



**Australian Government**

**Australian Transport Safety Bureau**

# Stickshaker activation involving a Boeing 717-200, VH-NXM

Brisbane Airport, Queensland, 27 May 2015

**ATSB Transport Safety Report**

Aviation Occurrence Report

AO-2015-056

Final – 22 December 2015

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

#### **Publishing information**

**Published by:** Australian Transport Safety Bureau  
**Postal address:** PO Box 967, Civic Square ACT 2608  
**Office:** 62 Northbourne Avenue Canberra, Australian Capital Territory 2601  
**Telephone:** 1800 020 616, from overseas +61 2 6257 4150 (24 hours)  
Accident and incident notification: 1800 011 034 (24 hours)  
**Facsimile:** 02 6247 3117, from overseas +61 2 6247 3117  
**Email:** [atsbinfo@atsb.gov.au](mailto:atsbinfo@atsb.gov.au)  
**Internet:** [www.atsb.gov.au](http://www.atsb.gov.au)

© Commonwealth of Australia 2015



#### **Ownership of intellectual property rights in this publication**

Unless otherwise noted, copyright (and any other intellectual property rights, if any) in this publication is owned by the Commonwealth of Australia.

#### **Creative Commons licence**

With the exception of the Coat of Arms, ATSB logo, and photos and graphics in which a third party holds copyright, this publication is licensed under a Creative Commons Attribution 3.0 Australia licence.

Creative Commons Attribution 3.0 Australia Licence is a standard form license agreement that allows you to copy, distribute, transmit and adapt this publication provided that you attribute the work.

The ATSB's preference is that you attribute this publication (and any material sourced from it) using the following wording: *Source:* Australian Transport Safety Bureau

Copyright in material obtained from other agencies, private individuals or organisations, belongs to those agencies, individuals or organisations. Where you want to use their material you will need to contact them directly.

#### **Addendum**

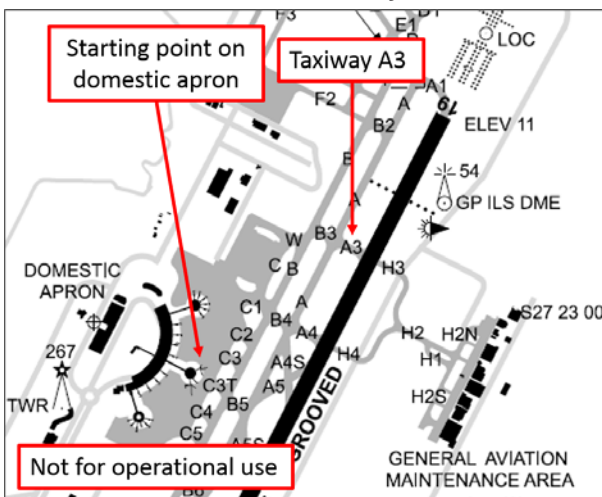
Page	Change	Date

# Stickshaker activation involving a Boeing 717-200, VH-NXM

## What happened

On 27 May 2015, a Cobham Aviation Services Boeing 717-200 aircraft, registered VN-NXM, was being operated from Brisbane to Gladstone, Queensland. The weather in Brisbane was fine and clear, with a light wind from the south. The Captain was the pilot flying (PF) and the First Officer was the pilot monitoring (PM).<sup>1</sup> As part of their preparation for the flight, the crew determined the required flap setting for take-off, and set the flap/slat control handle take-off position detent accordingly (see flap and slat control description). The PM later recalled that, on this occasion, a flap setting of 5.6 degrees was required. Engine start and push-back were normal, and the crew taxied soon after 0900 Eastern Standard Time (EST) for an A3 intersection departure from runway 19 (Figure 1).

