Australian Government
Australian Transport Safety Bureau

Flap overspeed and altitude exceedance during go-around Airbus A321, VH-VWY

Cairns Airport, Queensland | 3 September 2012

Investigation

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Addendum

Page	Change	Date

Safety summary

What happened

On 3 September 2012, an Airbus A321, registered VH-VWY and being operated by Jetstar Airways, was being flown on a scheduled passenger flight from Melbourne, Victoria to Cairns, Queensland. During a visual approach to runway 15 at Cairns, the aircraft drifted slightly high on profile and the captain instructed the first officer, who was the pilot flying, to go around. During the go-around, the aircraft exceeded the flap limit speed and climbed to 2,700 ft, exceeding the 2,000 ft limit assigned by air traffic control.

What the ATSB found

The ATSB found that the first officer had a low level of expectancy of, and was not mentally prepared for, a go-around. Although the initial steps in the go-around procedure were implemented effectively, the first officer’s attention focussed on airspeed management and they did not retard the thrust levers from the take-off go-around detent to the climb detent at an appropriate point during the go-around. Consequently, the aircraft’s auto-thrust system was not activated to reduce the amount of thrust. After the initial breakdown in applying the go-around procedure, the crew experienced a high workload, which significantly limited their capacity to resolve the situation.

The ATSB found that this occurrence had similar features to many previous go-around occurrences. In summary, all-engine go-arounds in modern air transport aircraft are often a challenging task when there is a requirement to level-off at a low altitude, and many pilots have had limited preparation for such tasks.

What's been done as a result

Following this and a number of related occurrences, Jetstar Airways included ‘unscripted’ go-arounds in its recurrent training sessions. One of these sessions also emphasised the importance of moving the thrust levers to the climb detent without delay.

In August 2013, as a result of a detailed review of similar go-around occurrences, the French Bureau d’Enquêtes et d’Analyses pour la sécurité de l’aviation civile (BEA) issued a series of recommendations about go-around issues to the European Aviation Safety Agency.

Safety message

A go-around with all aircraft systems available to the crew is a normal but infrequently flown, dynamic manoeuvre, requiring a very methodical series of actions on the part of the flight crew, at relatively high tempo, particularly when level-off at a low altitude is planned. This occurrence serves as a reminder of the importance of being mentally prepared to conduct a go-around, even in fine conditions.

Contents

The occurrence

Descent and approach to Cairns

On 3 September 2012, an Airbus A321-231 (A321), registered VH-VWY and operated by Jetstar Airways, was being flown on a scheduled passenger flight from Melbourne, Victoria to Cairns, Queensland. The first officer was the pilot flying. [1]

Air traffic control (ATC) cleared the crew to make a visual arrival to runway 15 at Cairns using the Noise Abatement Procedure, tracking via waypoint BENJI and the Creek Corridor. During the arrival briefing, the crew noted that the first officer had not conducted this arrival procedure into Cairns before but had prepared for the task.

At about 0900 Eastern Standard Time (EST)[2] the crew commenced the descent. Weather conditions at the time of the approach were fine with about a 10 kt southerly breeze, visibility greater than 10 km, and light cloud cover with a base of 3,000 ft above the airport.

Approaching 3,600 ft on descent, the crew selected 1,500 ft on the aircraft's Flight Control Unit (FCU) altitude selector as the intended go-around altitude in the event that a go-around was required. The crew later reported that, given the fine conditions, they did not consider a go-around likely. As it was a visual approach, there was no published missed approach procedure and the crew did not discuss any go-around requirements in detail during the arrival briefing.

Initiation of the go-around

At 0921:57, while the aircraft was nearing 2,300 ft above mean sea level, the first officer disconnected the autopilot and commenced manually flying the approach to runway 15. At about 500 ft, the captain assessed that the aircraft was marginally high on the approach and instructed the first officer to go around. The captain later reported that the approach was 'nicely flown' but that the first officer unintentionally allowed the rate of descent to reduce during the later stages.

At 0924:44, the first officer commenced the go-around by advancing the thrust levers to the take-off go-around (TOGA) detent, announcing 'go-around' and rotating the aircraft to the go-around pitch attitude. The captain retracted one stage of flap by moving the flap lever from the full position to position 3. After a brief pause and a prompt by the captain, the first officer continued the go-around procedure by announcing the auto-flight system modes displayed on the Flight Mode Annunciator (FMA). The captain then announced that they had a positive climb. At 0924:58, the first officer engaged autopilot 2 and called for the landing gear to be retracted and the captain retracted the gear.

At 0925:01, as the aircraft climbed through about 700 ft, the auto-flight system vertical mode sequenced to the altitude capture mode (ALT*) to command capture of the selected altitude (1,500 ft). When ALT* engages in this situation, the autopilot lowers the aircraft's pitch attitude to commence the capture of the selected altitude, and with the thrust levers in the TOGA detent the aircraft will accelerate.

At 0925:04, the captain notified the tower controller of the go-around. The tower controller provided the crew with the option of flying either the missed approach procedure associated with

[1] Pilot Flying (PF) and Pilot Monitoring (PM) are procedurally assigned roles with specifically assigned duties at specific stages of a flight. The PF does most of the flying, except in defined circumstances; such as planning for descent, approach and landing. The PM carries out support duties and monitors the PF's actions and aircraft flight path.

[2] Eastern Standard Time was Coordinated Universal Time (UTC) + 10 hours.

the Instrument Landing System (ILS)[3] approach to runway 15 or a visual left circuit.[4] The captain immediately indicated a preference for a visual left circuit, to which the tower controller responded with the clearance ‘make a left circuit, not above 2,000, visual’.

At 0925:11, the crew changed the auto-flight lateral mode from navigation (NAV) mode to heading (HDG) mode in preparation for the left turn. At that time, the aircraft was climbing through 1,100 ft. The airspeed was accelerating through 180 kt and approaching the published maximum airspeed for the flap setting (V_{FE}) of 195 kt.

