Australian Government

Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY REPORT

Aviation Occurrence Investigation AO-2007-044

Final

Go-around event
Melbourne Airport, Victoria
21 July 2007
VH-VQT, Airbus Industrie A320-232

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Figure: 1, 2, 3, & 8 courtesy Airbus Industries
Figure: 4 courtesy aircraft operator

Abstract

On 21 July 2007, an Airbus Industrie A320-232 aircraft was being operated on a scheduled international passenger service between Christchurch, New Zealand and Melbourne, Australia. At the decision height on the instrument approach into Melbourne, the crew conducted a missed approach as they did not have the required visual reference because of fog. The pilot in command did not perform the go-around procedure correctly and, in the process, the crew were unaware of the aircraft's current flight mode. The aircraft descended to within 38 ft of the ground before climbing.

The aircraft operator had changed the standard operating procedure for a go-around and, as a result, the crew were not prompted to confirm the aircraft's flight mode status until a number of other procedure items had been completed. As a result of the aircraft not initially climbing, and the crew being distracted by an increased workload and unexpected alerts and warnings, those items were not completed. The operator had not conducted a risk analysis of the change to the procedure and did not satisfy the incident reporting requirements of its safety management system (SMS) or of the *Transport Safety Investigation Act 2003*.

As a result of this occurrence, the aircraft operator changed its go-around procedure to reflect that of the aircraft manufacturer, and its SMS to require a formal risk management process in support of any proposal to change an aircraft operating procedure. In addition, the operator is reviewing its flight training requirements, has invoked a number of changes to its document control procedures, and has revised the incident reporting requirements of its SMS.

In addition to the safety action taken by the aircraft operator the aircraft manufacturer has, as a result of the occurrence, enhanced its published go-around procedures to emphasise the critical nature of the flight crew actions during a go-around.

THE AUSTRALIAN TRANSPORT SAFETY BUREAU

The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory agency. The Bureau 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; 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.

Purpose of safety investigations

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. The terms the ATSB uses to refer to key safety and risk concepts are set out in the next section: Terminology Used in this Report.

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.

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 initiate proactive safety action that addresses safety issues. Nevertheless, the ATSB may use its power to make a formal safety recommendation either during or at the end of an investigation, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation.

When safety recommendations are issued, they focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on a preferred method of corrective action. As with equivalent overseas organisations, the ATSB has no power to enforce the implementation of its recommendations. It is a matter for the body to which an ATSB recommendation is directed to assess the costs and benefits of any particular means of addressing a safety issue.

When the ATSB issues a safety recommendation to a person, organisation or agency, they must provide a written response within 90 days. That response must indicate whether they accept the recommendation, any reasons for not accepting part or all of the recommendation, and details of any proposed safety action to give effect to the recommendation.

The ATSB can also issue safety advisory notices suggesting that an organisation or an industry sector consider a safety issue and take action where it believes it appropriate. There is no requirement for a formal response to an advisory notice, although the ATSB will publish any response it receives.

TERMINOLOGY USED IN THIS REPORT

Occurrence: accident or incident.

Safety factor: an event or condition that increases safety risk. In other words, it is something that, if it occurred in the future, would increase the likelihood of an occurrence, and/or the severity of the adverse consequences associated with an occurrence. Safety factors include the occurrence events (e.g. engine failure, signal passed at danger, grounding), individual actions (e.g. errors and violations), local conditions, risk controls and organisational influences.

Contributing safety factor: a safety factor that, if it had not occurred or existed at the relevant time, then either: (a) the occurrence would probably not have occurred; or (b) the adverse consequences associated with the occurrence would probably not have occurred or have been as serious, or (c) another contributing safety factor would probably not have occurred or existed.

Other safety factor: a safety factor identified during an occurrence investigation which did not meet the definition of contributing safety factor but was still considered to be important to communicate in an investigation report.

Other key finding: any finding, other than that associated with safety factors, considered important to include in an investigation report. Such findings may resolve ambiguity or controversy, describe possible scenarios or safety factors when firm safety factor findings were not able to be made, or note events or conditions which 'saved the day' or played an important role in reducing the risk associated with an occurrence.

Safety issue: a safety factor that (a) can reasonably be regarded as having the potential to adversely affect the safety of future operations, and (b) is a characteristic of an organisation or a system, rather than a characteristic of a specific individual, or characteristic of an operational environment at a specific point in time.

Risk level: The ATSB's assessment of the risk level associated with a safety issue is noted in the Findings section of the investigation report. It reflects the risk level as it existed at the time of the occurrence. That risk level may subsequently have been reduced as a result of safety actions taken by individuals or organisations during the course of an investigation.

Safety issues are broadly classified in terms of their level of risk as follows:

- **Critical** safety issue: associated with an intolerable level of risk and generally leading to the immediate issue of a safety recommendation unless corrective safety action has already been taken.
- **Significant** safety issue: associated with a risk level regarded as acceptable only if it is kept as low as reasonably practicable. The ATSB may issue a safety recommendation or a safety advisory notice if it assesses that further safety action may be practicable.
- **Minor** safety issue: associated with a broadly acceptable level of risk, although the ATSB may sometimes issue a safety advisory notice.

Safety action: the steps taken or proposed to be taken by a person, organisation or agency in response to a safety issue.

EXECUTIVE SUMMARY

On 21 July 2007, an Airbus Industrie A320-232 aircraft, registered VH-VQT (VQT), was being operated on a scheduled international regular public transport service, between Christchurch, New Zealand and Melbourne, Australia.

The crew commenced an instrument landing system (ILS) approach to Melbourne International Airport, Victoria. The weather conditions were such that an instrument approach to the decision height for the approach was likely. The likelihood of the crew having to conduct a missed approach was high, as a number of aircraft ahead of VQT had already conducted missed approaches because of the low visibility due to fog. The crew were aware of those conditions prior to their departure from Christchurch, and had planned accordingly.

At the decision height on the ILS approach, the crew did not have the prescribed visual reference to continue the approach to land and commenced a missed approach (or go-around). During the initial part of the missed approach, the pilot in command had not correctly moved the thrust levers to the 'take-off/go-around' position and, as a result, the aircraft's automated flight mode did not transition correctly to the go-around phase. The crew were not aware that the aircraft had not transitioned to the expected flight modes for a go-around. The aircraft continued to descend towards the runway, reaching a minimum recorded height of 38 ft above the runway before the aircraft responded to manual flight crew inputs and began to climb away.

The aircraft was subsequently processed by air traffic control for another approach to Melbourne Airport. This second approach also resulted in the crew conducting a missed approach, which was completed within expected parameters. The aircraft was then diverted to Avalon Airport, where it landed uneventfully.

The aircraft manufacturer had published its go-around procedure with the requirement to check and announce the aircraft's flight mode as part of the initial actions of the go-around. That requirement was included to ensure that the crew could confirm the necessary changes to the aircraft's flight mode.

The aircraft operator had changed the go-around procedure and moved the positive confirmation of flight mode to a much later position in the procedure. The changed procedure required that a call be made after a positive rate of climb was obtained. In this instance, due to the aircraft continuing to descend, with the crew distracted by unexpected warnings and a subsequent increased workload, this call could not be made by the flight crew so the standard operating procedure in support of the go-around effectively paused at that point. As a result, the crew never obtained positive confirmation of the aircraft's flight mode.

The aircraft operator had implemented a safety management system (SMS) that included a change management process. That process indicated that a change of this type to a standard operating procedure could be undertaken without a formal risk analysis. The investigation was unable to obtain any additional documentation from the aircraft operator in support of the change to the go-around procedure.

During the investigation, it was found that the aircraft operator had not complied with the requirements of its SMS in relation to the reporting of occurrences and as a result had not complied with the reporting requirements of the *Transport Safety Investigation Act 2003.*

As a result of this occurrence, the aircraft operator changed its go-around procedure to reflect that published by the aircraft manufacturer, and its SMS to require a formal risk management process in support of any proposal to change an aircraft operating procedure. In addition, the operator is reviewing its flight training requirements, has invoked a number of changes to its document control procedures, and has revised the incident reporting requirements of its SMS.

In addition to the safety action taken by the aircraft operator, as a result of this occurrence, the aircraft manufacturer enhanced its published go-around procedures to emphasise the critical nature of the flight crew actions during a go-around.

FACTUAL INFORMATION

History of the flight

On 21 July 2007, an Airbus Industrie A320-232 aircraft, registered VH-VQT (VQT), was being operated on a scheduled international regular public transport service between Christchurch, New Zealand and Melbourne, Australia.

At 0747 Eastern Standard Time[1], following an uneventful flight from New Zealand, the flight crew commenced an instrument landing system (ILS) approach to runway 27 at Melbourne International Airport, Victoria. The weather conditions had been forecast to include fog, which subsequently eventuated, requiring the conduct of an instrument approach. There was a high likelihood of the crew having to conduct a missed approach[2], as a number of aircraft ahead of VQT had already conducted missed approaches because of low visibility due to the fog. The crew were aware of those conditions prior to their departure, and had flight planned accordingly. They had also conducted a briefing on the likelihood of having to conduct a missed approach prior to commencing the descent into Melbourne.

At the decision height[3] on the ILS approach, the crew did not have the prescribed visual reference and commenced a missed approach. During the initial part of the missed approach, the crew were not aware that the aircraft had not transitioned to the expected flight mode[4]. The aircraft continued to descend towards the runway, reaching a minimum recorded height of 38 ft above the runway before the aircraft responded to manual flight crew inputs and began to climb away.

The aircraft was subsequently processed by air traffic control (ATC) for a second approach. This second approach also resulted in the flight crew conducting a missed approach, and the aircraft was diverted to Avalon Airport, where it landed uneventfully. During the second missed approach, the aircraft systems functioned as the crew expected.