**Figure 1: Excerpt from Brisbane aerodrome chart showing the location on the domestic apron where the aircraft commenced taxiing and taxiway A3 where the aircraft waited for a clearance to enter the runway**



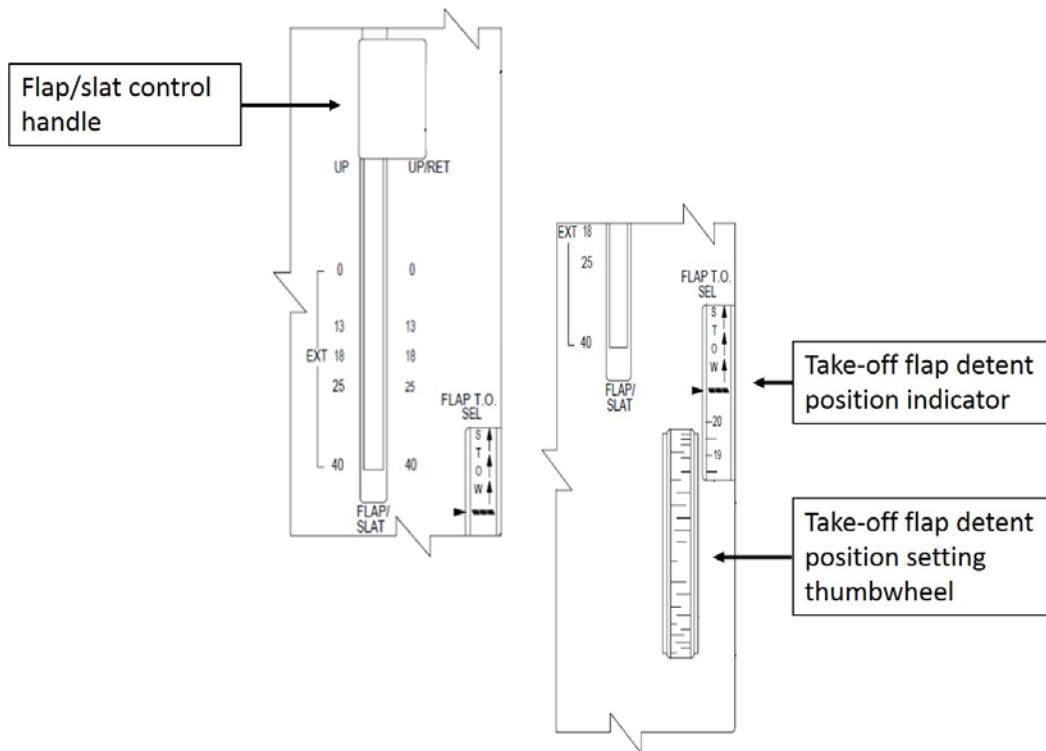
Source: Airservices Australia, with annotations added by the ATSB

### **Flap and slat control**

The flaps and slats are controlled by a handle on the right side of the centre pedestal (Figure 2). The flap setting for take-off is determined by the crew according to the conditions. The detent position setting thumbwheel is then used to position a detent for the control handle according to that determination, when a flap setting other than 13 or 18 degrees is required. The flap take-off selection indicator window displays the position of this movable detent. Unlike the flaps, the slats are either fully extended or fully retracted – there is no intermediate setting. The position of the flaps and slats is displayed on each pilot's primary flight display, beneath the airspeed indicator (Figure 3). The flap/slat control handle needs to be lifted to move it forward from the 0/EXT setting (flaps up/slats extended) to the UP/RET setting (flaps up/slats retracted), to retract the slats.

<sup>1</sup> PF and PM are procedurally assigned roles with specifically assigned duties at specific stages of flight. The PF does most of the flying, except in defined circumstances. The PM carries out support duties, and monitors the actions of the PF and the flight path of the aircraft.

Figure 2: Flap and slat control



Source: Boeing, with annotations added by the ATSB

As they taxied to the holding point, the crew completed relevant procedures, which included a requirement to confirm that the flap and slat configuration was set for take-off. The crew then held position on taxiway A3 while they waited for a clearance from air traffic control to enter the runway.