Actions to manage airspeed during the go-around

The first officer later reported that events were happening quickly and they were concerned about the need for an early left turn. They also noticed the increasing airspeed and became focussed on trying to resolve the speed problem. At 0925:13, the first officer pulled the speed selector knob on the FCU to enable manual speed selection, but this action had no effect because the thrust levers were still in the TOGA detent and the engines continued to deliver TOGA thrust.

The correct procedural step to control aircraft acceleration at this point in the go-around was to retard the thrust levers to the climb (CL) detent, which would have re-activated the auto-thrust system and reduced engine thrust according to auto-flight system demands. After the ALT* mode engaged, a LVR CLB (see the section titled *Thrust, vertical and lateral auto-flight modes*) annunciation would have been flashing on the FMA, prompting the first officer to retard the thrust levers to the CL detent. However, the first officer reported being focussed on the speed at this stage, and not looking at the FMA.

The captain reported that, in response to the first officer’s attempt to control speed using the speed selector knob, they instructed the first officer to ‘pull the power back’, using these or similar words. However, the thrust levers remained in the TOGA detent. Soon after, from about 0925:19, the following actions were carried out:

- The first officer disconnected the autopilot and raised the aircraft’s pitch attitude in a further attempt to control the aircraft’s speed. As the autopilot was disconnected, the auto-flight system was no longer set to level the aircraft at 1,500 ft.
- The captain moved the flap lever from position 3 to position 2, which increased V_{FE} from 195 kt to 215 kt.
- The first officer momentarily retarded the thrust levers by a small amount, before resetting the thrust levers to the TOGA detent.
- The captain again instructed the first officer to ‘pull the power right back’, using these or similar words.

Airspeed and altitude exceedances

At 0925:30, as the airspeed reached 215 kt and the aircraft was approaching 1,800 ft, the first officer retarded the thrust levers to the flexible take-off/maximum continuous thrust (FLX/MCT) detent. Although this action reduced engine thrust, in this detent the thrust remained unresponsive to auto-flight system requirements.

At 0925:33, the captain read back the ATC instruction.[5] One second later, with the airspeed stabilised at just over 215 kt and the aircraft passing 2,000 ft, the overspeed warning system

[3] An Instrument Landing System approach is based upon vertical and lateral guidance to a published minimum height. If the required visual references are not established at the minimum height, the crew is required to conduct a missed approach procedure (often referred to as a ‘go-around’).

[4] The tower controller noticed that the crew had discontinued the approach prior to the captain contacting ATC, and they contacted the approach controller to ascertain go-around instructions. The approach controller provided a clearance for the ILS missed approach procedure, which requires a left turn onto a track of 015° and a climb to 3,700 ft.

activated, activating a master warning light and an aural warning chime.[6] At about this time the first officer commenced a gradual left turn.

From about 0925:36, the captain:

- selected the flap lever from position 2 to position 1, increasing V_{FE} to 235 kt and alleviating the overspeed condition
- took over control of the aircraft as pilot flying
- retarded the thrust levers to the CL detent, which re-activated the auto-thrust system and resulted in the auto-flight system commanding a reduction in engine thrust.

The aircraft's altitude peaked at about 2,700 ft at 0925:54, about 70 seconds after the first officer initiated the go-around. After the captain arrested the climb and descended the aircraft to 1,500 ft, aircraft control was handed back to the first officer to complete the visual circuit and landing.

During the go-around the flap limiting speed was exceeded by a maximum of 5 kt. A subsequent engineering inspection of the flap system revealed no damage. There were no other aircraft in the vicinity at the time of the go-around.

Figure 1 provides data from the aircraft's flight data recorder. Figure 2 provides information on the timing and duration of transmissions between the crew and the tower controller.

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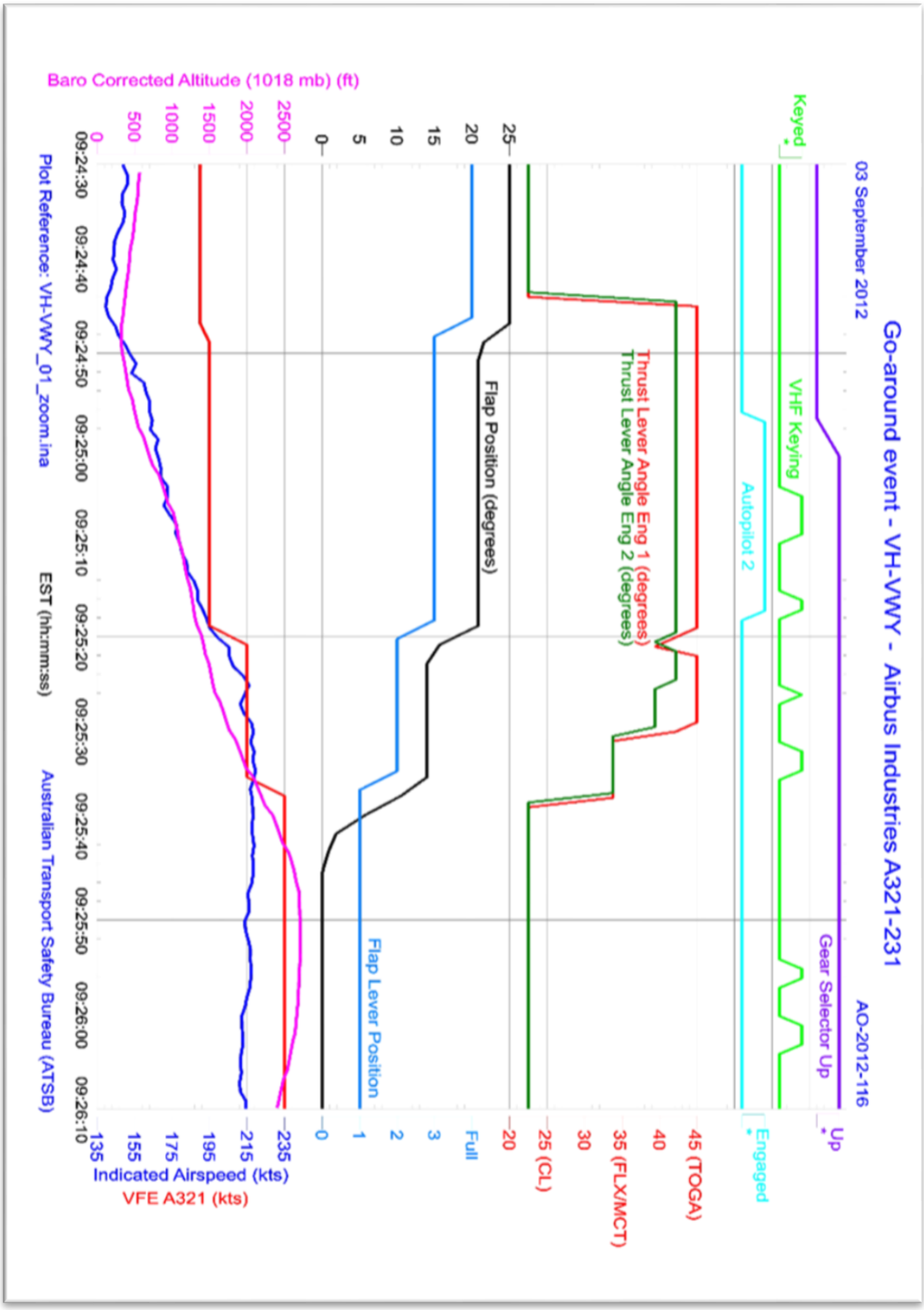
5 The readback was difficult to understand given a coincident transmission from another station. The aircraft radio was also keyed briefly at 0925:25, but there was no apparent voice transmission.