1 The 24-hour clock is used in this report to describe the local time of day, Eastern Standard Time (EST), as particular events occurred. Eastern Standard Time was Coordinated Universal Time (UTC) + 10 hours.

2 A missed approach (otherwise known as a go-around) is a part of an instrument approach procedure. It is executed when a safe landing cannot be accomplished. When an aircraft is required to conduct a missed approach, the crew normally increase the power on the engines, retract the landing gear and flaps, and climb the aircraft away from the ground to reposition for another approach or divert to an alternate aerodrome.

3 The decision height is the published height above ground level at which the crew must have the required visual reference with the landing runway to enable them to continue the approach and landing. If the required visual reference is not available, the crew must conduct a missed approach.

4 To assist flight crew in controlling the Airbus A320 aircraft, flight mode information is provided to flight crew on a display called the Flight Mode Annunciator (FMA). The current flight mode is derived from input from various aircraft systems. Current flight modes and any change to a flight mode are displayed on the FMA.

Incident notification

Sections 18 and 19 of the *Transport Safety Investigation Act 2003* (TSI Act) defined the requirements for the compulsory reporting of immediately and routinely reportable matters. Section 18 (1) stated:

> If a responsible person has knowledge of an immediately reportable matter, then the person must report it to a nominated official as soon as is reasonably practicable and by the means prescribed by the regulations.[5]

Section 19 (1) stated:

> If a responsible person has knowledge of an immediately reportable matter or a routine reportable matter, then the person must within 72 hours give a written report of the matter (containing the particulars prescribed by the regulations) to a nominated official.[6,7]

Broadly, the incident reporting requirements of the operator's Safety Management System (SMS) reflected the requirements of the TSI Act and Regulations and made specific reference to those two pieces of legislation.

The incident occurred on 21 July 2007 and was reported to the aircraft operator by the flight crew on their return to New Zealand. The aircraft operator reported receiving the report from the flight crew on 23 July 2007. On 26 July 2007, the operator reported the incident to the Australian Transport Safety Bureau (ATSB).

The operator's report indicated that the incident resulted in a diversion of the flight to another destination following the go-around at Melbourne. There was no indication in that report that there had been any activation of the aircraft's Enhanced Ground Proximity Warning System (EGPWS). The report also indicated that the automated systems on board the aircraft did not transition to the go-around mode, and that the crew took manual control of the aircraft.

On the basis of the information contained in the operator's incident report, the ATSB assessed that the circumstances did not warrant the initiation of an investigation.

On 2 August 2007, the operator commenced an internal investigation into the incident, which involved crew interviews and the examination of the recorded flight data from the aircraft's Quick Access Recorder (QAR). That examination revealed the activation of EGPWS alerts during the first missed approach. The information relating to the activation of the EGPWS alerts was not provided to the ATSB at that time.

On 11 September 2007, in response to media reports of a potentially serious incident at Melbourne Airport, the ATSB contacted the operator, who provided additional information on the 21 July incident. Based on that additional information, the ATSB re-assessed the circumstances to be of sufficient seriousness to warrant the initiation of an investigation.

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5 No time frame was specified in the TSI Act relating to when the knowledge was obtained.

6 The definition of responsible person was contained in the *Transport Safety Investigation Regulations 2003*, Regulation 2.5 and included the owner or operator of the aircraft.

7 The required content of a written report was listed in Regulation 2.6.

Aircraft operator reporting procedures

The operator's SMS, which was part of the operator's operations manual, outlined the operator's occurrence reporting requirements and the required timeframes for those reports. The TSI Act and Regulations and the operator's operations manual, contained specific definitions relating to immediately and routinely reportable matters. An occurrence where flight into terrain was narrowly avoided, or a failure to achieve predicted performance during initial climb were listed in both documents as immediately reportable matters. In addition, an EGPWS alert was listed as a routinely reportable matter.

Whenever a crew member was involved in a safety-related occurrence, the operations manual required that it be reported to the operator's safety department as soon as possible after the occurrence. The crew in this occurrence completed an Operational Safety and Company Advisory Report (OSCAR) and submitted it to the safety department when they returned to New Zealand. The operations manual stated that once this had been done, the safety department would then assume responsibility for notifying any external agency.

The operations manual also identified that the responsibility for the initiation of an internal investigation rested with the Manager, Safety Audit and Investigation and was to be done in consultation with the Group General Manager, Safety.

Personnel information

Pilot in command

Licence type	Air Transport Pilot (Aeroplane) Licence (ATPL(A))
Total hours	6,500 hours (2,500 B717)
Total hours on type	1,580 hours

The pilot in command (PIC) was endorsed on the A320 in July 2005. That endorsement took the form of a 'transition endorsement'[8]. Prior to that endorsement, the PIC was employed by the same operator as a command pilot, flying the Boeing Company B717 aircraft.

A review of training records obtained from the training provider indicated that the PIC had successfully completed the endorsement training. However, due to the absence of qualitative comments on those training records, the investigation was unable to determine if the PIC experienced any particular difficulty developing an understanding of the aircraft's flight modes, or with the operation of the aircraft's automated systems.

In comparison, when the PIC was checked to line and subsequently completed recurrent simulator training by the aircraft operator, extensive qualitative comments regarding his performance and areas of difficulty were included in the operator's training records. None of those comments indicated that the PIC had any difficulty understanding aircraft flight mode systems.

8 A transition endorsement was defined by the third party training provider as an endorsement provided to a pilot who had previously been endorsed on jet aircraft and had experience operating heavy jet transport type aircraft.

Copilot

Licence type	ATPL(A)
Total hours	5,000 hours
Total hours on type	500 hours

The copilot completed his endorsement training on the A320 in December 2006. That training was based on the copilot not having any previous jet endorsements, and having no previous experience on heavy jet transport aircraft.

A review of training records obtained from the training provider indicated that the copilot successfully completed the endorsement training. However, as was the case with the PIC, the absence of qualitative comments on the training records meant that the investigation was unable to determine if the copilot had any difficulty developing an understanding of the aircraft's flight modes, or with the operation of the aircraft's automated systems.

In comparison, when the copilot was checked to line and subsequently completed recurrent simulator training by the aircraft operator, extensive qualitative comments regarding his performance and areas of difficulty were included in the operator's training records. None of those comments indicated that the copilot had any difficulty in understanding aircraft flight mode systems.

Crew training

During their endorsement training, both the PIC and copilot were trained to the procedures, checklists and checklist announcements as prescribed in the aircraft manufacturer's operating manuals. Once the pilots obtained their A320 endorsements, they underwent a transition simulator session that was conducted by the aircraft operator to learn the procedures, checklists and announcements that were specific to the operator.

During the pilots' recurrent simulator training and checking sessions[9] that were conducted by the aircraft operator, the conduct of the go-around procedure was practised, including the conduct of a go-around with one engine inoperative, and with all engines operating.

Fatigue

The crew reported that they were both adequately rested prior to commencing the flight from New Zealand.

Regulatory framework for pilot training

The Civil Aviation Safety Authority (CASA) Civil Aviation Regulation (CAR) 217 required the operator of regular public transport aircraft with a maximum take-off weight exceeding 5,700 kg, to have a training and checking organisation to ensure that their operating crew were trained appropriately, and that they maintained competency.

9 The operator required all pilots to undergo training and checking in simulators on a 6-monthly basis. Over a period of 3 years, pilots underwent training/checking on all of the required normal and emergency procedures applicable to the aircraft type.

Civil Aviation Order 82.5 (3) placed a number of obligations on the operator with regard to the provision of training for, and the checking of its crew. Appendix 2 of the Order identified the responsibilities of the operator's training and checking organisation; in particular, the obligations with regard to the employment or contracting of persons to conduct training and checking of crew.

At the time of the occurrence, there was no CASA Regulation or Order that identified the responsibilities of third party training organisations.

Proposed CASR Part 142

The proposed Civil Aviation Safety Regulation (CASR) Part 142 Training and Checking Operators was intended to formalise the responsibilities of third party training organisations. In instances where training would be provided to Air Operator Certificate (AOC) holders, CASR Part 142 would define the responsibilities of the training provider and their relationship with the AOC holder.

A Notice of Proposed Rule Making (NPRM) in respect of CASR Part 142 was issued by CASA on 22 July 2003; however, the regulation had not been enacted at the time of finalising this report.

Training provided by a third party

When third party training providers give endorsement training to private individuals, an employee of the training provider, who has been given a CASA delegation, is responsible for ensuring that the minimum standards of the endorsement are met. In the case of a pilot who has been endorsed on an aircraft type as a private individual, and who later becomes an employee of an AOC holder that operates the aircraft type, it is the responsibility of the AOC holder to ensure that the pilot meets all the requirements of a flight crew member conducting regular public transport operations.

Training provider

The aircraft operator did not provide initial endorsement training to its pilots; instead it contracted a third party training provider some time prior to the occurrence to endorse pilots that were either employed, or were going to be employed, on its A320 aircraft. That endorsement training included both aircraft systems and simulator training.

On completion of the training, a recommendation to issue the endorsement was made by a CASA-approved simulator instructor who was employed by the training provider.

Aircraft

The aircraft operator reported that there were no recorded defects or anomalies with either the aircraft's auto-thrust system or flight control computers that may have contributed to the occurrence. Further, it was reported that a review of the aircraft's maintenance records, for the period from 6 months before until 3 months after the occurrence, revealed that there were no ongoing problems recorded with the aircraft's automated systems.

Operating procedures and systems description

Due to the fog at Melbourne, the crew were flying the approach using low visibility operating procedures. Those procedures required the PIC to assume the role of pilot flying[10] and the copilot to perform the duties of the pilot not flying.[11]

The aircraft was being flown by the PIC using the autopilot system.

The A320 used a number of flight control computers to provide guidance mode input to the autopilot in order to provide aircraft control. During an ILS approach, the applicable guidance modes were 'glideslope' and 'localiser'. Those modes provided vertical and lateral guidance respectively during the approach.

