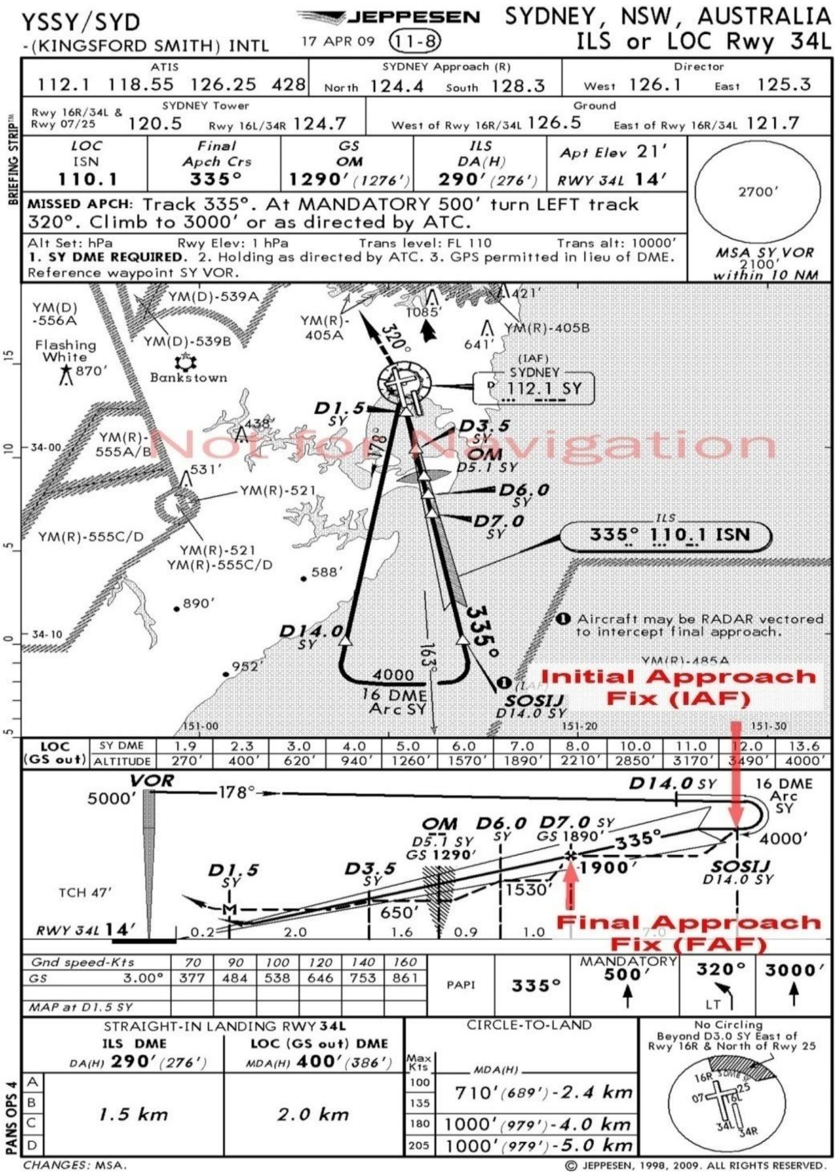
2 A localiser is an integral component of an ILS, and provides runway centreline guidance to aircraft during the approach.

the autopilot to descend to the altitude clearance limit of 2,000 ft above mean sea level (AMSL). After capturing this altitude, the aircraft's autopilot intercepted the runway 34L localiser at about 13 NM (24 km) from the runway threshold. The initial approach fix (IAF)[3] for the approach was located at 14 NM (26 km) (Figure 1).

The PF reported that, as the aircraft reached the clearance altitude earlier than expected, he elected to delay configuring the aircraft until later in the approach. An increase in power was required to maintain the airspeed at about 185 kts until the final approach fix (FAF)[5], where further descent could be expected.

A number of standard radio transmissions were made by the PNF during the approach. The last transmission prior to the go-around was to Sydney Tower about 1 second after the autopilot captured the RWY 34L glideslope for the final phase of the approach.

Figure 1: Sydney runway 34L ILS[4]



3 The initial approach fix was a published position on an instrument approach chart that indicated the start of the initial approach segment.