6 Consistent with its design, the overspeed warning did not activate until the aircraft speed reached about 219 kt, some 4 kt above the published flap limiting speed.

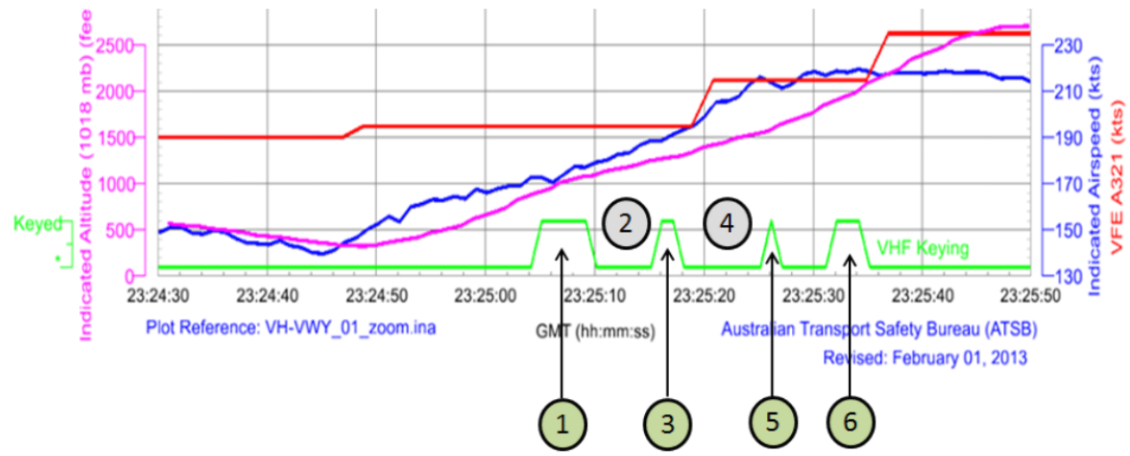
Figure 1: Selected flight parameters recorded during the go-around[7]



Source: ATSB

7 Other recorded data showed that both engines were operating at the same engine pressure ratio after the TOGA detent was selected. The apparent asymmetry in thrust lever angle, when both thrust levers were actually in the TOGA detent, is the result of limited data fidelity (limited to about 3°).

Figure 2: Flight crew-ATC communication during the go-around



Transmission number	Transmission by	Transmission content
1	Aircraft	Notifying ATC of go-around
2	ATC	Acknowledging go-around and asking PIC for intentions (published missed approach or visual left circuit)
3	Aircraft	Advising ATC of preference for a visual left circuit
4	ATC	Clearing PIC to conduct a visual left circuit (not above 2,000 ft)
5	Aircraft	Click only with no apparent voice transmission
6	Aircraft	Separate ATC internal communication at this time made aircraft transmission difficult to understand but the transmission sounds like a read-back of the ATC clearance

Source: ATSB

Context

Personnel information

Captain

The captain had flown for the operator for about 6 years and been a captain on Airbus A320/A321 aircraft since December 2010. They had over 10,000 hours total flying experience and almost 5,000 hours on A320/A321 aircraft. The captain's last recurrent training session (see the section titled *Go-around training*) was in August 2012, which included the conduct of go-arounds with all engines operative and with one engine inoperative.

The captain conducted a sequence of three overnight or late night duty periods that ended at 2320 on 30 August 2012. They were free of duty for the 3 days immediately prior to the occurrence flight and reported obtaining a normal (8-hour) sleep period during the first two nights. Although they had tried to get to sleep early the night before the occurrence flight, they had only been able to obtain 4 hours sleep before commencing duty at 0500. They reported feeling tired but fit for duty on the morning of the flight, and they had not experienced any recent illnesses.

First officer

The first officer obtained their A320 endorsement in October 2011 before commencing line training with the operator in November 2011 and line operations in January 2012. They also completed the operator's A321 'Differences Training' in June 2012. The first officer had about 5,000 hours total flying experience with about 400 hours on A320/A321 aircraft. They had flown as a second officer with another airline for 3 years prior to joining the operator, and also had experience flying twin-engine turboprop aircraft.

The first officer conducted many go-arounds during their A320 endorsement training. Line training records also showed that in January 2011 the first officer conducted a go-around as pilot flying following an unstable visual approach, and that the go-around was 'flown well'. The first officer completed a recurrent training session in March 2012, which included go-arounds with one-engine inoperative (once as pilot flying and once as pilot monitoring).