Engine thrust could be controlled by the auto-thrust system. The crew reported, and the flight data recorder showed, that the auto-thrust system was active during the approach. The thrust levers could be placed in any one of four detents on the thrust lever quadrant according to the phase of flight.[12] During a normal instrument approach, the levers remained in the climb (CL)[13] detent. If auto-thrust was active during an approach, then the aircraft's speed was normally controlled by the thrust commanded by that system. The two detents forward of the CL detent were the 'flexible take-off/maximum continuous thrust' (FLX/MCT)[14] detent, and the 'take-off/go around' (TO/GA)[15] detent (Figure 1).

10 The term 'pilot flying' referred to the pilot who was manipulating the controls of the aircraft or providing input to the autopilot, during a manoeuvre.

11 The term 'pilot not flying' referred to the pilot who was monitoring the flight instruments and cockpit activity and providing support to the pilot flying, during a manoeuvre.

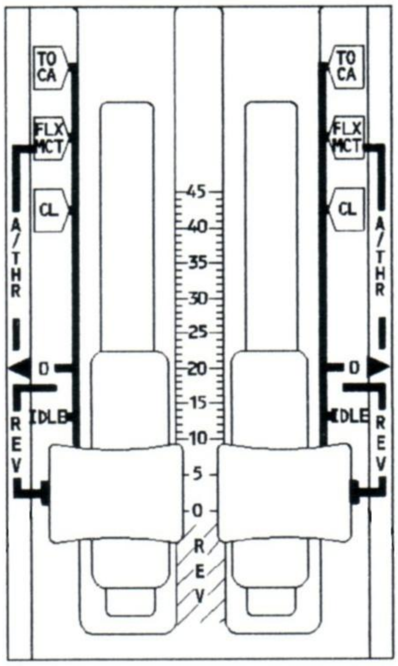
12 The A320 thrust control system did not require the pilot to continuously manipulate the thrust levers; rather, the pilot placed the thrust levers in the appropriate detent, and thrust was commanded in response to flight control computer and auto-thrust system inputs.

13 The CL detent provided for power up to maximum climb thrust from the engines.

14 The FLX/MCT detent provided maximum continuous thrust from the engines, or was used when conducting a flexible temperature take-off procedure. A flexible temperature takeoff was an option for crews when full take-off power was not required, and reduced take-off thrust was commanded by a crew instead.

15 The TO/GA detent provided maximum take-off thrust from the engines.

Figure 1: A320 thrust lever positions



If a crew did not have the required visual parameters at the decision height for the approach[16], they were required to conduct a missed approach (go-around). That required the pilot flying to advance the thrust levers from the CL detent to the TO/GA detent, and to positively rotate the aircraft to a climb attitude. It also involved a number of announcements from the crew in response to the manoeuvre, changes to the aircraft's flight mode, and actions to reconfigure the aircraft from the approach to a go-around configuration.

Movement of the thrust levers to the TO/GA position provided inputs to the flight control computers to initiate a change to the flight guidance modes. In a go-around, the applicable modes were 'speed-reference-system' (SRS) and 'go-around track' (GA TRK). In the go-around manoeuvre, the SRS system provided guidance to maintain the speed that existed at the commencement of the procedure, while GA TRK mode provided lateral tracking guidance. In addition, the movement of the thrust levers also commanded an increase in the thrust being produced by the engines.

[16] The decision height for the runway 27 ILS approach at Melbourne Airport was 203 ft above ground level.

Standard operating procedure for conducting a go-around

The aircraft manufacturer included a standard go-around procedure in its flight crew operating manual (FCOM). That procedure required a check and an announcement (call) of the FMA data (Figure 2) so that crews were aware of the current flight modes of the aircraft at item 3 (ROTATION) (Figure 3).

Figure 2: Primary flight display with flight mode annunciator and flight director indicated (highlight added by ATSB)

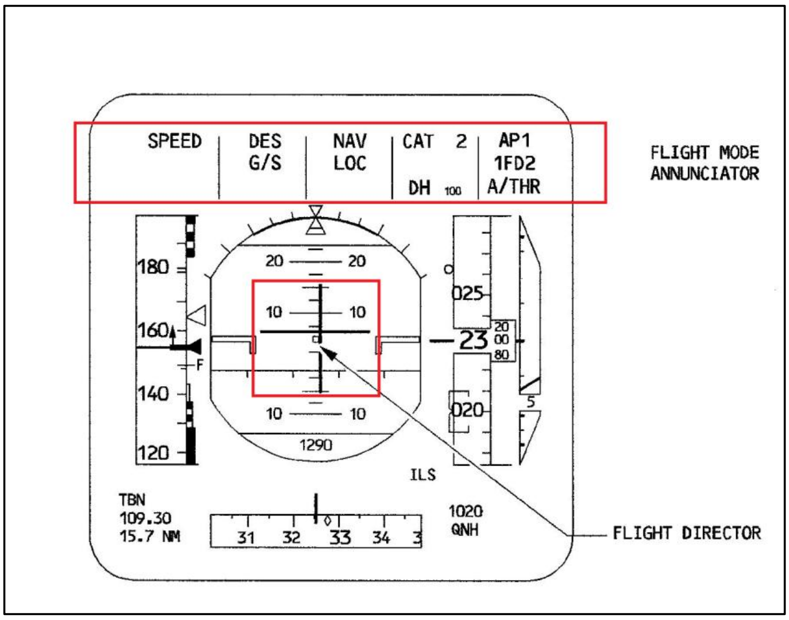


Figure 3: Aircraft manufacturer's standard go-around procedure (highlight added by ATSB)

A318/A319/A320/A321 FLIGHT CREW OPERATING MANUAL	STANDARD OPERATING PROCEDURES	3.03.23	P 1
	GO AROUND	SEQ 110	REV 36

GO AROUND

Apply the following three actions simultaneously :

– **THRUST LEVERS** . . . . **TOGA**

– **ANNOUNCE** . . . . **"GO AROUND – FLAPS"**

– **ROTATION** . . . . **PERFORM**
· Rotate the aircraft to get a positive rate of climb, and establish the required pitch ~~attitude, as directed by the SRS pitch command bar.~~
· Check and announce the FMA : MAN TOGA, SRS, GA TRK.

– **FLAPS** . . . . **RETRACT ONE STEP**
Announce "FLAPS..." when indicated.

– **ANNOUNCE** . . . . **"POSITIVE CLIMB"**

– **ORDER** . . . . **"GEAR UP"**

– **L/G UP** . . . . **SELECT**

– **CONFIRM/ANNOUNCE** . . . . **"GEAR UP–FLAPS"**

Note : Consider retarding to CL detent, if TOGA thrust is not required.

– **NAV or HDG mode** . . . . **SELECT**
Reselect NAV or HDG, as required (minimum height 100 feet).

Note : Go-around may be flown with both autopilots engaged. Whenever any other mode engages, AP 2 disengages.

● **At go-around thrust reduction altitude (LVR CLB flashing on FMA) :**

R – **THRUST LEVERS** . . . . **CL**

Aircraft operator

The aircraft operator's FCOM volume 3 contained the standard operating procedure for a go-around manoeuvre.

At some time between September 2006 and March 2007, and prior to this occurrence, the aircraft operator introduced a change to the go-around procedure in its FCOM. The revision number of the changed procedure was dated March 2003. However, as the aircraft operator did not commence operations until May 2004, the investigation was unable to use the revision date on the changed procedure as a reliable indicator of when the change to the standard operating procedure was made.

As a result of that change, the requirement for a crew member to check and announce (call) the FMA status was moved from item three on the list (ROTATION), to the ninth item on the list (ANNOUNCE FMA). The change to the procedure was annotated with a letter J in order to highlight the change to flight crews (Figure 4).

Figure 4: Operator's changed procedure for go-around (highlight added by ATSB)

A318 / A319 / A320 / A321 Flight Crew Operating Manual	STANDARD OPERATING PROCEDURES GO AROUND	3.03.23	P 1
		SEQ 110	REV 36

GO AROUND

Apply the following three actions simultaneously :

– THRUST LEVERS .... TOGA

– ANNOUNCE .... "GO AROUND – FLAPS"

– ROTATION .... PERFORM

- Rotate the aircraft to get a positive rate of climb, and establish the required pitch attitude, as directed by the SRS pitch command bar.

J

– FLAPS .... RETRACT ONE STEP
Announce "FLAPS..." when indicated.

– ANNOUNCE .... "POSITIVE CLIMB"

– ORDER .... "GEAR UP"

– L/G UP .... SELECT

– CONFIRM/ANNOUNCE .... "GEAR UP-FLAPS___"

Note : Consider retarding to CL detent, if TOGA thrust is not required.

J – ANNOUNCE FMA .... "MAN TOGA, SRS, GA TRK"

– NAV or HDG mode .... SELECT
Reselect NAV or HDG, as required (minimum height 100-feet).

Note : Go-around may be flown with both autopilots engaged. Whenever any other mode engages, AP 2 disengages.

● At go-around thrust reduction altitude (LVR CLB flashing on FMA) :

– THRUST LEVERS CL

The operator's SMS contained a process for changing its standard operating procedures. The change to a procedure was classified across three levels, depending upon its impact on company operations. The change to the go-around standard operating procedure was classified as a level B change, since it only required the variation of one volume of the operator's Operations Manual Suite. In that case, the change could be made without a formal risk assessment of its impact on aircraft operations. There was no other documentation supporting the change to the go-around procedure that was available from the aircraft operator.

In both the manufacturer's and the operator's procedures, a note to the 'gear up/flaps' announcement by the pilot not flying stated (Figures 3 & 4):

> Note: Consider retarding to CL detent, if TOGA thrust is not required.