4 Courtesy Jeppesen Sanderson, Inc.

5 The final approach fix was a published position on an instrument approach chart that indicated the start of the final approach segment.

The recorded data indicated that, at glideslope capture (about 0.5 NM (1 km) prior to the FAF), the nose of the aircraft pitched down and there was a corresponding increase in airspeed to 195 kts. The PF responded by retarding the power levers to FLIGHT IDLE and commanded the PNF to advance the propeller control levers to maximum RPM. A rapid decrease in airspeed followed, allowing the PNF to extend the landing gear and to select 15° of flap.

The PNF then continued the relevant approach duties, including writing down the landing clearance, setting the Sydney Ground frequency on the aircraft's secondary radio and selecting that radio to STANDBY, switching the taxi light to ON and conducting the instrument checks.

At about that time, the PNF noticed that the indicated airspeed was about 120 kts and decreasing. The PNF reported that, in response, he called 'check speed' to the PF. The recorded flight data showed that the autopilot disconnected at that time. The stickshaker[6] activated, prompting the PNF to call for a go-around[7]. In response, the PF applied the equivalent of maximum take-off power (MTOP). The stickshaker ceased momentarily as a result of control inputs by the PF. However, it was reported by the PF that there was a second stickshaker event. An examination of the recorded information suggested that the stickshaker reactivated 4 seconds after the initial activation.

In the 10 seconds after the initial stickshaker event, the aircraft maintained an altitude of about 1,160 ft and the airspeed reduced to 108 kts. Power was also reduced from MTOP to below 50% for a period of 2 seconds. The brief power reduction was reported to be a result of the PF attempting to continue the approach, despite the earlier call from the PNF to go around. Additionally, the landing gear remained down and the flap continued extending to a reselected value of 10°.

Maximum take-off power was then reapplied, the landing gear was retracted, and a climb was commenced as the crew prepared to conduct the Sydney RWY 34L ILS-LOC missed approach.[8]

A second approach was then conducted using the RWY 34L ILS-LOC approach. During this approach, the aircraft was stable[9] (see the *Approach procedures* discussion on page 4), and configured with the gear down and flap extended to 15° prior to the FAF.

Pilot information

Pilot in command

The PIC held an Air Transport Pilot (Aeroplane) Licence (ATPL(A)) that was issued in 1993. He had accumulated a total aeronautical experience of about 14,450 flying hours, with about 9,300 hours on the DHC8. Of those hours on type, 70 hours were accumulated in the last 3 months. He was appropriately endorsed, and held a valid Class 1 aviation medical certificate and Multi Engine Command Instrument Rating (MECIR).

Copilot

The copilot held a Commercial Pilot (Aeroplane) Licence (CPL(A)). He had accumulated a total aeronautical experience of about 2,100 flying hours, with about 220 hours on type. Of those, 120 hours were accumulated in the last 3 months. He was appropriately endorsed, and held a valid Class 1 aviation medical certificate and an MECIR.

As part of the company training program, pilots initially completed Crew Resource Management (CRM) and Threat and Error Management (TEM) training as part of the induction program. Annual recurrent training included CRM.

6 A stickshaker was an electro-mechanical device that was attached to the pilot's control column. When activated by the aircraft's stall protection system, the associated vibration of the control column provided a tactile warning to the pilot of an impending aerodynamic stall.

7 A go-around is the termination of an approach and can be associated with the commencement of a climb and entry into a missed approach procedure.

8 The published procedure to be followed if the approach could not be continued; for example, if the pilot did not have the required visual references.

9 A stable approach was defined as 'On glide path at the correct speed, correctly configured, all checklists and paperwork complete.' Gunston, B (2004). *The Cambridge Aerospace Dictionary*. University Press, Cambridge.

Meteorological conditions

The Bureau of Meteorology issued a trend type forecast (TTF METAR)[10] at 2200 for Sydney Aerodrome, with scattered[11] cloud reported at 900 ft above ground level (AGL) and a forecast temperature of 24° C.

The flight crew reported that during the approach, they entered cloud that extended from 3,000 ft to about 700 ft AMSL and did not experience any significant turbulence.