The first officer commented that they were comfortable with the go-around procedure, but that they had not been 'go-around' minded or considering a go-around during the approach into Cairns due to the in-flight conditions and the fact that the approach appeared to be progressing well. The first officer later commented that, as soon as the captain moved the thrust levers to the climb (CL) detent, they realised the nature of the problem and that they had only moved the thrust lever back one detent, instead of the two detents required to set CL.

The first officer completed no duty periods between 28 August and 1 September. On the day prior to the occurrence flight (2 September), they conducted two flights, commencing duty at about 0520 after a reported normal 8-hours sleep and completing duty at 1145. They recalled having 8 hours sleep over the afternoon and night before the occurrence flight and felt refreshed before commencing duty at 0500 that day.

Airport information

The elevation at the threshold of runway 15 at Cairns Airport is 10 ft. The airport has high terrain in all directions except to the north-east. A photograph taken from an aircraft on final approach to runway 15 at Cairns illustrates the nature of the terrain to the east-south-east (Figure 3).

To account for the surrounding terrain, the missed approach procedures for the instrument approaches to runway 15 required an early left turn to the north-east. In terms of go-arounds in visual meteorological conditions (VMC),[8] the Aeronautical Information Publication (AIP) Australia[9] stated that:

> In the event that an aircraft is required to go around from a visual approach in VMC, the aircraft must initially climb on runway track, remain visual and await instructions from ATC. If the aircraft can not clear obstacles on runway track, the aircraft may turn.[10]

As such, no specific missed approach procedure was published for the crew's visual approach into Cairns. Nevertheless, during a go-around from a visual approach to runway 15 at Cairns, the surrounding terrain makes an early left turn preferable in most cases. If an aircraft continues on the runway track, a visual left circuit at 1,500 ft quickly becomes impractical due to terrain to the east-south-east of the airport (Figure 3).

Figure 3: Approach to Cairns Airport runway 15 (terrain to the east-south-east of the airport indicated with a yellow circle)

Source: Jetstar Airways

Aircraft information

Airbus 321

The A321 is a 'stretched' version of the A320 aircraft, with uprated engine thrust to accommodate its greater potential weight. Although the A321 can provide additional climb performance relative to the A320, the operator reported that, on the occurrence flight, the actual landing weight 'was not unduly light so performance differences to the A320-variant should not be significant'.

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8 Visual Meteorological Conditions is an aviation flight category in which visual flight rules (VFR) flight is permitted—that is, conditions in which pilots have sufficient visibility to fly the aircraft maintaining visual separation from terrain and other aircraft.

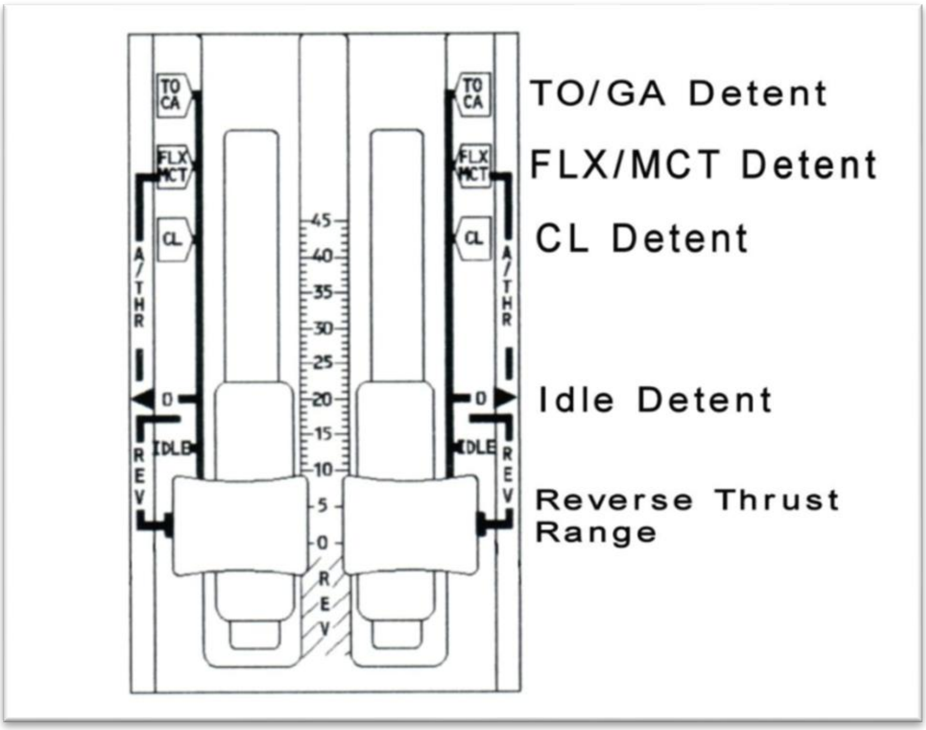
9 A package of documents that provides the operational information necessary for the safe and efficient conduct of national (civil) and international air navigation throughout Australia and its Territories.

10 The only exception to this procedure in Australia was at Sydney, New South Wales, where go-arounds in visual conditions were required to be conducted as directed by ATC or according to the published procedure for an ILS missed approach for the relevant runway.

Thrust lever system

The thrust levers can be moved forward from the idle stop to the climb (CL) detent, flexible take-off/maximum continuous thrust (FLX/MCT) detent, and the take-off go-around (TOGA) detent (Figure 4). With both engines operating, the auto-thrust system armed and the thrust levers between the IDLE and CL detents, the auto-thrust system becomes active and engine thrust varies according to the auto-flight system's requirements up to a maximum determined by the thrust lever position.[11]

Figure 4: Thrust levers



Source: Airbus (additions by the ATSB)

When the thrust levers are advanced beyond the CL detent to the FLX/MCT or TOGA detents, the auto-thrust system reverts from being active to the armed (or inactive) condition. In this condition, the amount of engine thrust is determined by the thrust lever position and is independent of other auto-flight functions. Moving the thrust levers to the TOGA detent during a go-around ensures that the auto-flight system sequences to a go-around mode and that the engines deliver TOGA thrust as commanded by the thrust lever position.