Go-around from an intermediate altitude

The aircraft manufacturer's and operator's FCOMs also contained a procedure for a go-around from an intermediate approach altitude.[17] That procedure was to be used if an aircraft was not at the minimum altitude on an approach when the go-around was initiated, and outlined the steps for reducing thrust from the TO/GA position if it was not required (Figure 5).

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[17] Although the FCOM did not define an intermediate approach altitude, it can be considered to be an altitude considerably higher than the minimum altitude for an instrument approach. The Australian Aeronautical Information Publication (AIP) listed the intermediate part of an approach as ending at the final approach fix. The final approach fix for the Melbourne runway 27 ILS approach was at an altitude of 1,675 ft.

Figure 5: Operator's procedure for a go-around from an intermediate approach altitude (highlight added by ATSB)

A318 / A319 / A320 / A321 Flight Crew Operating Manual	STANDARD OPERATING PROCEDURES GO AROUND	3.03.23 P 2 SEQ 102 REV 38

- **At go-around acceleration altitude :**
  - **– Monitor that the target speed increases to green dot.**
  - **If the target speed does not increase to green dot :**
    - **– FCU ALT .... CHECK and PULL**
  - **– Retract flaps on schedule.**

  Note : Consider the next step :
  - *– Engage NAV mode, to follow the published missed approach procedure, or*
  - *– Prepare for a second approach by selecting the ACTIVATE APP PHASE, and CONFIRM on the PERF page.*

GO-AROUND FROM AN INTERMEDIATE APPROACH ALTITUDE

To interrupt the approach, or to perform a go-around, from an intermediate altitude in the approach, and if TOGA thrust is not required, proceed as follows :

– SET the thrust levers to TOGA detent, then retard the thrust levers as required.
This enables to engage the GO-AROUND phase, with associated AP/FD modes.

– SELECT the applicable AP/FD and A/THR modes on the FCU.

Note : If the thrust levers are not set briefly to TOGA detent, the FMS does not engage the GO AROUND phase, and flying over, or close to the airport (less than 7 NM) will sequence the Destination waypoint in the F-PLN.

The *Go-around from an intermediate approach altitude* procedure required the thrust levers to be set to the TO/GA position, and then to be retarded as required to the CL detent. The movement of the thrust levers to the TO/GA position was, in addition to increasing the thrust from the engines, to ensure that the flight guidance systems would transition to the go-around phase correctly.

The procedure of moving the thrust levers to the TO/GA position for a short time, and then retarding them to another position, was known colloquially by some of the operators' pilots as a 'TOGA tap'.

The operator's management pilots reported that they were aware of the term TOGA tap being used by line and training pilots, but indicated that there was no approved procedure in the aircraft operating manuals by that name. When interviewed, the management pilots indicated that the TOGA tap could be applied to a go-around from an intermediate altitude, or that it could be used to minimise the chances of exceeding flap limit speeds[18] during a go-around. Other pilots employed by the operator reported that they were also aware of the term, and indicated that the knowledge and use of when pilots could apply a procedure known as the TOGA tap was not consistent across the pilot group.

The PIC reported that he was aware of the term TOGA tap. The copilot reported that he had also heard of the term and that it had been explained to him as a procedure to be used to prevent overspeeding the flaps during a go-around.

The PIC reported that, following the occurrence, he was contacted by other pilots who were employed by the operator and was told of similar occurrences where the A320 aircraft had not correctly transitioned to the appropriate flight mode following the application of the TOGA tap during a go-around. Reportedly, that included in flight and in the simulator. On those occasions, it was reported that the other flight crew member detected the problem. The aircraft operator indicated receiving no formal reports of those events.

Crew recollection of the first missed approach

The PIC recalled that, during the initial go-around, and in consideration of the aircraft's light weight at that time, he moved the thrust levers forward towards the TO/GA position and then moved them back to the CL detent. He reported hearing the engines spool-up[19], feeling the associated increase in thrust, and noticing an apparent pitch up of the aircraft in response to the initial thrust lever movement. He also recalled that the airspeed started to increase, but that there was no 'positive climb' announcement from the copilot and that the flight director pitch command bars had not pitched up. As he was unsure of the status of the aircraft, he disconnected the autopilot and flew the aircraft manually. When a positive climb was announced by the copilot, the PIC commanded the landing gear to be retracted. That action immediately activated an aural and visual master warning[20], which became distracting. The PIC reported that when the landing gear was raised, he knew there was a requirement to confirm the FMA status.

The copilot reported that a TOGA tap procedure was not briefed during the approach briefing in the event of a missed approach. He recalled hearing the go-around call from the PIC and, in response, retracting the flaps one stage. He reported noticing that the flight director pitch command bars were indicating pitch down, rather than the expected upwards position. Although aware of the requirement to alert the pilot flying of the continuing descent, the copilot was

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18 The wing flaps on an aircraft have operating airspeed limits imposed on them. These airspeed limits apply when the flaps are being lowered, and when the flaps are already in the lowered position.

19 Normally associated with a turbofan or turbojet engine, to accelerate engine rpm to a much higher level than previously.

20 A master warning consists of a visual light on the instrument panel glareshield and an audible tone to attract the flight crew's attention.

momentarily unable to recall the correct phrase to be used[21]. He recalled that the PIC disconnected the autopilot and, when the aircraft obtained a positive rate of climb, he made the appropriate announcement and retracted the landing gear when commanded. He also reported that an EGPWS alert[22] and the master warning activated once the landing gear was raised and that it became very distracting. As a result of the master warning, he spent some time re-checking the flap and gear lever positions to ensure that they were in the correct positions for the go-around.

The master warning aural alert sounded for the next 17 seconds and, during that time, both crew members indicated that it was very distracting for them. The copilot stated that he attempted to cancel the warning using the cancel button on the instrument panel glareshield, but the warning horn did not cancel. The PIC recalled observing the copilot attempting to cancel the horn at one stage, and noticed the landing gear selector was in the raised position. He reported that he could not immediately understand why the warning was sounding.

The master warning aural alert was subsequently cancelled by the flight crew using the emergency cancel button on the centre pedestal.

The PIC recalled he was concerned about overspeeding the flaps during the go-around, as the airspeed display showed a very narrow band between the flap limit speed and the minimum speed. As a result, he was concentrating on that aspect of flying the aircraft. When he engaged the autopilot to fly the aircraft, it immediately commanded the aircraft to pitch down. In response, the PIC manually disconnected the autopilot. He also reported hearing an EGPWS alert before he selected TO/GA on the thrust levers and the aircraft began to climb away.

The recorded data showed that there were two EGPWS alerts (Figure 6), of which the PIC only recalled hearing the second. The copilot recalled hearing the first EGPWS alert but not the second.

Recorded flight data

Recorded data from the flight was retrieved from the onboard flight data interface management unit (FDIMU) by the operator and was provided to the ATSB. Data was successfully downloaded from the flight data recorder (FDR) and the quick access recorder (QAR).

First missed approach

An examination of the recorded flight data indicated that the aircraft was configured for an instrument approach to runway 27, and that the flight control computers were in the appropriate flight modes during the approach. A number of pertinent recorded parameters relating to the first missed approach are shown at Figure 6.

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21 The aircraft operator's FCOM Volume 4 – page 4.05.80 titled 'FLIGHT PHASE RELATED PROCEDURES – GO-AROUND' contained the details of specific calls to be made by the pilot not flying during a go-around manoeuvre. If the aircraft was not climbing, the procedure indicated that the correct call to be made was 'SINK RATE'.

22 Mode 3 Alert – Indicating an altitude loss after take-off or go-around. The aural alert was a voice message 'DON'T SINK', indicating to the crew that the aircraft was sinking instead of climbing.

At the commencement of the first missed approach, and at a radio altitude of 185 ft, the thrust levers were momentarily moved to a position of 37° thrust lever angle, which was just forward of the FLX/MCT detent[23], before being retarded to that detent. The data showed that the auto-thrust system automatically deactivated at the same time. The flaps and slats were commanded to retract from the FULL position to the FLAP 3 position[24] 3 seconds later. Both autopilots remained engaged during the commencement of the missed approach, and were disengaged 4 seconds after the flaps commenced retracting. The recorded radio altimeter height at that time was 57 feet, and there was an EGPWS mode 3 alert and a master system warning.

One second later, the flaps reached the FLAP 3 position and the recorded radio altitude was 44 ft. The aircraft reached its lowest recorded radio altitude of 38 ft 1 second later, at an airspeed of 164 kts and with the landing gear in the down position. A further 1 second later, the aircraft commenced a climb, and the landing gear commenced retracting 4 seconds later. A master system warning then annunciated for the next 17 seconds. The aircraft continued to climb and, at a recorded radio altitude of 281 ft, the auto-thrust system became active and the thrust levers moved to the CL detent. One autopilot was engaged for a short period and the aircraft continued to climb, albeit at a reduced rate.

The aircraft levelled off at a recorded radio altitude of 652 ft and remained at that altitude for the next 12 seconds, under manual control, before commencing a shallow descent to a recorded radio altitude of 570 ft over the next 7 seconds. At that altitude, the thrust levers were moved to the TO/GA detent, coincident with another EGPWS mode 3 alert, and another master system warning. The data revealed that the SRS and GA TRK modes activated 1 second later, and that the thrust levers were retarded to the CL detent 7 seconds after that. The aircraft then climbed to the prescribed missed approach altitude and was processed by ATC for a second approach, this time to runway 16 at Melbourne Airport.