After waiting for several minutes, the crew were instructed by air traffic control to line up on the runway, but with a caveat that they needed to be ready for an immediate departure. The crew were ready, so accepted the clearance to line up, which was soon followed by their take-off clearance. The crew later commented that the wording used by air traffic control in providing the clearance to enter the runway was somewhat unusual, but there was no confusion and they clearly understood the intent. The crew entered the runway and commenced a rolling take-off.<sup>2</sup> The crew recalled that the take-off roll was normal in all respects, with standard communication and checks made as the take-off roll progressed.

Soon after take-off, the stickshaker activated (see stickshaker description). The PF responded immediately by checking the control column slightly forward to reduce the aircraft pitch attitude. The PF noted that the airspeed at that moment was in the expected target range of  $V_2$ <sup>3</sup> to  $V_2 + 10$  kt, but below minimum speed ( $V_{min}$ )<sup>4</sup> and stickshaker activation speed ( $V_{ss}$ )<sup>5</sup> (Figure 3). The PF also noted the airspeed appeared to be stable, with no indication of a speed reducing trend. The crew recalled that the stickshaker remained active for only a very brief period.

<sup>2</sup> A rolling take-off is a take-off that commences when the aircraft enters the runway and proceeds with the take-off without stopping in the lined-up position.

<sup>3</sup>  $V_2$  is often referred to as the take-off safety speed. It is the minimum speed at which a transport category aircraft complies with those handling criteria associated with climb, following an engine failure.  $V_2$  is normally obtained by factoring other critical speeds, to provide a safe margin with respect to aircraft controllability.

<sup>4</sup>  $V_{min}$  is the minimum manoeuvring airspeed in the existing aircraft configuration.  $V_{min}$  provides a specific margin above the stickshaker activation airspeed and aerodynamic stall airspeed.

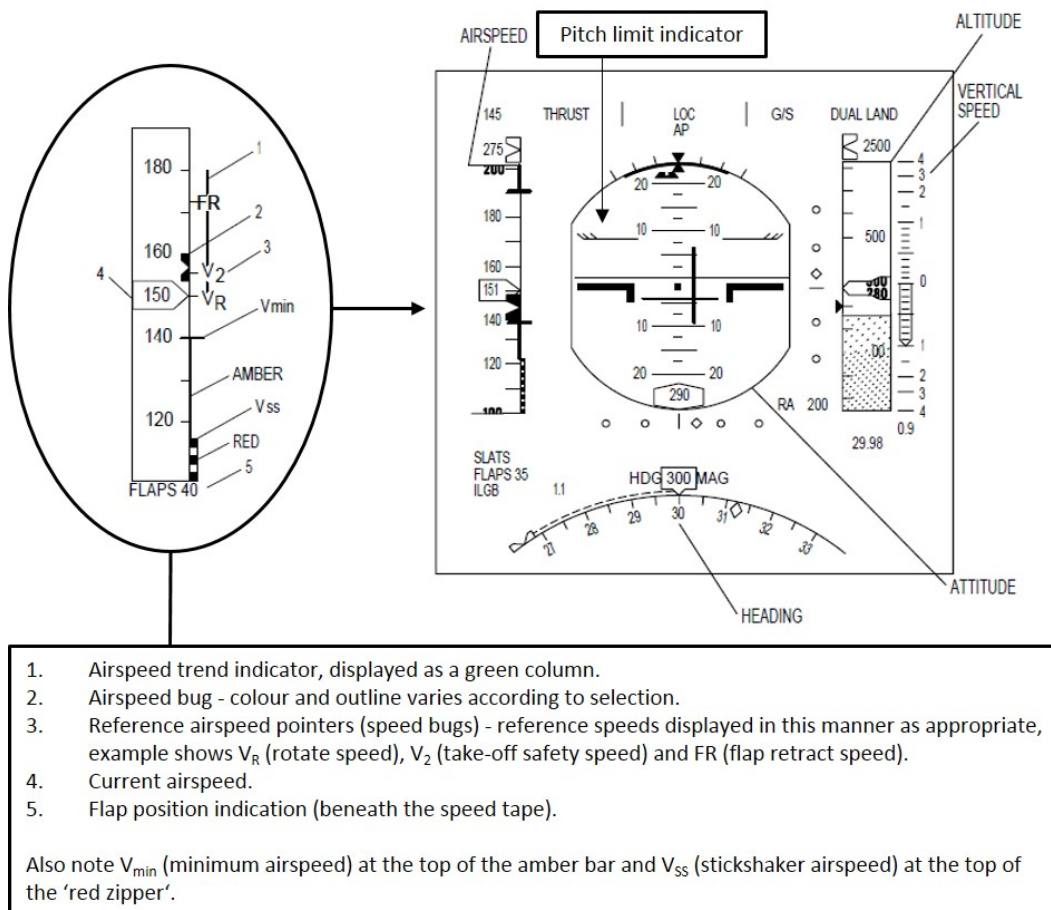
<sup>5</sup>  $V_{ss}$  represents the airspeed at which the stickshaker activates to alert the crew to the possibility of an approaching aerodynamic stall.

