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Data input error involving a Boeing 737, VH-XZI

near Adelaide Airport, South Australia on 12 October 2014

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Aviation Occurrence Investigation
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Addendum

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Data input error involving a B737, VH-XZI

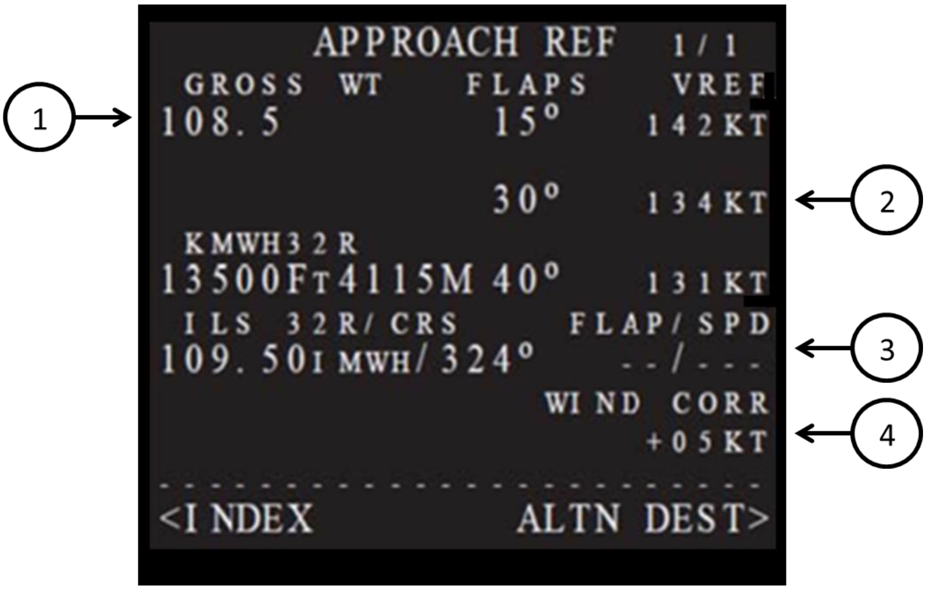
What happened

On 12 October 2014, at about 1517 Central Daylight-saving Time, the flight crew operating a Qantas Airways B737 aircraft, registered VH-XZI, were preparing for the approach and landing into Adelaide, South Australia. The aircraft had departed about one and a half hours earlier from Alice Springs, Northern Territory, with the captain as the pilot flying (PF) and the first officer as the pilot monitoring (PM).

During descent preparations, air traffic control (ATC) issued arrival instructions which the crew loaded into the flight management computer (FMC)[1] via the control display unit (CDU)[2] (Figure 1). In accordance with company procedures, the PM calculated the expected landing weight. After obtaining confirmation from the PF that his calculations were valid, he entered this figure into the aircraft gross weight (Gross WT) section of the approach reference page, (Figure 1). However, according to the post-flight data obtained from the quick access recorder (QAR), a figure of 52 tonne (T) had been inadvertently entered instead of the predicted landing weight of 62 T.

To complete the manual selections, the PM stated he verbalised, and then selected the flap 30 field on the CDU (Table 1).

Figure 1: An example of a CDU Approach Reference page



Source: Qantas Flight Crew Training Manual

1 The FMC used information entered by the crew, aircraft systems data, and navigation and performance databases, to provide auto-flight and auto-throttle guidance and control.

2 The Control Display Unit (CDU) is the interface between the flight crew and the FMC.

Table 1: Approach reference page expanded information

No.	Item	Function / notes	Detail
1	Aircraft Gross WT	Normally displays the FMC calculated aircraft Gross WT.	Manual entry of Gross WT is allowed. **Leaving and returning to this page replaces a manually entered weight with FMC computed Gross WT.**
2	Vref	FLAPS – VREF	Displays landing Vref for three flap settings as computed by the FMC. Speeds are based on displayed gross weights. Vref once selected, will not be updated. To obtain an updated speed, the current speed must be deleted, or a different Vref selected or entered.
3	Flap/Speed (FLAP/SPD)	Displays selected approach reference flap and speed setting.	Manual input of desired flap and/or speed settings may be made.
4	Wind Correction	Displays current wind correction for approach.	Default is +5 kt

Source: Qantas

Following the inadvertent landing weight data entry error, the FMC calculated the flap speed schedule and the landing reference speed (Vref), based on this lower weight. With each stage of flap selection, the magenta bug[3] moved and pointed to the new command speed on the airspeed indicator. With the selection of flap 30, the command speed became Vref plus any wind correction factor entered by the crew[4] (Figure 2).

The captain briefed, then flew the arrival and approach onto runway 23 in clear conditions and mild, westerly winds. At about 1,500 ft above mean sea level, the aircraft was fully configured for landing with the gear down and flap 30. The captain disconnected the autopilot and hand flew the remainder of the approach and landing.