When the thrust levers are retarded to the CL detent or below, the auto-thrust system re-activates, and engine thrust varies according to auto-flight system demands. The go-around procedure requires that, after initially being set to TOGA (see the section titled *Operational information*), the thrust levers are retarded to the CL detent at the go-around thrust reduction altitude to allow the auto-thrust system to become active. With the auto-thrust system active, flap overspeed protections are enabled.

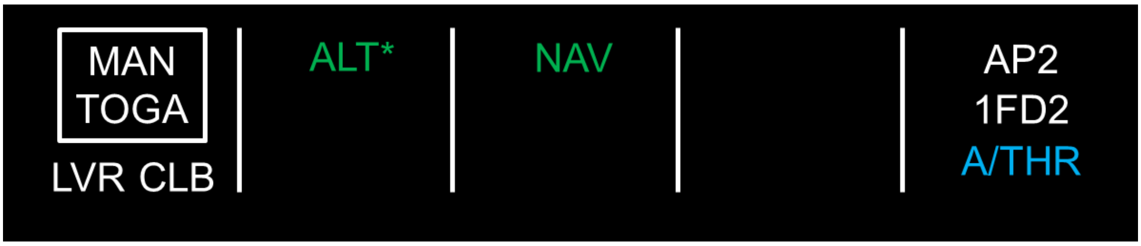
Thrust, vertical and lateral auto-flight modes

Auto-flight modes are indicated on the Flight Mode Annunciator (FMA) at the top of each pilot's Primary Flight Display (PFD). The FMA includes five columns for displaying mode information,

[11] With one engine inoperative, the auto-thrust system becomes active when the thrust levers are retarded to the FLX/MCT detent.

including information about thrust (column 1), vertical modes (column 2), lateral modes (column 3) and the status of autopilots, flight directors and auto-thrust system (column 5). Figure 5 provides an example of potential modes during a go-around.

Figure 5: Representation of the FMA during a go-around (example)



Source: ATSB (adapted from Airbus publications)

Auto-thrust mode and annunciation

When the thrust levers are advanced to the TOGA detent during a go-around, the FMA displays MAN TOGA surrounded by a white box to indicate that at least one thrust lever has been placed in the TOGA detent. At the same time, the status of the auto-thrust system is annunciated using blue lettering (A/THR) to indicate that the system is in an armed rather than an active condition.

If the thrust levers are moved back to the FLX/MCT detent, the FMA shows that thrust operation has changed to MAN MCT. The A/THR status remains armed.

Soon after a go-around commences, the FMA displays a flashing white LVR CLB annunciation to prompt the flight crew to retard the thrust levers to the CL detent.[12] This occurs when either of the following conditions occur:

- The aircraft reaches the go-around thrust reduction altitude. This altitude is set on the Performance Approach (PERF APPR) page of the Multipurpose Control and Display Unit (MCDU).[13] In VMC, such as for the occurrence flight, the operator’s default thrust reduction altitude was 1,000 ft above the airport elevation.[14]
- The auto-flight system’s vertical mode transitions to the altitude capture (ALT*) mode.

Retarding the thrust levers to the CL detent or below changes the thrust system mode annunciation (column 1 in Figure 5) in accordance with the related auto-flight modes. The A/THR status indication in column 5 changes to white to indicate that the system is active and controlling engine thrust according to the auto-flight system’s requirements.

Vertical mode and annunciation

As previously stated, the thrust levers are advanced to the TOGA detent during a go-around, sequencing the auto-flight system’s vertical mode sequences to the speed reference system (SRS) mode. The SRS mode provides auto-flight guidance to hold the aircraft at the speed coincident with commencement of the go-around, or the approach speed, whichever is higher. The SRS mode disengages automatically at the go-around acceleration altitude or when another vertical mode engages.

At the go-around acceleration altitude, assuming various conditions are met, the aircraft’s auto-flight system transitions to the climb (CLB) vertical mode and the aircraft accelerates to the

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[12] In the case of a one engine inoperative go-around, the FMA displays a flashing LVR MCT annunciation to prompt the flight crew to retard the thrust levers to the FLX/MCT detent. This occurs when the aircraft reaches the green dot speed.

[13] The MCDU allows the flight crew to enter and display a wide range of navigation and performance data, and provides a flight crew interface to the Flight Management Guidance System for flight path and speed management.

[14] During a take-off, the flight crew are also required to move the thrust levers from the TOGA or FLX/MCT detent to the CL detent. The operator’s default thrust reduction altitude on take-off was 800 ft.

green dot speed (best lift/drag speed for the aircraft in the clean configuration) or other managed or selected speed. The go-around acceleration altitude is set on the Performance Approach (PERF APPR) page of the MCDU. In VMC, the operator's default go-around acceleration altitude was 1,500 ft above the airport elevation.

Other vertical modes can engage prior to reaching the acceleration altitude. In particular, as the aircraft approaches the altitude selected by the crew on the Flight Control Unit (FCU), the vertical auto-flight mode sequences to the ALT* mode. At that time, the autopilot lowers the aircraft pitch attitude and the aircraft accelerates to the green dot speed.

Lateral mode

When the thrust levers are placed in the TOGA detent, the lateral auto-flight mode sequences to the navigation (NAV) mode, whereby the auto-flight system provides guidance to follow the pre-programmed lateral track. During the occurrence, the crew selected HDG as the lateral mode. In HDG mode the auto-flight system follows the heading selected by the crew.

The operator's published documentation for the occurrence aircraft (VH-VWY) incorrectly stated that when the thrust levers were placed in the TOGA detent, the auto-flight system would sequence to the go-around track (GA TRK) mode. The GA TRK mode guides the aircraft along the same track that was being flown at the time the thrust levers were advanced to the TOGA detent. The discrepancy between the published documentation regarding lateral modes and the aircraft's operation did not influence the crew's execution of the go-around procedure during the occurrence.