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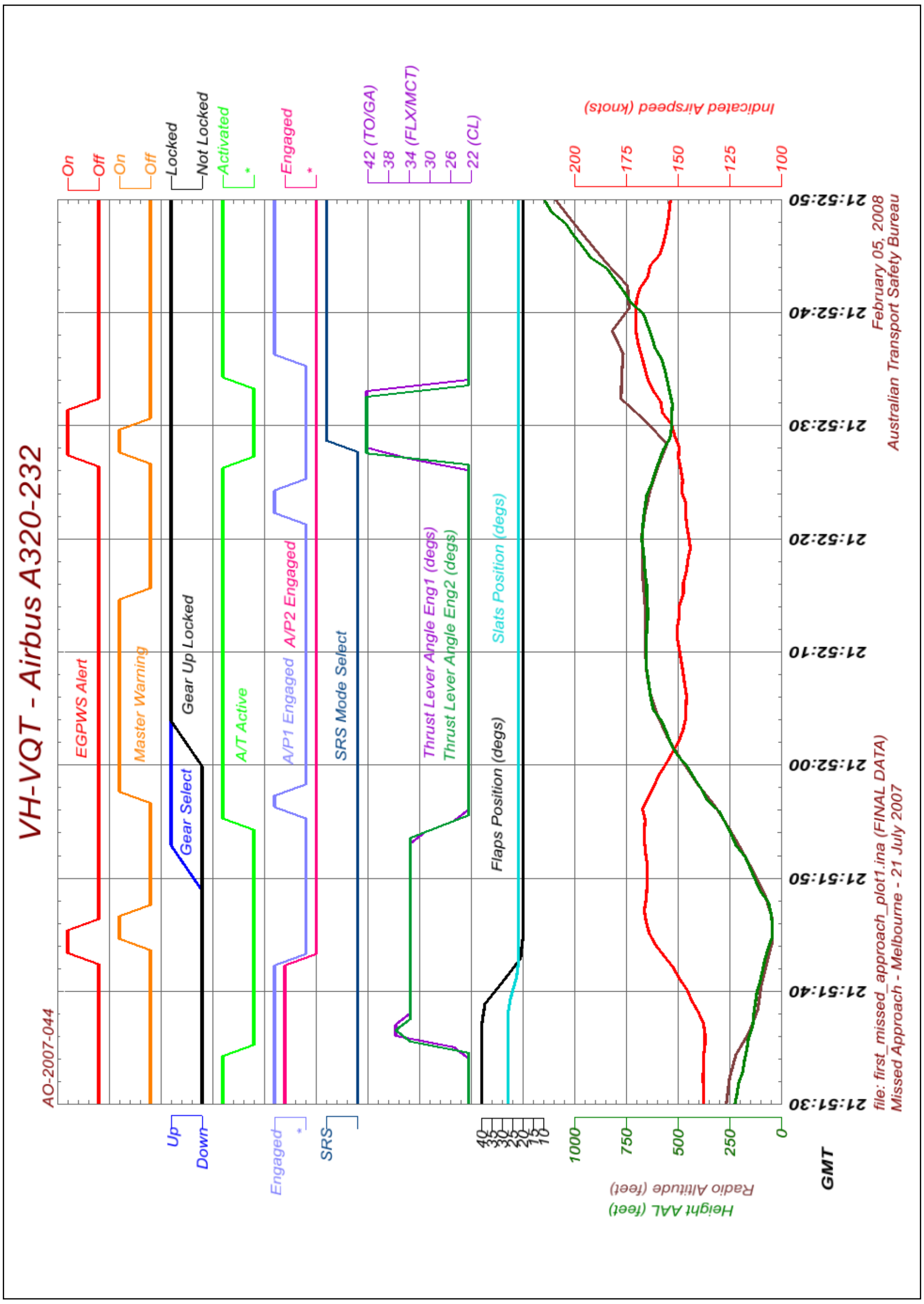
23 The FLX/MCT detent was at a thrust lever angle of 34°.

24 FLAP 3 positioned the flaps to 20° and the slats to 22°. The FULL position extended the flaps to 35° and the slats to 27°.

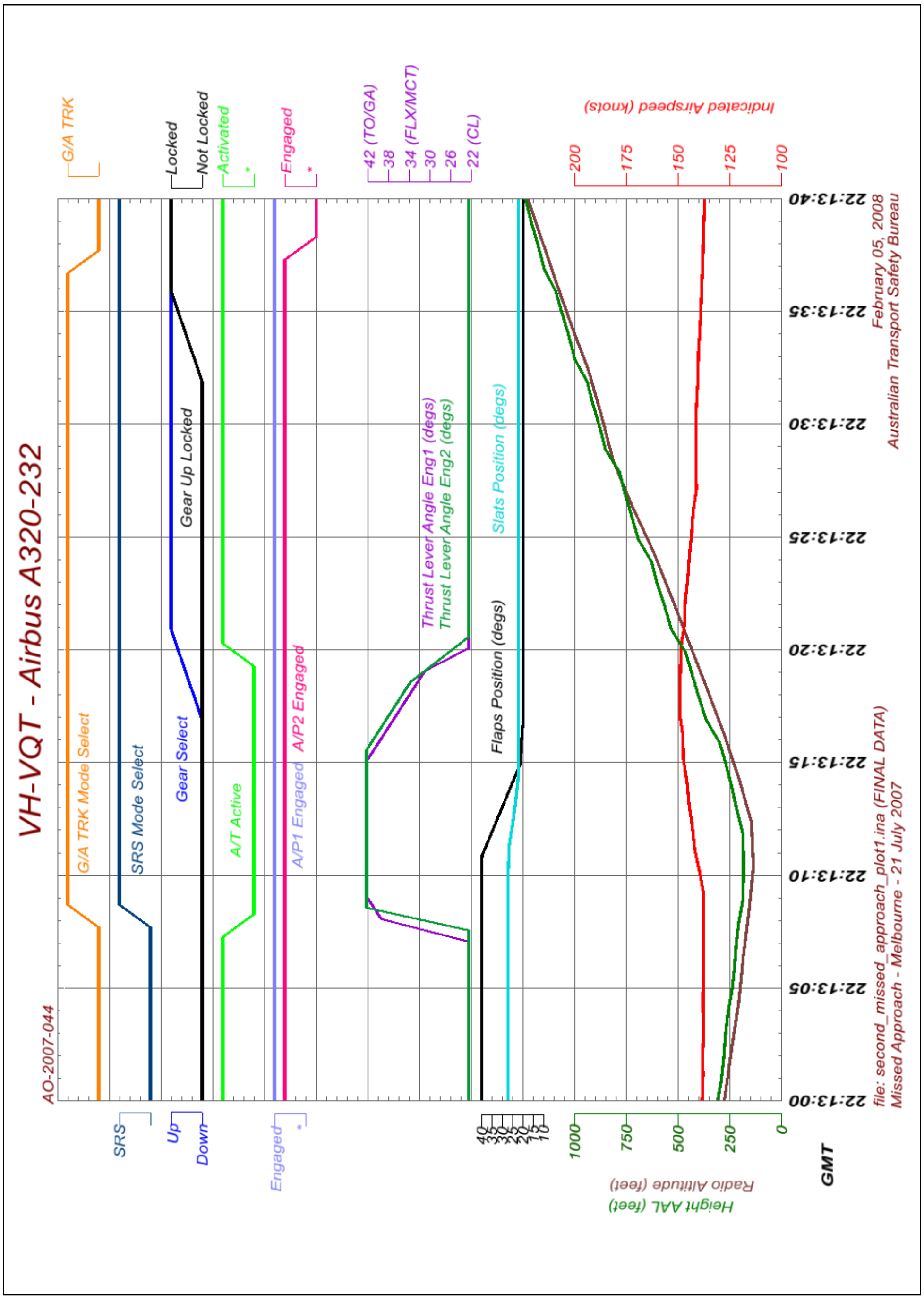
Figure 6: Graphical representation of a number of recorded parameters during the first missed approach



Second missed approach

Examination of the flight data for the second missed approach revealed that, at the commencement of the go-around, the thrust levers were moved to the TO/GA position and that the SRS and GA TRK modes engaged. Eleven seconds after the thrust levers were placed into the TO/GA detent, they were retarded to the CL detent, and the landing gear was selected up 2 seconds later. There were no recorded alerts or warnings during the missed approach. A number of recorded parameters relating to the second missed approach are shown at Figure 7.

Figure 7: Graphical representation of a number of recorded parameters during second missed approach



Human factors aspects

Aircraft automated systems

Modern air transport aircraft are highly automated. This has led to significant increases in aviation safety. However, at times, the interaction between flight crew and automated aircraft systems can present problems. Over two decades ago, Wiener (1989) described the concept of 'automation surprise', where the reaction of flight crews to the unexpected actions of an automated aircraft system was, at times; 'What is it doing? Why did it do that? What will it do next?' (Sarter and Woods, 1995; Sarter, 2008). Aviation safety occurrence reports worldwide indicate that such problems still occur in air transport aircraft today.

Mode awareness

One aspect common to many automated systems is their ability to function in different operating modes; for example, different modes for the management of the vertical or lateral navigation of an aircraft. In such situations, the safe operation of the aircraft depends on the flight crew maintaining an accurate awareness of the operating modes of the automated system. That is, they must maintain 'mode awareness' at all times. Pilots must now fly the aircraft safely, navigate, communicate and manage systems.

A lack of mode awareness was considered to have been a contributing factor in a number of air transport aircraft accidents in the 1980s and 1990s (Ladkin, 2008). More recently, accidents and incidents in a number of countries have occurred, in part, because the crew had a poor understanding of the operation of the aircraft's automated flight control systems. Those include: an A320 overspeed during descent to Malaga, Spain, in April 2004; a Boeing Company B737 'controlled flight into terrain only marginally avoided' serious incident during a go-around at Knock, Ireland, in March 2006; and the crash of an A320 during a go-around at Sochi, Russia, in May 2006 (for additional information on these occurrences, see Appendix A).

Efforts to reduce the likelihood of air safety occurrences involving a lack of mode awareness have focused on system design and flight crew training (US Federal Aviation Administration (FAA), 1996). Evidence suggests that pilots develop much of their understanding of their aircraft's automated systems during line flying and that, even after 18 months of experience on an aircraft type, their mental model of how complex modes operate may still be changing (Hutchins, 2007).