**Stickshaker**

The stickshaker is part of the aircraft stall protection system. Stickshaker activation is based on a number of parameters, including the angle-of-attack of the aircraft and the position of the flaps and slats. When the required conditions are established, an oscillating force shakes the control column rapidly through a small angle to alert the crew that the aircraft may be approaching an aerodynamic stall. If the aircraft continues towards an aerodynamic stall, other levels of warning and protection may be activated, including visual and aural alerts, and a stick-pusher.

The airspeed range for activation of the stickshaker is displayed as a 'red zipper' on the lower part of the airspeed indicator (Figure 3).  $V_{SS}$  marks the top of the red zipper. When the airspeed is below  $V_{SS}$  the pitch limit indicator (which provides an indication of the angle-of-attack margin to the activation of the stall warning system) changes colour from cyan to red, to provide an additional alert to the crew. Additionally, the digits (and the outline box surrounding the digits) representing the current airspeed indication turn red if the airspeed falls below  $V_{SS}$ .

**Figure 3: Primary flight display and description of relevant airspeed indications**



Source: Boeing, with annotations added by the ATSB

Within moments of stickshaker activation, the PM noticed that the flap/slat control handle was set to the UP/RET position (flaps up/slats retract). Upon noticing the position of the handle, the PM immediately called 'flaps', and moved the flap/slat control handle to the previously determined take-off setting position.

As the aircraft continued to climb, the PF noticed that the landing gear was still down - the landing gear would normally be raised soon after having established a positive rate of climb (see description of the operator's normal configuration management procedures). The crew then raised the landing gear and the climb continued. Later during the climb, the flaps were selected up, and soon after, as the aircraft continued to accelerate, the slats were retracted. The flight then continued to Gladstone without further incident.

Following the incident, the crew deduced that the PM must have selected the flap/slat control handle to the UP/RET position soon after take-off, rather than raising the landing gear handle. The crew's deduction was based upon the configuration of the aircraft before, and immediately after, stickshaker activation. The crew were confident that before take-off procedures had been completed correctly, and that the flaps and slats had been correctly set. The crew also noted that had they commenced the take-off without the flaps and slats set, they would have received an aural warning alerting them accordingly – there was no such aural warning on this occasion.

***Operator's normal configuration management procedures after take-off***

Normal procedures require that the landing gear be retracted soon after take-off. The PM observes that a positive rate of climb has been established and that the aircraft has accelerated to  $V_2$ . Normally, when those conditions are met, the PM calls 'positive rate'. If the PF is satisfied that the appropriate conditions are met, he/she responds by commanding 'gear up'. The PM then raises the landing gear control handle to the UP position accordingly, and when the landing gear has retracted, calls 'gear up'.

Later during the climb, as the aircraft accelerates through the flap retraction speed, the PF calls 'flaps zero'. The PM checks that the speed is at or above the flap retraction speed, and that the aircraft is accelerating, then moves the flap/slat control handle to the 0/EXT position (flaps up/slats extended). When the flaps have reached the selected position, the PM calls 'zero set'. Slat retraction follows a similar process at slat retraction speed which is a slightly higher speed than the flap retraction speed. To retract the slats, the PM sets the flap/slat control handle to the UP/RET position (flaps up/ slats retracted) and when the slats have retracted, calls 'aircraft clean'.