The operator reported that many of its aircraft were subject to a modification in June 2012 as part of an upgrade for RNP-AR (Required Navigation Performance – Authorisation Required) operations. Although VH-VWY was not part of the RNP-AR upgrade, it was upgraded for fleet commonality purposes. However, a Notice to Crew (NTC) and alternative operations manual information regarding the upgrade was only issued for the aircraft involved in the RNP-AR upgrade program. Following the detection of this problem, the operator reported that its technical service team were advised to ensure that if an aircraft's operation was affected by a change, then a NTC needed to be issued. The relevant maintenance manual was also updated to emphasise this requirement.

Flap system and speed limits

The flap selector lever has five settings. The flap selector position, the corresponding flap and slat positions in the take-off or go-around phase of flight and the associated maximum flap extended speed (V_{FE}) for the A321 are summarised in Table 1.

Table 1: **Flap selector positions, flap and slat positions and limiting speeds**

Flap selector position	Slat position (in degrees)	Flap position (in degrees)	V_{FE} (kt indicated airspeed)
0	0	0	
1	18	0*	235
		10*	225
2	22	14	215
3	22	21	195
FULL	27	25	190
*During a go-around, when position 1 is selected the flaps will travel to 10° deflection if the airspeed is less than 210 kt, and retract automatically to 0° deflection at or above 210 kt.			

Airspeed is presented on a linear scale on the left side of each pilot's PFD and the airspeed indicator incorporates a range of symbology to highlight significant speed references. A speed trend pointer indicates the speed the aircraft will reach in 10 seconds based upon the current acceleration or deceleration. A bar indicates the maximum applicable speed at any particular time given the existing aircraft configuration.

When the flap selector is in position 2 or position 3, the minimum flap retraction speed (F), or speed at which the flaps can be moved to position 1, is displayed on the airspeed indicator. When the flap selector is in position 1, the minimum slat retraction speed (S), or speed at which the flaps can be moved to position 0, is displayed. When the flap selector is in position 0, the green dot speed is displayed. The F, S and green dot speeds are calculated by the Flight Management Guidance System (FMGS) based on various parameters.

Operational information

Go-around procedures

The go-around procedure is considered a normal procedure rather an emergency or abnormal procedure. The operator's go-around procedure was detailed in its A320/A321 *Flight Crew Operating Manual* (FCOM).[15] The procedure required several flight crew actions (Figure 6).

The go-around procedure was also presented in the operator's A320/A321 *Quick Reference Handbook* (QRH). The tabular presentation in the QRH distinguished between the required actions of the pilot flying and the pilot monitoring. The go-around sequence presented in the FCOM differed slightly from that presented in the QRH. After selection of the landing gear lever to the UP position, the FCOM required the crew to select the lateral auto-flight mode to NAV or HDG as required, then select the autopilot as required. The QRH reversed these two steps but the discrepancy was not considered significant and did not have any bearing on the occurrence.

The FCOM also included other relevant information regarding auto-flight guidance modes during a go-around and the FMGS procedures associated with a go-around. In addition, the operator's go-around procedure was discussed in its A320/A321 *Flight Crew Training Manual* (FCTM). The FCTM noted the importance of selecting TOGA to initiate the go-around, but did not specifically note the importance of moving the thrust levers to the CL detent during the go-around.

With the normal take-off procedure, the thrust levers are initially set at the TOGA or FLX/MCT detent, with the FLX/MCT setting being more common. After aircraft rotation, the steps of the take-off procedure are similar to the go-around procedure, although the take-off procedure includes several specific references to announce FMA indications.

Descent preparation

As part of the descent preparation or during descent, the operator's procedures required a number of crew actions in case of a go-around. These included setting the go-around thrust reduction altitude and the go-around acceleration altitude in the Performance (PERF) Go-Around page of the MCDU. In addition, the crew were required to select the intended missed approach altitude on the FCU altitude selector. During the occurrence flight, the crew selected 1,500 ft as the intended level-off altitude in the event that a go-around was required, consistent with the operator's requirement for visual circuits to be flown at 1,500 ft above the airport.

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15 The operator's manuals were based on those provided by Airbus.

Figure 6: Excerpt from the operator's go-around procedure

GO AROUND WITH FD

Apply the following three actions simultaneously:

THRUST levers....................TOGA

If TOGA thrust is not required, 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.

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.*

ROTATION....................PERFORM

Initiate rotation towards 15 ° of pitch with all engines operative (approximately 12.5 ° if one engine is out) to get a positive rate of climb, then follow the SRS Flight Director pitch bars orders.

GO AROUND ....ANNOUNCE
FLAPS lever....................SELECT AS RQRD

Retract one step of flaps.

FMA.................... CHECK AND ANNOUNCE

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

POSITIVE CLIMB ....ANNOUNCE
LDG GEAR UP ....ORDER
L/G lever....................SELECT UP
NAV or HDG mode....................AS RQRD

Reselect NAV or HDG, as required (minimum height 100 ft).

AP....................AS RQRD

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

AT GO-AROUND THRUST REDUCTION ALTITUDE

THRUST levers.................... CL

LVR CLB flashing on FMA.

AT GO-AROUND ACCELERATION ALTITUDE

Monitor that the target speed increases to green dot.

- **If the target speed does not increase to green dot:**
  ALT knob....................CHECK and PULL
- **At F speed:**
  FLAPS 1....................ORDER
  FLAPS 1.................... SELECT
- **At S speed:**
  FLAPS ZERO.................... ORDER
  FLAPS ZERO.................... SELECT
  GRND SPLRS.................... DISARM
  EXTERIOR LIGHTS.................... SET

Source: Jetstar Airways

Briefing requirements

The operator's procedures required the flight crew to brief the arrival. This involved reviewing relevant aspects of the appropriate approach chart, terrain, weather and operational considerations. If the arrival included an instrument approach procedure, the operator's procedures required that items of the associated missed approach procedure be briefed. A missed approach procedure includes aircraft tracking and altitude requirements, rather than the specific crew actions to conduct a go-around procedure.