Approach procedures

The operator's Standard Operating Procedures (SOP)[12] required the conduct of an approach brief in preparation for all approaches. Although the precise content of the briefing was not prescribed, the intent of the briefing was for flight crews to describe their intentions during the approach in a manner that had meaning to the respective crews. As a result of the brief, both pilots would clearly understand their roles and responsibilities as PF or PNF. The briefings would assist the crews to comply with the requirements outlined in the company Flight Administration Manual.

The Flight Administration Manual included the requirement that:

- the PNF must be aware at all times of the intent of the PF, the procedure nominated and monitor that the aircraft is being operated in accordance with these procedures.

In addition, the SOP's required that, when conducting an instrument approach, the relevant aircraft configuration[13] should be accomplished prior to a defined position in the approach. For an ILS, the crew was to achieve a speed reduction to 180 kts by the IAF. From the IAF, the aircraft was to be slowed further to a speed below 163 kts and then to 150 kts, where landing gear extension and flap extension of 15° could be selected. It was reported that the aircraft's speed and configuration was not communicated between the crew prior to reaching the FAF.

Before the aircraft passed the FAF, the operator's SOP required the completion of the landing checklist and that a target speed of 120 to 130 kts was achieved. At the FAF, the propeller control levers were to be advanced to provide maximum RPM, and the indicated airspeed reduced to Vref[14]+5 to Vref+20 kts by 500 ft AGL.

Upon reaching 500 ft AGL, additional approach requirements were to be met. The operator's SOP included that, for the approach to be considered stable:

- only small changes in heading and pitch are required to maintain the correct fight path
- the sink rate is no greater than 1,000 ft/min
- power setting is appropriate for the configuration
- the aircraft is established on the ILS within one dot of the localiser and glidepath
- the airspeed is not more than Vref+20 kts and not less than Vref+5 kts.

If those criteria were not established and maintained during an approach to land, the approach was, by definition, unstable and an immediate go-around was mandatory.

Stall warning system

The aircraft's stall warning system consisted of two stall warning computers, an angle of attack (AOA) vane on each side of the forward fuselage, a

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10 A TTF may be appended to a METAR, and relates to the expected weather at the aerodrome. The validity period for a TTF is 3 hours. A METAR is an aviation routine weather report, which is used to identify routine hourly or half-hourly observations when conditions are above specified levels.

11 Cloud amounts are reported in oktas. An okta is a unit of sky area equal to one-eighth of total sky visible to the celestial horizon. Few = 1 to 2 oktas, scattered = 3 to 4 oktas, broken = 5 to 7 oktas and overcast = 8 oktas.

12 Standard operating procedures were contained in the company operations manual for the use and guidance of operations personnel. They outlined the procedures required to operate a particular company aircraft type safely.

13 Arrangement of aircraft for flight, including the disposition of the wings and control surfaces, aircraft body, landing gear and engines.

14 Vref. Reference speed that is commonly used to determine an aircraft's approach speed. Vref is Vs multiplied by a factor of 1.3. Vs is the minimum indicated airspeed at which the aeroplane exhibits the characteristics of an aerodynamic stall.

stickshaker on each control column, and a stick push actuator.

The aircraft's two stall warning computers received AOA data from the respective AOA vanes, as well as true airspeed, flap angle and pitch rate information. The computers used that information to determine a compensated angle which, if greater than the stall warning threshold angle, would activate the stickshaker. That activation occurred at a speed of 6 to 8 kts above the computed stall speed.

If action was not taken by a flight crew in response to the stickshaker, and aerodynamic stall was encountered, the stall warning computer would activate a stick push actuator to drive the control column forward. This would decrease the aircraft's AOA to aid recovery from the stall.

According to the company SOP's, the recovery action following a stickshaker was to simultaneously:

- Call stick shaker
- Advance power levers to within 10% of MTOP then adjust for maximum power
- Select flap 15 if flap 35 is extended
- Gear up with positive rate of climb
- Select flap zero when IAS is above flap retraction speed

Human factors

The PF reported that, as the aircraft passed the FAF, there was a considerable increase in workload that was accentuated by the need to slow the aircraft and to configure it for landing.

A pilot experiences various levels of stress and workload across all phases of flight.[15] In addition, the amount of performance error and workload varies depending on the phase of flight.[16] In respect of the conduct of anticipated phase-of-flight procedures, the highest levels of pilot stress and workload are experienced during the take-off and landing phases with the highest levels of pilot performance errors occurring in the landing phase of flight.