Crew training in the use of automated flight control systems

Shortcomings in pilot training in the use of automated flight control systems has been a recurring, worldwide trend over many years.

The 1996 FAA report *The interface between flightcrews and modern flight deck systems* stated:

> The HF Team is very concerned about both the quality and the quantity of automation training flightcrews receive. *(FAA, 1996, p 33).*

The 1998 Bureau of Air Safety Investigation *Advanced Technology Aircraft Safety Survey Report* stated:

> Some pilots perceived that the quantity and quality of training they received for their current aircraft was inadequate. Pilots also commented on the experience and qualification of instructional staff. Training, and hence safety, could be enhanced by airline operators ensuring staff (ground, simulator and flight instructors) are trained in appropriate educational techniques. *(BASI, 1998, p 93).*

The 2004 UK Civil Aviation Authority *Flight crew reliance on automation* report stated:

> ... pilots lack the right type of knowledge to deal with control of the flight path using automation in normal and non-normal situations.... The current level of training does not adequately prepare crews to recognise or deal with all situations that might arise. *(CAA, 2004, p 3-2 and p 4-3).*

Safety Management Systems

At the time of this occurrence, there was no legislated requirement for the aircraft operator to have a formal safety management system (SMS). However, the operator had implemented such a system for its operation and had produced an SMS manual that was part of its Operations Manual[25].

The operator's SMS did not require a formal risk management process to be undertaken for a number of activities, including in the case of changes to company operating policies or procedures.

[25] Civil Aviation Regulations (1988) Regulation 215 required that an operator provide an operations manual for the guidance of its personnel. Regulation 215 (9) required that personnel must comply with instructions contained within an operations manual.

ANALYSIS

Introduction

During an approach to Melbourne Airport, Victoria in instrument meteorological conditions, the flight crew did not have the required visual reference at the missed approach point and commenced a missed approach (go-around). The pilot in command (PIC) did not move the thrust levers to the correct position to allow the aircraft flight mode to correctly transition to the go-around phase. That led to crew confusion, which was compounded by alerts and warnings that distracted them; the end result was a higher-than-normal and unexpected workload, and the crew being unaware of the aircraft's current flight mode. The aircraft was not in the correct flight mode for a period of 48 seconds and during that time, reached a minimum recorded height of 38 ft above the runway. Subsequently, the PIC moved the thrust levers to the correct position, the flight mode transitioned to the go-around phase and the aircraft responded normally.

A subsequent examination of the aircraft's automated systems indicated that there were no system faults or anomalies that may have contributed to the event.

The following analysis will examine the circumstances of the occurrence from the viewpoint of how a flight crew can become 'mode unaware' while conducting what could be considered to be a relatively routine manoeuvre. It will also highlight the risk of an aircraft operator making a change to a standard operating procedure without ensuring that the intent and validity of the procedure remained intact under all conditions. Finally, a number of shortcomings in training methods will be examined, and the need for personnel at all levels of an organisation to abide by safety management system (SMS) principles will be highlighted.

Individual actions

The flight crew adequately and correctly briefed for the approach, including on the potential for a missed approach (go-around) at the decision height for the approach. The briefing did not specifically include a reference to reducing power after the initial application of take-off/go-around (TO/GA) thrust.

During the first missed approach, the PIC moved the thrust levers forward to what he thought was the TO/GA position; however, the levers were moved to just forward of the flexible-maximum continuous thrust (FLX/MCT) position. When the landing gear was commanded to be raised, the PIC moved the thrust levers back to the climb (CL) detent, as if conducting a missed approach with an early reduction of thrust. This was one of the operator's standard operating procedures (SOP) to which the 'TOGA tap' could be applied.

There was, however, no confirmation from the aircraft's flight mode annunciator (FMA) that the thrust levers had reached the TO/GA position before they were retarded to the CL detent. The movement of the thrust levers to the TO/GA position was essential to transition the aircraft flight mode computers to the vertical and horizontal flight modes necessary for a go-around and initial climb. Correspondingly, an announcement by the flight crew to confirm that the required mode transition had been achieved was included in the aircraft manufacturer's go-around SOP, to ensure that A320 crews maintain mode awareness.

The copilot responded to the 'go-around' command from the PIC and commenced the actions as required by the operator's SOP. That included raising the flaps one stage and monitoring the aircraft's rate of climb. The reported distractions and increased workload possibly contributed to the copilot's momentary inability to recall the required announcement in the case of a continuing descent, with the result that the go-around procedure did not progress at the point of the 'positive climb' call.

Following the initial movement of the thrust levers, neither of the flight crew identified the aircraft's actual flight mode. The announcement of the FMA status was an item that the aircraft manufacturer had included in the early part of its go-around SOP, in order to ensure crews' awareness of the aircraft's flight mode. As there were three simultaneous changes to the aircraft's flight mode during a go-around (thrust setting, vertical and lateral guidance modes), this announcement was pivotal in ensuring flight crew awareness of any changes in their aircraft's flight modes. The change to the go-around procedure that had been made by the aircraft operator, to move the order of that announcement from the third to the ninth item, meant that its crews' flight mode awareness could be lost, as the majority of the procedure had to be performed, without error or delay, before the crew got to the item that confirmed the flight mode status of the aircraft.

Mode awareness of the flight crew

The first instrument landing system approach was carried out with the autopilot and auto-thrust systems engaged. The relevant autoflight systems were engaged in the 'localiser' and 'glideslope' modes respectively, and the thrust levers were in the CL detent.

The intent by the PIC to carry out a TOGA tap procedure ought normally to have meant that the thrust levers were momentarily moved from the CL detent to the TO/GA detent, and then back again. However, in this instance, their movement to slightly beyond the FLX/MCT detent meant that the aircraft's automated systems did not make the mode transitions that were anticipated by the flight crew. In particular, the vertical navigation mode did not transition from 'glideslope' to 'speed-reference-system'.

Approximately 48 seconds elapsed from the time that the PIC performed what was intended as a TOGA tap, with the intention of initiating a go-around, until the PIC again advanced the thrust levers; this time to the full extent necessary to reach the TO/GA detent, and hence engage the speed-reference-system vertical mode. The effect on the flight crew's performance during that time of the unexpected warnings, increased workload as a result of the unanticipated change in aircraft performance, and emphasis by both pilots to confirm the position of the aircraft's controls, could not be quantified. However, neither the PIC nor the copilot confirmed the aircraft's flight mode and, in the first 8 seconds of that period, the aircraft gained airspeed and continued to descend to within 38 ft of the ground.

The revision by the aircraft operator of its go-around procedure meant that the crew never reached the 'announce FMA' item, and hence were not prompted to confirm the aircraft's flight modes. If the manufacturer's original go-around procedure had been in use, the crew would have been prompted to check the selected flight mode immediately after the rotation of the aircraft to the required pitch attitude.

In addition, the flight crew received two specific indications that had the potential to alert them as to the nature of the event. The first indication was the configuration warning that they received when they raised the landing gear. However, the flight crew did not discern the underlying reason for that warning. In essence, the aircraft's automated system was querying why the aircraft was apparently still going to land, and yet the landing gear had been retracted. The crew reported that they found the configuration warning, and the associated master caution, very distracting. They attempted to silence the warning, but had difficulty doing so. That would have increased their level of stress and distraction. In addition, the PIC was focussed largely on responding to the increasing speed of the aircraft and the co-pilot was re-checking the position of the landing gear and flaps. All of these factors made it harder for the crew to quickly and accurately assess their situation.

The degree of stress and distraction experienced by the crew was evidenced by the fact that, while two enhanced ground proximity warning system (EGPWS) alerts were generated during the incident, both crew members reported hearing only one alert, and each recalled hearing a different one. This apparent lack of perception of both warning system alerts is symptomatic of the degree of narrowly-focussed attention that can occur during times of stress and high workload.

The second specific indication to the flight crew of the nature of the event was the fact that the aircraft pitched down when the autopilot was reengaged. In this case, the PIC did recognise the underlying reason for the aircraft's response – being that the glideslope vertical navigation mode was engaged. Once the PIC reacted to move the thrust levers to the TO/GA position, engaging the speed-reference-system mode, the aircraft was correctly configured for the go-around, and responded accordingly.

Local conditions

Neither the PIC's nor the copilot's training or experience, when coupled with the unexpected distractions and workload during the event, enabled them to quickly diagnose the situation during the early part of the first missed approach. For a period of approximately 48 seconds, they were uncertain as to what the automated flight control system of the aircraft was doing, or why.

Both crewmembers had completed their endorsement training with the same third party training provider and had been checked to the line by the operator. They had also undergone recurrent simulator checks as part of the operator's normal training program. During their initial endorsement training, both pilots were trained to the go-around procedures as specified by the aircraft manufacturer. Subsequently, they underwent a course of transition training to learn the procedures and calls specific to the aircraft operator. The risk with such a separation of training into 'endorsement' and 'post-endorsement' components, with each being provided by different organisations, was that techniques or procedures may either be overlooked, or taught differently by the respective organisations. As a result, trainees could be required to unlearn some of their newly-acquired knowledge or, when under pressure, the possibility exists that crews could revert to previously or first-learned techniques and knowledge.

Despite the level of training and checking of flight crew, the existence of the unapproved and generally misunderstood 'TOGA tap' meant that flight crews could apply a procedure in a situation where it was inappropriate. The investigation found that there were three occasions when the employment of the TOGA tap may have been considered appropriate by flight crews; in accordance with the note in the standard operating procedure for a go-around, when conducting a go-around from an intermediate altitude, or to prevent over-speeding the flaps. In terms of exposure therefore, the risk to the operator of the existence of an informal procedure, including the potential for its inappropriate use, was elevated.