During the approach, the PM made a verbal reference about the airspeed being 'wrong'. The PF reported he did not clearly hear what the PM had said, nor did he understand what message the PM was trying to convey. The captain assumed that the PM may have been making a comment in relation to a relatively new company procedure[5] used to calculate the approach speed. All the instrumentation presented to him looked normal, so he made the assumption that it was not something critical, and continued to focus on aircraft flight path management.

The PF continued to make adjustments to the thrust levers to allow for changes in wind. As was their normal procedure, the PF used the head-up guidance system (HGS) during the flight.[6] The PF reported that after the Flap 30 selection, he noted that the speed bug ('magenta' bug) moved a greater distance down the speed tape than normal, but he was not unduly concerned and continued to focus on flight path management.

At a height of about 200 ft, the PM reported he called "speed' when he noticed the magenta speed bug on the primary flight display (PFD) airspeed indicator (ASI) reduce to within close proximity of the top of the amber band (Figure 2); however the PF reported not hearing this call.

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3 Speed bug (magenta) pointed to the command airspeed. This is calculated from the information inputted to the CDU; whereas the manoeuvring margin amber band is responding to the actual aircraft weight as calculated by the FMC (based on what information was given to the FMC prior to take-off).

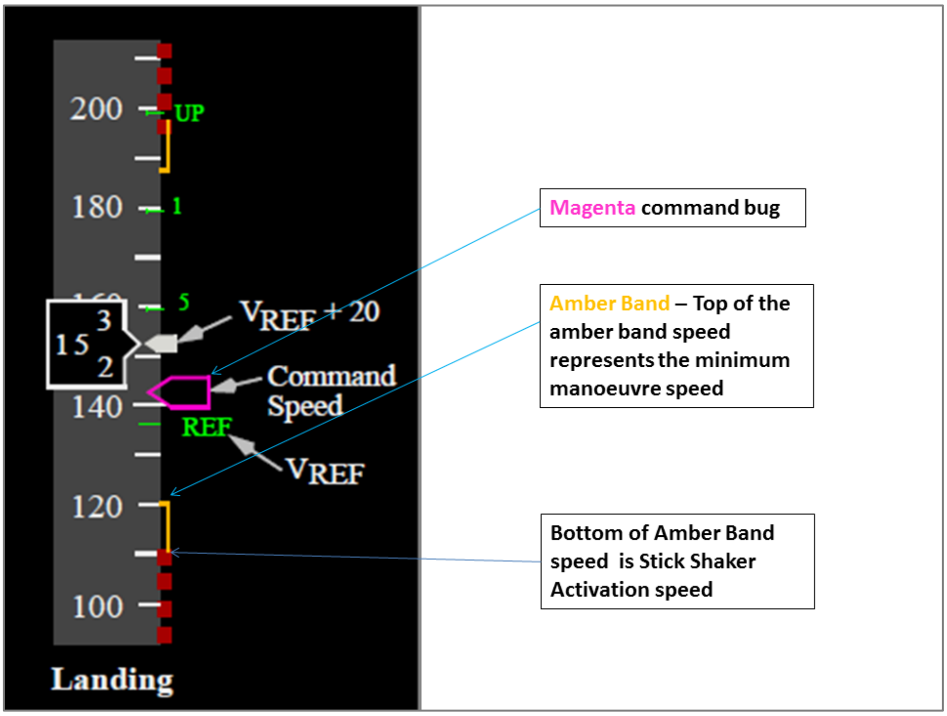
4 Minimum of Vref +5 to a maximum of Vref +20 (Boeing Approach Speed Calculation)

5 In July 2014, Qantas aligned the company procedure for Vref calculation with the Boeing recommended, Boeing Approach Speed Calculation.

6 The HGS gave a representation of the information of the PFD, but is seen as a monochrome green by the user. Different symbology is given with each different mode selected.

During touchdown, both crew noted that the aircraft's pitch attitude was higher than usual. The aircraft had a nose-up pitch of 7.5°; whereas a normal nose-up pitch was 3.5-3.75°. The remainder of the landing was normal and there were no injuries and no damage to the aircraft.

Figure 2: Sample B737 primary flight display airspeed indicator



Source: Adapted from Boeing 737 FCTM

Captain's comments

The captain commented that with a non-VNAV approach, the crew set the approach speed into the mode control panel speed window (MCP). However, as in this case with a VNAV approach, the speed window is blank, the FMC selects the speed bug as the crew select the flap. This removed an opportunity for the crew to detect the speed mismatch.

The captain stated that in hindsight the aircraft nose attitude must have been higher than normal on the approach,[7] however he did not notice it during the occurrence.

First officer (PM) comments

When the PM noted that the magenta bug was closer than normal to the manoeuvring margin amber band on the PFD airspeed indicator, he thought the 'moving' amber band may have reached a higher airspeed due to the increased g loading in the gusty conditions, until he also noted the discrepancy on the CDU from the flaps 30 Vref calculated earlier during the preparation for descent phase.

The PM reported that when he made a reference about the airspeed being 'wrong', to the PF, he believed the call was clear and concise; he also added the instruction to fly a certain airspeed. He believed this was a safer option that going "head down" and reselecting the landing vref on the CDU.