The operator had no formal requirement for crews to discuss missed approach or go-around requirements during an arrival briefing for a visual approach. Other major Australian operator's also had no specific requirements. As previously noted (see the section titled *Airport information*), there is no published missed approach procedure for a visual approach and therefore no specific go-around aircraft tracking or altitude requirements to brief. The operator noted that flight crews can generally expect a visual circuit at 1,500 ft but at Cairns, due to the proximity of terrain and the potential for light aircraft traffic, there are no guarantees for such an assumption.

The operator's procedures for arrival briefings also required the crew to identify and discuss any specific threats. Given the fine conditions during the approach, the crew did not identify any potential threats associated with a go-around.

There was no formal requirement for the crew to review the specific actions detailed in the go-around procedure before each approach. However, there was an expectation that crews would be 'go-around minded' and self-brief or mentally rehearse the go-around actions as required. The introductory statement in the FCTM stated:

> Failure to recognize the need for and to execute a go-around, when required, is a major cause of approach and landing accidents. Because a go-around is an infrequent occurrence, it is important to be "go-around minded". The decision to go-around should not be delayed, as an early go-around is safer than a last minute one at lower altitude.

Other go-around guidance

The Flight Safety Foundation (FSF) issued Approach and Landing Accident Reduction (ALAR) *Briefing Note 6.1 - Being Prepared to Go Around* in 2000. Among other general guidance information, it stated:

> The importance of being *go-around prepared* and being *go-around minded* must be emphasised, because a go-around is not a frequent occurrence. This requires having a clear mental image of applicable briefings, standard calls, sequences of actions, task-sharing and cross-checking, and being prepared to abandon the approach if requirements are not met…
>
> To be go-around prepared, the approach briefing should include a discussion of the primary elements of the go-around maneuver and the published missed approach procedure…
>
> Because the approach briefing was conducted at the end of the cruise phase, the crew should review primary elements of the go-around maneuver and the published missed approach procedure at an appropriate time during final approach…

Airbus also published similar information in its Flight Operations Briefing Notes. In addition, Airbus has published a series of articles for flight crews and operators in its *Safety First* magazine. A 2010 article emphasised the importance of moving the thrust levers to the TOGA detent. A 2011 article stated:

> Go Around is an essential safety maneuver for all pilots. It is regularly practiced in the simulator, but often with engine failure, and often from minima.
>
> By contrast, most real-world Go Arounds are:
>
> - Light weight
> - High thrust
> - From any other point on the approach.

> Pilots must be familiar and confident with all aspects of the Go Around manoeuvre. However, recently we have seen several examples where a safe Go Around was not achieved, and following these in-service incidents, we must review Go Around management and flight crew task sharing for the Go Around.

The article provided a review of several go-around situations. It included some discussion about early altitude capture and the associated potential for rapid acceleration and flap overspeed. The article highlighted the importance of setting the thrust levers to the CL detent 'without delay' to control acceleration and to activate the auto-thrust system with the associated overspeed protections.

Go-around training

Endorsement training

One organisation that provided A320 endorsement training in Australia was asked to provide details of the number and types of go-arounds conducted during a typical endorsement training program. It advised that 24 go-arounds were conducted, with each of the two-pilot crew acting as the pilot flying in half of the events. Most (16) of the go-arounds involved all-engine operation, none involved levelling off at an altitude below 3,000 ft and none were unscheduled or a surprise to the trainees.

The French Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile (BEA) recently published a detailed review of issues associated with go-arounds (BEA 2013). In terms of endorsement training, it noted that two providers of A320 endorsement training included 13 go-arounds in their syllabus, with most (nine) involving all-engine operation. It also noted that the training imposed very few constraints or surprises on the flight crew.

Recurrent training

The operator's A320/A321 flight crew cyclic training and proficiency program was established to meet the requirements of Civil Aviation Regulation 217 and other relevant Civil Aviation Orders. At the time of the occurrence, the cyclic program involved 8 pairs of simulator training and assessment sessions conducted over a 4-year period. Each pilot completed one of the eight pairs of sessions approximately every 6 months. In terms of go-around events:

- There were 20 go-arounds scheduled over the 4-year period, with at least two go-arounds conducted in each pair of the cyclic sessions. The captain involved in the session acted as the pilot flying in just over half of the go-arounds.
- All of the pairs of cyclic sessions included at least one one-engine inoperative go-around.
- Eight of the 20 go-arounds involved all-engine operations, and five of the eight pairs of cyclic sessions included at least one all-engine go-around. This had increased since 2007, when all-engine go-arounds were included in only two of six pairs of cyclic sessions.
- In order to maximise the cost-effectiveness of limited training time, most of the go-around exercises ended once the landing gear was selected up and the aircraft was in the go-around configuration.
- Some of the all-engine go-arounds required a relatively low-level altitude capture, such as 1,600 ft or 2,000 ft.

In 2009, the operator provided a series of on-line instructional and awareness videos to promote crew familiarity with go-around manoeuvres in different situations. These included a go-around from 1,000 ft to capture an altitude of 1,500 ft.

In its review of go-around issues, the BEA noted that many operators' go-around training was often performed with one-engine inoperative during recurrent training, and that the training usually did not include a scenario that involved a disruption or an element of surprise. They concluded that 'The number of go-arounds with all engines operating is insufficient and the scenarios used are often predictable.' The frequency of all-engine go-arounds that were conducted during recurrent training by the operators examined by the BEA was not discussed.

Related occurrences

Overview of go-around events

Airbus (2014) reported that the general go-around rate is one in every 340 approaches on the A320 family fleet and one in every 240 approaches on the A330/340 fleet. The BEA estimated that in Europe a medium-haul flight crew on average performs one go-around a year and a long haul flight crew performs on average one go-around every 5 years (BEA 2013). It stated that common reasons for conducting a go-around were meteorological conditions, an unstabilised approach or an ATC requirement.