***Landing gear control***

The landing gear control handle is located on the instrument panel, ahead of and slightly to the left of the pilot in the right seat. The handle is moved in a near vertical motion between the UP and DOWN positions to raise and lower the landing gear.

***Flight data analysis***

A review of the flight data downloaded following the flight showed that the flaps and slats had been set for take-off. The slats were extended and the flaps had been set to the take-off position determined by the crew. Soon after take-off, at around the time that the landing gear handle would normally be selected to the UP position, the flight data indicates that the flap/slat control handle was moved to the UP/RET position. The stickshaker activated shortly after the flap/slat control handle was moved. At that time, the airspeed was relatively steady at slightly over 160 kt.

The stickshaker was active for about 2 seconds, and stopped at about the time the PF lowered the pitch attitude of the aircraft from about 10 degrees nose-up, to about 6.5 degrees nose-up. The stickshaker stopped as the aircraft was climbing through about 170 ft, with the airspeed continuing to remain relatively steady at slightly over 160 kt. Although the climb shallowed momentarily immediately following stickshaker activation, a positive rate of climb was maintained throughout.

From about 7 seconds after the flap/slat control handle was selected to the UP/RET position, the handle was moved back to the position that had been set prior to take-off. During that 7 seconds, the flaps had travelled to the fully up position, and the slats had begun to retract. As the handle was reset, the slats moved back to the extended position (before having reached the fully retracted position) and the flaps moved back to the position that had been set prior to take-off. By the time the flaps and slats returned to the take-off configuration, the aircraft was accelerating through about 174 kt, and climbing through about 330 ft.

Flight data showed that after the configuration was reset, the aircraft continued to climb at a relatively steady speed of about 180 kt. As the aircraft climbed through about 700 ft, the landing gear was selected up. As the aircraft climbed through about 3,000 ft, the flaps were selected up as the aircraft accelerated, and soon after, the slats were retracted.

### **Crew comments**

The crew made a number of comments regarding the incident, including:

- When the stickshaker activated, the PF initially suspected a problem with the aircraft system that senses the position of the slats. Under some conditions, a faulty sensing system may result in a misleading stickshaker activation. The PF had experienced a failure of that nature previously, with similar symptoms.
- When the stickshaker activated, the PF immediately assessed that the airspeed was appropriate (in the range  $V_2$  to  $V_2+10$ ) at that point, and that the pitch attitude was normal. Although there was no immediate explanation for stickshaker activation, the PF lowered the pitch attitude slightly to ensure that the speed was maintained. The PF then heard the PM call 'flaps', and became aware that the PM was manipulating the flap/slat control handle (this was at the point that the PM was resetting the configuration, back to the take-off configuration).
- The PF also commented that with the benefit of hindsight, the thrust setting should have been increased at the onset of the stickshaker. Although that may have been an appropriate response, the limited duration of the stickshaker meant that there was little time to react.
- The PM could not recall moving the flap/slat handle after take-off, and could not explain why the flap/slat control handle was selected to the UP/RET position when it was. Neither pilot could specifically recall the 'positive rate' and 'gear up' communication and command that normally takes place soon after take-off, but believe that it was probably carried out.
- The PM indicated that, even though the flap/slat control handle needs to be lifted in order to move it forward from the 0/EXT position to the UP/RET position, the handle can be moved through the 0/EXT position in a single motion.
- Both crew commented that, with the exception of brief remarks regarding the flow of air traffic while they waited on taxiway A3, sterile flight deck procedures<sup>6</sup> were being observed.
- Neither the PF nor PM could recall any specific distractions that may have diverted the attention of the PM at a critical moment during the take-off.
- For the PM, the day of the incident was the fourth consecutive day of duty. While the PM had slept adequately during the evenings leading up to the incident flight, they reported some

---

<sup>6</sup> Sterile flight deck procedures relate to a requirement for pilots to refrain from non-essential conversations and activities during critical phases of flight.



tiredness associated with a recent change in personal circumstances and a longer commute to and from work.