Evidence from a range of studies worldwide indicates that shortcomings in flight crew training associated with the operation of aircraft automated flight control systems is of ongoing concern. Accidents and incidents where the flight crew have a poor understanding of the operation of the automated systems continue to occur (Appendix A).

Proposed Civil Aviation Safety Regulation Part 142

The draft Civil Aviation Safety Authority (CASA) Civil Aviation Safety Regulation (CASR) Part 142 Training and Checking Operators proposes that third party training organisations that provide training, either independently to individuals or in concert with aircraft operators, must be responsible for the training they provide. In instances where flight crew training is provided to aircraft operators, a shared responsibility between the third party training provider and the aircraft operator would exist.

Although a Notice of Proposed Rule Making (NPRM) in respect of CASR Part 142 was issued on 22 July 2003, it had not been enacted at the time of finalising this report. The regulatory framework has not, therefore, been updated to reflect the roles and responsibilities of third party training organisations when they act on behalf of aircraft operators. Third party training providers have been established in training relationships with aircraft operators for many years. However, the provision of contracted third party training to operators has not been subject to direct regulation.

CASA advised the Australian Transport Safety Bureau (ATSB) that civil aviation legislation governing an operator’s responsibilities in relation to the maintenance of flight standards specified that an operator could not devolve its responsibilities with regard to flight standards. Until this framework is updated, the responsibility for oversight of training provided by third party training organisations remains with the individual AOC holder who has contracted the third party organisation to provide the training.

As the aviation industry is increasingly using third party training providers to provide training for aircraft operators, it is becoming increasingly important that proposed requirements under CASR Part 142 be introduced as a priority.

Risk controls

A standard operating procedure is a form of risk control, and considerable deliberation goes into its construction. Its design must take into account a range of factors, including the operational logic of the task at hand, as well as aspects related to human performance.

Any change to a procedure may subsequently produce unforseen and undesirable consequences. Those consequences may only come to light when a particular combination of events or circumstances occurs. The change that the operator made to the their go-around procedure was a case in point.

All other things being equal, the further down the order of a procedure an item appears, the greater will be the chance of the item not being performed at the appropriate time. This is because there is an increased chance for interruptions and distractions to occur, all of which have the potential to interfere with the sequence of the procedure. Therefore, within operational constraints, critical items should be placed as near as possible to the top of the procedure (Degani and Wiener, 1990).

The aircraft manufacturer developed the go-around procedure with the requirement for an announcement of the aircraft's flight mode status early in the procedure, ensuring flight crews' awareness of their aircraft's flight mode status before any further change in their aircraft's configuration.When the operator moved the requirement for a crew member to check and call out the FMA status from item three of the go-around procedure to item nine, the potential for the item to be delayed or not actioned was increased. If the operator's procedure was interrupted at any point before the later flight mode announcement, the possibility of alerting the crew of an incorrect flight mode was lost.

In this occurrence, the go-around procedure effectively came to a halt early in the procedure, and the crew was distracted from the remainder of the actions by a later unexpected warning. The end result was that the crew never reached the appropriate point in the operator's changed go-around procedure to confirm the aircraft's flight mode during the initial part of the first missed approach.

Had the operator conducted a risk assessment of the change to the go-around standard operating procedure, it may have identified the issues that underpinned the proposed move of this important checklist item to later in the procedure, which ultimately led to the unintended safety consequences in this occurrence.

Also, when modifying the standard operating procedure, the aircraft operator did not indicate the corrected revision number so that flight crew could readily identify the current version. Although the crew in this occurrence used the current version of the procedure, the existence of an incorrect revision number could result in crews not being aware of changed procedures and applying superceded procedures during normal operations.

Incident notification

It was likely that the operator, as a responsible person in accordance with the Transport Safety Investigation Regulations 2003 (TSI Regulations – available at www.atsb.gov.au), felt that it had satisfied its occurrence reporting obligations under the *Transport Safety Investigation Act 2003* (TSI Act) upon its initial notification on 26 July 2007. However, the TSI Act specifically indicates that, once a person had knowledge of an immediately reportable or routinely reportable matter, they must report that matter within the timeframes indicated in the TSI Act. The reporting requirements in the operator's SMS were consistent with those in the TSI Act.

Although not known to have occurred by the operator at the time of the initial incident report to the ATSB, the EGPWS alerts that were found by the operator's internal investigation to have occurred during the go-around, should have prompted a written report by the operator to the ATSB within 72 hours of the operator becoming aware of those alerts. The written report could also have been expected to have included the additional circumstances of the incident that had, in the interim, been ascertained by the operator's investigation. No written report was received by the ATSB in that timeframe, with the effect that the decision to not investigate remained extant. It was only when the ATSB was alerted by media reports of the potentially serious nature of the occurrence that sufficient information become available from the aircraft operator on which the ATSB could determine the need for a formal investigation under the TSI Act. The delay in the initiation of an ATSB investigation may have the potential to deny opportunities for safety lessons to be learnt and associated safety action to be taken in a timely fashion to prevent recurrence.

The enhancement of transport safety is a shared responsibility between the ATSB and all elements of the aviation industry. The reporting requirements of the operator's SMS, although not met in this case, confirmed that shared responsibility.

Regulation 2.6 of the TSI Regulations outlines the information that should be included in any written occurrence report, to the extent that the person reporting has that information to hand. The completion of the Accident and Incident Notification Form, either online at www.atsb.gov.au or via letter or facsimile, will ensure the submission of comprehensive reports by responsible persons.

The ATSB investigation found no evidence that the failure of the operator to provide a comprehensive written report was a deliberate act. The operator's SMS, as part of the operations manual, provided clear instructions on what was to be reported to external agencies, and that the decision to commence an internal investigation was to be made at a senior level within the operator's management. Compliance by the operator's senior management with the requirements of the TSI Act and with the operator's SMS would have meant that knowledge of the EGPWS alerts during the occurrence would have been reported to the ATSB when they first became known during the operator's internal investigation.

The delay in the initiation of this investigation highlighted the importance of the timely, comprehensive reporting of all relevant information relating to accidents and incidents.

FINDINGS

From the evidence available, the following findings are made with respect to the go-around event at Melbourne Airport, Victoria on 21 July 2007 involving Airbus Industrie A320 aircraft, registered VH-VQT, and should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing safety factors

- The pilot in command did not correctly move the thrust levers to the take-off/go-around position when carrying out the first missed approach procedure.
- The aircraft operator had changed the standard operating procedure for the go-around. The change resulted in the flight crew being unaware of the flight mode status of the aircraft during the first part of the first missed approach. *[Significant Safety Issue]*

Other safety factors

- The aircraft operator did not conduct a risk analysis when changing the go-around procedure, nor did its safety management system require one to be conducted. *[Significant Safety Issue]*
- Flight crew undergoing initial endorsement training with the third party training provider were not trained until later to the procedures and systems used by the operator. *[Minor Safety issue]*
- The aircraft operator did not comply with accepted document change procedures when modifying the standard operating procedure for the go-around. *[Minor Safety Issue]*
- There was no provision in the current CASA Regulations or Orders for third party flight crew training providers. As such,the responsibility for training outcomes were unclear. *[Minor Safety issue]*

Other key findings

- The aircraft operator did not comply with the incident reporting requirements of its safety management system, which was part of its operations manual, or with the reporting requirements of the *Transport Safety Investigation Act 2003*.

SAFETY ACTION

The safety issues identified during this investigation are listed in the Findings and Safety Actions sections of this report. The Australian Transport Safety Bureau (ATSB) expects that all safety issues identified by the investigation should be addressed by the relevant organisation(s). In addressing those issues, the ATSB prefers to encourage relevant organisation(s) to proactively initiate safety action, rather than to issue formal safety recommendations or safety advisory notices.

All of the responsible organisations for the safety issues identified during this investigation were given a draft report and invited to provide submissions. As part of that process, each organisation was asked to communicate what safety actions, if any, they had carried out or were planning to carry out in relation to each safety issue relevant to their organisation.

Aircraft operator

Change to go-around procedure

Safety issue

The aircraft operator had changed the standard operating procedure for the go-around. The change resulted in the flight crew being unaware of the flight mode status of the aircraft during the first part of the first missed approach.

Action taken by/response from operator

The operator has advised that the standard operating procedure for a go-around has been modified in line with the procedure promulgated by the aircraft manufacturer.

ATSB assessment of response/action

The ATSB is satisfied that the action taken by the aircraft operator adequately addresses the safety issue.

Changes between initial endorsement and recurrent training

Safety issue

Flight crew undergoing initial endorsement training with the third party training provider were not trained to the procedures and systems used by the operator.

Action taken by/response from operator

The operator has reported that it is conducting a review of existing flight training arrangements.

ATSB assessment of response/action

The ATSB is satisfied that the action proposed by the aircraft operator will adequately address the safety issue.

Inadequate document change procedures

Safety issue

The aircraft operator did not comply with accepted document change procedures when modifying the standard operating procedure for the go-around.

Action taken by/response from operator

The operator has implemented changes to its document control procedure to indicate when specific operator initiated changes to procedures are made.

ATSB assessment of response/action

The ATSB is satisfied that the action taken by the aircraft operator adequately addresses the safety issue.

Incident reporting requirements not followed

Although a safety issue was not identified in respect of the reporting of this incident, the aircraft operator has revised the content of the operator’s safety management system that deals with occurrence reporting.

Risk analysis not conducted

Safety issue

The aircraft operator did not conduct a risk analysis when changing the go-around procedure, nor did its safety management system require one to be conducted.

Action taken by/response from operator

The operator has introduced a change to the safety management system such that any change to an aircraft operating procedure requires the completion of a formal risk analysis prior to that change being implemented.

ATSB assessment of response/action

The ATSB is satisfied that the action taken by the aircraft operator adequately addresses the safety issue.