As noted in Table 1 – note 1, once the crew left the approach reference page on the CDU and then returned to it, the page defaulted back to the FMC calculated (higher) GW and (higher) Vref for Flap 30. This realisation prompted the PM to say that the 'speed's wrong' to the captain. When

[7] In the landing configuration, a lower speed requires a higher angle of attack (higher nose attitude) at any given weight

the PM saw the captain advance the thrust levers (for the gusty conditions) he thought this was a response to his comment.

Operator report

The operator conducted an investigation into the incident. Their report detailed the following:

- The data entry error was made when entering the expected landing weight into the FMC Approach Reference page; this figure was not reconciled against the final load sheet
- As the PM had only just started to comprehend the speed disparity, this led to the non-assertive comment. [note PM comment under First Officer comments regarding this aspect]
- The Boeing Speed Calculation method may have contributed to a reduced level of recognition by the Captain of the significance of the position of the magenta bug and the amber band. This method varied from the previous Reference Ground Speed (RGS) method used to allow for changes in wind between when the aircraft was on approach and the wind experienced during touchdown
- It is likely that the advancement of the thrust levels at the time the PM started to recognise a speed disparity led to a level of confirmation bias that the speed disparity was being addressed
- The predicted landing weight was printed on the final load sheet given to the flight crew just prior to departure, however this figure did not allow for variations in fuel burn experienced in flight. The load sheet estimated landing weight was often used as a gross error check by flight crew, but it was not part of the company standard operating procedures. On this occasion, the crew did not conduct a gross error check using the load sheet figure, nor were they required to do so.

Non-technical skills training (NTS)

The operator reported that 'flight crews undergo extensive non-technical skills training and recurrence during initial and cyclic training sessions. As part of this training, various levels of assertion are regularly highlighted in the event that a disparity in aircraft performance is recognised. Key indicators of uncertainty were observed in this occurrence around error recognition and confirmation. It is likely that this uncertainty resulted in a breakdown of the expected levels of assertion and a reduction in the preventative control'.

Recovery controls

The operator also noted that recovery controls would have been effective had the speed reduced to a critical amount. The head up guidance system provides visual caution/warning to the captain in the event that a tail strike pitch angle or rate is approaching, or has been exceeded. The head-up guidance system also indicates the angle of attack and normal angle of bank as a visual cue to the captain.

Safety action

Whether or not the ATSB identifies safety issues in the course of an investigation, relevant organisations may proactively initiate safety action in order to reduce their safety risk. The ATSB has been advised of the following proactive safety action in response to this occurrence.

Flight operations

As a result of this occurrence, Qantas has advised the ATSB that they are taking the following safety actions:

Action taken by Qantas

As a result of this incident, the operator intends to revise the flight crew operations manual (FCOM) descent procedures. The procedures will include an item requiring the PM to compare the landing weight entered into the Approach Reference page during descent preparation, with the load sheet estimated landing weight.

Safety message

Data entry errors

The ATSB SafetyWatch highlights the broad safety concerns that come out of our investigation findings and from the occurrence data reported to us by industry. One of the safety concerns is data input errors.

Although having a primary focus on data input errors in preparation for take-off, the message is common. Errors can occur irrespective of pilot experience, operator, aircraft type, location and take-off [or landing] performance calculation method.

An ATSB research study titled *Take-off performance calculated and entry errors: A global perspective* is a research paper which focused on such incidents and accidents in the 20 years prior to 2009. A consistent aspect was the apparent inability of flight crew to perform ‘reasonableness checks’ to determine when parameters were inappropriate for the flight.

This research article is available at the ATSB website.

Also the ATSB have produced a short YouTube video on Safety concerns in regard to data input errors. This can be viewed at the ATSB website.

Crew communication

This incident highlights the importance of effective crew communication. The PM attempted to communicate his uncertainty to the PF, but the PF did not understand the specific nature of the PM’s concerns.

Non-technical skills (NTS) previously known as cockpit resource management (CRM) training has developed over many years to promote team work among pilots and to lead to a reduction in human error. Two studies conducted by Fischer, U., and Orasanu, J., published in 1999 looked at language and communication strategies between two groups of captains and first officers from three major US airlines. Of interest, the studies found that the strategies pilots indicated they would use to mitigate pilot errors, may not be the most effective ones. Also, there was a considerable difference between the captains’ and the first officers’ communication strategies.

General details

Occurrence details

Date and time:	12 October 2014– 1545 CDT	
Occurrence category:	Incident	
Primary occurrence type:	Incorrect configuration	
Location:	Near Adelaide Airport, South Australia	
	Latitude: 34° 56.70’ S	Longitude: 138° 31.83’ E

Aircraft details

Manufacturer and model:	Boeing 737-838
Registration:	VH-XZI
Operator:	Qantas Airways

Serial number:	39364	
Type of operation:	Air Transport High Capacity - Passenger	
Persons on board:	Crew – 2 flight crew	Passengers – Unknown
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.