When carrying out procedures that are not normally undertaken during a particular phase of flight, there is an increased risk of pilot performance errors being made.

A PNF also experiences higher levels of stress in flight phases that involve frequent instrument checks and communications with external agencies, such as with the control tower during the landing phase. Those stressors, when combined with the increase in workload resulting from sudden or unexpected events, can degrade the quality of a pilot's performance.

ANALYSIS

Opportunities existed prior to the final approach fix for the crew to voice any concerns about deviations from the planned approach profile, and to take appropriate action to ensure that the aircraft was correctly configured. Had that been the case, the pilot flying would have had more time to configure the aircraft, and to have made an earlier decision to go around.

The inappropriate aircraft configuration, and unexpected descent due to the capture of the glideslope by the autopilot, resulted in an unanticipated increase in the flight crew's workload. The tasks associated with that increased workload distracted the crew from monitoring the deteriorating aircraft performance. Unnoticed, this led to an unstable aircraft state that preceded the activation of the stickshaker.

If more attention was given to monitoring the aircraft's performance after the configuration changes, the rapid deceleration due to increased drag and the low power settings would have been identified earlier and probably have been better managed.

Both pilots were aware of the company's requirements for an instrument landing system approach, the stable approach criteria and the prescribed procedures for a go-around. Had the crew initiated a go-around and missed approach earlier, the unstable state and stickshaker activation could have been averted.

15 Wiener E.L & Nagel D.C (1988). *Human factors in aviation.* Academic Press Inc, California.

16 Johannsen G. & Rouse W.B (1983). Studies of planning behaviour of aircraft pilots in normal, abnormal, and emergency situations. IEEE Transactions on Systems, Man & Cybernetics, SMC.

This incident reinforces the importance of adhering to company SOP's. Poorly managed stick shaker recovery techniques and go-around procedures increase the likelihood of inducing aerodynamic stall and stick pusher activation.

FINDINGS

From the evidence available, the following findings are made with respect to the unstable approach involving Bombardier Inc DHC-8-315 aircraft, registered VH-TQL, at Sydney Aerodrome, New South Wales on 26 December 2008. They should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing safety factors

- There was a lack of communication between the flight crew relating to the configuration and position of the aircraft on the approach.
- The crew were aware that the aircraft was not appropriately configured prior to the final approach fix, but did not initiate a missed approach as required by the operator's Standard Operating Procedures.
- The late change in the aircraft's configuration increased the flight crew's workload to the extent that they did not detect the decreasing airspeed.
- The aircraft's performance deteriorated to a point that the stickshaker activated.

Other safety factors

- The stick shaker recovery procedure was not conducted in accordance with the operator's standard operating procedures and the decision to action a go-around was delayed.

SAFETY ACTION

The safety issues identified during this investigation are listed in the Findings and Safety Actions sections of the report. However, whereas an investigation may not identify any particular safety issues, relevant organisation(s) may proactively initiate safety action in order to further reduce their safety risk.

All of the relevant organisations identified during this investigation were given a draft report and invited to provide submissions. Although no safety issues were identified during this investigation, the following proactive safety action was advised by the aircraft operator.

Aircraft operator

The operator has advised that, as a result of this incident:

- flight crew have been briefed on: the effects of configuration changes on the stability of the aircraft; the importance of forward planning; and the monitoring and prioritisation of tasks when conducting approaches
- annual flight crew training programs and cyclic training exercises now incorporate a Threat and Error Management (TEM) program
- Check and Training Captains are undergoing TEM training to ensure TEM competencies and standards in aircraft performance, error management and crew support are maintained during training
- the flight crew underwent TEM training, additional line training, and line checks.

SOURCES AND SUBMISSIONS

Sources of Information

The sources of information during the investigation included:

- the flight crew
- flight recorder data
- the Bureau of Meteorology
- the aircraft operator.

Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003*, the Australian Transport Safety Bureau (ATSB) may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. Section 26 (1) (a) of the Act allows a person receiving a draft report to make submissions to the ATSB about the draft report.

A draft of this report was provided to the flight crew, the aircraft operator, and to the Civil Aviation Safety Authority. Submissions were received from the operator and the Civil Aviation Safety Authority. The submissions were reviewed and, where considered appropriate, the text of the draft report was amended accordingly.