ATSB safety advisory notice AO-2007-044-SAN 109

This incident highlights the potential for unintended consequences when changes to standard operating procedures are introduced without first conducting an appropriate risk analysis. Therefore, the ATSB advises that all aircraft operators should consider the safety implications of this safety issue and take action where considered appropriate.

Aircraft manufacturer

Change to go-around procedure

Safety issue

The aircraft operator had changed the standard operating procedure for the go-around. The change resulted in the flight crew being unaware of the flight mode status of the aircraft during the first part of the first missed approach.

Action taken by the aircraft manufacturer

Although this safety issue arose out of a change that was made to the go-around procedure by the aircraft operator, as a result of this occurrence, the aircraft manufacturer consulted with the aircraft operator. Following that consultation, the aircraft manufacturer revised the go-around procedure within the manufacturer's Flight Crew Operating Manual. The aim of that revision was to emphasise the critical nature of the actions by flight crew during a go-around. The revised go-around procedure is at Figure 8.

ATSB assessment of response/action

The ATSB is satisfied that the action taken by the aircraft manufacturer adequately addresses the safety issue.

Figure 8 – Revised go-around procedure[26]

A318/A319/A320/A321 FLIGHT CREW OPERATING MANUAL	STANDARD OPERATING PROCEDURES GO AROUND	3.03.23 SEQ 001	P 1 REV 42

GO AROUND WITH FD ON

Apply the following three actions simultaneously :

– **THRUST LEVERS** . . . . **TOGA**

R **ROTATION** . . . . **PERFORM**
R · Rotate the aircraft to get a positive rate of climb, and establish the required pitch
R attitude, as directed by the SRS pitch command bar.

R – **GO AROUND** . . . . **ANNOUNCE**

R – **FMA** . . . . **CHECK AND ANNOUNCE**
R Check the FMA on the PFD. The following modes are displayed : MAN TOGA / SRS / GA
R TRK / A/THR (in blue).

R – **FLAPS** . . . . **RETRACT ONE STEP**

R – **POSITIVE CLIMB** . . . . **ANNOUNCE**

R – **LDG GEAR** . . . . **SELECT UP**

– **NAV or HDG mode** . . . . **SELECT**
Reselect NAV or HDG, as required (minimum height 100 feet).

Note : Go-around may be flown with both autopilots engaged. Whenever any other mode engages, AP 2 disengages.

● **At go-around thrust reduction altitude (CLB or LVR CLB flashing on FMA) :**

– **THRUST LEVERS** . . . . **CL**

Civil Aviation Safety Authority

Proposed CASR Part 142

Safety issue

There was no provision in the current CASA Regulations or Orders for third party flight crew training providers. As such, the responsibility for training outcomes was unclear.

26 The letter ‘R’ in the left column denotes a manufacturer initiated revision to the procedure.

Action taken by CASA

CASA has advised the ATSB that the proposed CASR Part 142 is under review as a matter of priority and has now been progressed to the Office of Legislative Drafting and Publishing.

ATSB assessment of response/action

The action taken by CASA appears to adequately address the safety issue.

APPENDIX A: PREVIOUS INCIDENTS

Previous incidents involving lack of awareness of the status of automated flight control systems

Airbus A320-232 aircraft G-TTOA, near Malaga, Spain, on 15 April 2004

The aircraft was on descent to Malaga Airport, Spain. However, because the crew misunderstood the state and operation of the aircraft's automated flight control systems, the aircraft's speed during the descent approached V_{MO} (maximum operating speed), with the speed trend arrow indicating a continued acceleration to a speed well above V_{MO}. The autopilot was disconnected and both pilots simultaneously applied aft stick in an attempt to prevent an overspeed. This combined input resulted in the aircraft experiencing a force of 2g, and three of the cabin crew were injured.

The UK Air Accidents Investigation Branch Report (12-2004) is available at http://www.aaib.gov.uk/cms_resources/dft_avsafety_pdf_033318.pdf

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Boeing B737-800 aircraft EI-DHX, at Ireland West Airport, Knock, Ireland, on 23 March 2006

The aircraft was on a flight from London Gatwick Airport to Ireland West Airport. The crew lacked familiarity with the automated flight control system of the aircraft, and became engrossed in trying to enter data into the system. A change in landing runway increased the crews' workload and resulted in the aircraft being high and fast on the glideslope. During the approach the aircraft was incorrectly configured, including the non deployment of flaps, landing gear, and speed brakes. When the aircraft broke clear of cloud at about 410 ft, the pilot-in-command disengaged the autopilot and commenced a go-around. At the same time the Enhanced Ground Proximity Warning System sounded. The occurrence was a 'Serious Incident' as defined in ICAO Annex 13; in particular, a 'controlled flight into terrain only marginally avoided'.

The Irish Air Accident Investigation Unit Report (2006-028) is available at http://www.aaiu.ie/upload/general/8545-0.pdf

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Airbus A320-211 aircraft EK-32009, near Sochi Airport, Russia, on 3 May 2006

The aircraft was on a flight from Yerevan, Armenia, to Sochi, Russia. During the descent to Sochi, the aircraft's automated flight control system did not operate as the captain expected, due to a misunderstanding of how the selected vertical navigation mode functioned. Subsequently, air traffic control instructed the crew to discontinue the approach due to the weather. In responding, the crew made an apparently unintentional input to the automated flight control system, again resulting in the system acting in a way that they did not expect. The autopilot was then disengaged, probably because the crew doubted that it was functioning correctly. While performing the go-around climb with the autopilot disengaged, the captain became disoriented and made nose down control inputs. The crew did not adequately monitor the flight path of the aircraft, or respond appropriately to a subsequent EGPWS warning. The aircraft struck the water and was destroyed, with the loss of all 8 crew and 105 passengers onboard.

The Russian Air Accident Investigation Commission report is available at http://www.bea.aero/docspa/2006/ek-9060502/pdf/ek-9060502.pdf

APPENDIX B: SOURCES AND SUBMISSIONS

Sources of Information

The sources of information during the investigation included:

- the flight crew of VH-VQT
- the aircraft operator
- the aircraft manufacturer
- recorded flight and other data.

References

BASI (1998). *Advanced technology aircraft safety survey report*. Bureau of Air Safety Investigation. Canberra, ACT.

CAA (2004). *Flight crew reliance on automation*. UK Civil Aviation Authority Paper 2004/10. Gatwick, UK.

Degani A, and Wiener EL (1990). *Human factors of flight-deck checklists: The normal checklist*. Contractor Report 177549. NASA Ames Research Center, Moffett Field, CA.

FAA (1996). *The interface between flightcrews and modern flight deck systems*. US Federal Aviation Administration Human Factors Team Report. Washington, DC.

Hutchins E (2007). *Measuring change in pilots' conceptual understanding of autoflight*. In Proceedings of the 14th International Symposium on Aviation Psychology (ISAP 2007), p 475-480. Dayton, OH.

Ladkin PB (2008). *Computer-related incidents with commercial aircraft,* http://www.rvs.uni-bielefeld.de/publications/compendium, accessed 1 December 2008.

Sarter NB (2008). *Investigating mode errors on automated flight decks: Illustrating the problem-driven, cumulative, and interdisciplinary nature of human factors research*. Human Factors, 50, pp 506-510.

Sarter NB and Woods DD (1995). *How in the world did we ever get into that mode? Mode error and awareness in supervisory control*. Human Factors, 37, pp 5-19.

Wiener EL (1989). *Human factors of advanced technology ("glass cockpit") transport aircraft*. NASA Ames Research Center Technical Report 177528. Moffett Field, CA.

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, the aircraft manufacturer, the French Bureau d’Enquetes et d'Analyses pour la securite de l'aviation civile, and the Civil Aviation Safety Authority (CASA).

Submissions were received from the flight crew, the aircraft manufacturer, the aircraft operator and CASA. The submissions were reviewed and, where considered appropriate, the text of the report was amended accordingly.

APPENDIX C: MEDIA RELEASE

Mishandled air manoeuvre prompts changes to procedures

An aircraft operator has changed its operating procedures following a go-around during an attempted landing at Melbourne in July 2007. The aircraft manufacturer has also revised some of its procedures for the aircraft type.

An Airbus A320 passenger aircraft was attempting to land at Melbourne airport in fog, but abandoned the landing due to low visibility. During the go-around, the aircraft descended to within 38 feet of the ground before climbing.

An Australian Transport Safety Bureau (ATSB) investigation report, released today, found that the go-around did not work as intended due to:

- the incorrect positioning of the thrust levers for the aircraft's engines
- the flight crew being unaware of the aircraft's flight mode status during the first part of the missed approach because of the sequencing of the operator's flight procedures.

The ATSB investigation also found that reporting of the occurrence had not met the requirements of the *Transport Safety Investigation Act 2003*.

This incident has prompted the operator to change its go-around procedures and to ensure that a formal risk assessment is done for any changes to aircraft operating procedures. The ATSB has also issued a safety advisory notice to all aircraft operators reminding them of the importance of conducting risk assessments before changes to operating procedures are implemented.

The aircraft manufacturer has also changed its published procedures to emphasise some crucial flight crew actions in go-around manoeuvres.

The Chief Commissioner of the ATSB, Mr Martin Dolan, said that the investigation was a good example of how safety investigators could work with operators to improve transport safety.

'We can often learn as much or more from occurrences like this as we can from investigating tragic accidents,' Mr Dolan said.

'I would like to remind all transport operators that safety is a shared responsibility that relies, in part, on the timely reporting of accidents and incidents,' Mr Dolan added.

Full details of the incident and investigation can be found in the ATSB's investigation report (Report number AO-2007-044) on the ATSB's website at www.atsb.gov.au.

Go-around event Melbourne Airport, Victoria 21 July 2007
VH-VQT, Airbus Industrie A320-232