- For the PF, the day of the incident was the third day of a three-day roster, but the schedule was not demanding.
- After a brief discussion immediately following the event, both pilots were conscious of the need to maintain their focus on the safe and efficient conduct of the flight ahead. They elected not to discuss the incident further during the flight until they were safely on the ground at their destination. Following the flight, they discussed the incident and submitted a report.

## ATSB comment

Available evidence suggests that the PM inadvertently selected the flap/slat handle to the UP/RET position, instead of selecting the landing gear handle to the UP position. While the reasons are unclear, the most likely explanation resides in an understanding of human error types. The SKYbrary website includes information about human errors that may have relevance to this occurrence, particularly with respect slips and lapses – referred to collectively as execution errors ([Human Error Types](#)). The SKYbrary website also includes an article dealing with the relationship between human performance and level of arousal ([Level of Arousal](#)). The article illustrates that over-arousal can lead to a degradation in performance, but importantly, under-arousal can have a similar influence.

In a similar incident in 2003 ([ATSB Report 200302037](#)), the co-pilot of a Boeing 717-200 repositioned the flap/slat handle soon after take-off, instead of the landing gear handle. In response to that incident, the operator added the following caution to the procedures for flap/slat retraction after landing:

When retracting flaps/slats to UP/RET, pause at the UP/EXT position until the flaps indicate UP on the PFD prior to retracting the slats. Never move the flap/slat handle to UP/RET in one motion.

The ATSB report states that:

The purpose of the change was to separate the retraction of the flaps and slats into two distinct actions, in an attempt to prevent the retraction of the flaps and slats becoming 'learned' as a single continuous action.

In another incident, the flaps of a British Aerospace 146-300 began to retract soon after take-off, just before the aircraft reached 100 ft above ground level. Flap retraction began at about the time the call to raise the landing gear would have normally been made ([ATSB Investigation Report 9704041](#)). Although there were numerous factors surrounding the incident, the report commented that 'On balance ... the likelihood rests that the co-pilot inadvertently selected the flaps up instead of the landing gear.'

More information about stall warnings in high capacity aircraft is available in ATSB research report AR-2012-172 ([Stall warnings in high capacity aircraft: The Australian context 2008 to 2012](#)). The report outlines the results of a review of 245 stall warnings and stall warning system events over a 5-year period from 2008 to 2013. Of those 245 events, 163 were stickshaker activations.

## Safety message

This incident highlights the susceptibility of pilots to execution errors such as slips and lapses, irrespective of knowledge and experience. Pilots are encouraged to reflect on the circumstances surrounding this incident to help build their own awareness of human factors issues associated with operating complex equipment in a highly dynamic environment.



## General details

### Occurrence details

Date and time:	27 May 2015 – 0915 EST	
Occurrence category:	Incident	
Primary occurrence type:	Incorrect configuration	
Location:	Brisbane airport, Queensland	
	Latitude: 27° 23.05' S	Longitude: 153° 07.05' E

### Aircraft details

Manufacturer and model:	Boeing 717-200	
Registration:	VH-NXM	
Operator:	Cobham Aviation Services	
Serial number:	55094	
Type of operation:	Air transport – high capacity	
Persons on board:	Crew – 5	Passengers – 49
Injuries:	Crew – Nil	Passengers – Nil
Damage:	None	

## About the ATSB

The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory agency. The ATSB is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers. The ATSB's function is to improve safety and public confidence in the aviation, marine and rail modes of transport through excellence in: independent investigation of transport accidents and other safety occurrences; safety data recording, analysis and research; and fostering safety awareness, knowledge and action.

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.

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

It is not a function of the ATSB to apportion blame or determine liability. At the same time, 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.

## About this report

Decisions regarding whether to conduct an investigation, and the scope of an investigation, are based on many factors, including the level of safety benefit likely to be obtained from an investigation. For this occurrence, a limited-scope, fact-gathering investigation was conducted in order to produce a short summary report, and allow for greater industry awareness of potential safety issues and possible safety actions.