Although most go-arounds are conducted without significant problems, difficulties are experienced. As part of its detailed review of go-around issues, the BEA (2013) conducted a survey of flight crews from several French and British airlines. Key results included:

- About 60 per cent of pilots indicated that they had encountered difficulties during the conduct of a go-around manoeuvre. The most common difficulties were capturing the go-around altitude, auto-flight system management, aircraft configuration management, coping with modifications to the flight path on ATC request and visual scan management.
- Instructors reported observing similar types of difficulties, with some specific difficulties including 'incompatibility between TOGA thrust and low stabilisation altitude' and 'the concurrent management of configurations and thrust to adhere to the V_{FE} limitation'.
- About 85 per cent of pilots reported that they were adequately trained in go-arounds with one engine inoperative but almost half the pilots indicated that they were not sufficiently trained for go-arounds with all engines operating.

The BEA's analysis of the survey results stated that a key problem was:

> The sudden onset of new tasks, the need to perform vital, rapid and varied manoeuvres, and the rapid changes in the numerous parameters to be managed (controlled) in a limited period of time combine to make it difficult for a crew to perform a go-around that is not controlled right from the start.

A recent report into the operation of flight path management systems (PARC/CAST Flight Deck Automation Working Group 2013) noted the following relating to all-engine go-arounds:

> This is a topic that was raised by multiple pilots and training instructors. Pilots expressed the concern that high power, low weight, low altitude level off, and autoflight logic combined to result in a very challenging maneuver, all while cleaning up the configuration of the aircraft. In the LOSA[16] data, 87% of unstabilized approaches result in safe landings within all parameters. An additional 10% of those approaches resulted in safe landings, but with some parameter exceeded (e.g., landing slightly long). The other 3% conducted a go-around, but 98% of those go-arounds exceeded some parameter (e.g., flap speed).

BEA review of go-around occurrences

The BEA's 2013 study reviewed occurrences involving problems with 'aeroplane state awareness during go-around' (ASAGA) in air transport aircraft. The BEA identified at least 25 accidents or serious incidents between 1985 and 2010, and 13 of these occurrences were fatal accidents. The BEA report studied 16 occurrences in detail. Common aspects included significant speed and pitch excursions, leading to excursions in climb speed and altitude. In most cases the initial tasks for the go-around were successfully executed (such as landing gear and flaps), but problems occurred after these initial tasks.

One of the occurrences, involving an Airbus 380, had many similarities to the occurrence at Cairns on 3 September 2012. The first officer was flying the approach. The captain ordered a go-around when the aircraft was at 500 ft above ground level and the approach was not stabilised, and the

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[16] A Line Operations Safety Audit (LOSA) is a process by which trained observers audit a sampling of normal line operations. The data included in the working group report was based on 9,155 flights worldwide.

go-around call surprised the first officer. During the execution of the go-around, the thrust levers were pushed to the TOGA detent and then reduced to the MCT detent. The flaps were not retracted one stage and the relevant speed was exceeded for 12 seconds. The aircraft reached 1,600 ft, exceeding the prescribed go-around altitude of 1,000 ft, before the thrust levers were pulled back to the CL detent and the effective thrust reduced. During the go-around, the captain was engaged in several conversations with ATC to request a stabilisation altitude higher than 1,000 ft. The BEA concluded that 'The small difference between the decision altitudes and the recovery altitude for the go-around gave the crew little time to manage the rapid rise of a light aircraft with high thrust.'

The BEA also observed the performance of 11 crews in the simulator (six Boeing 777 crews and five Airbus 330 crews). The crews were not aware that a go-around would be required, and ATC instructed the crews to go to 2,500 ft instead of the 5,000 ft altitude associated with the published instrument approach procedure. None of the 11 crews strictly adhered to the published go-around procedure, with many adaptations occurring. The initiation of the go-around was performed without difficulties, although there were some problems with announcing the go-around (one case) or calling out the initial FMA modes (two cases). Most crews did not call out any subsequent modes, several crews exceeded the 2,500 ft limit or did not comply with the assigned heading, and there was one case where a LVR CLB message was flashing on the FMA for 10 seconds. Eye movement data identified at least four cases where one crew member focussed their attention on one task for an extensive period and did not notice another relevant aspect.

In its report summary, the BEA stated:

> It is apparent from the study that most ASAGA-type events involve twin-jet aeroplanes. They are light at the end of the flight because of the fuel burnt and have a very high thrust/weight ratio. In fact, the twin engines powering these aeroplanes develop very high thrust since, in accordance with certification standards, the aeroplane must be able to perform a go-around on a single engine.
>
> ASAGA-type go-arounds are often associated with a disruptive element, before or during the application of thrust, which startles the crew (e.g. unexpected ATC constraints, automatic system inputs not in line with the go-around, unfavourable meteorological environment). Crews find themselves faced with a situation where they have to make a large number of critical actions (landing gear retraction, flight path management) under strong time pressure…
>
> The succession of mode changes is difficult to detect, call out and check during the go-around. The time pressure associated with limited human cognitive abilities – and therefore of crews – is the major problem in ASAGA. The crew must perform a number of actions and cross-check them in a short time. The induced cognitive overload may prevent the detection of deviations both by the [pilot flying], who is mainly concentrated on the PFD, and by the [pilot monitoring], who undertakes a set of tasks that divert his attention…

In its conclusions, the BEA stated that ASAGA-type events involved a combination of factors, including:

- Time pressure and a high workload.
- The inadequate monitoring of primary flight parameters during go-arounds, especially with a startle effect…
- The low number of go-arounds with all engines operating performed by crews, both in flight and in the simulator…
- Interference from ATC.
- The mismatch between the design of procedures for go-arounds and the performance characteristics of modern public transport aeroplanes…
- The channelised attention of a crew member.
- The difficulty of reading and understanding FMA modes.

The BEA issued a significant number of recommendations relating to go-around issues, some of which are discussed in the section titled *Safety issues and actions*.

Jetstar Airways occurrences

On 21 July 2007, an Airbus A320 aircraft was being operated on a scheduled international passenger service from Christchurch, New Zealand to Melbourne, Victoria.[17] 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 crew did not initially move the thrust levers to the TOGA detent, and they were unaware of the aircraft's current flight mode. The aircraft descended to within 38 ft of the ground before climbing. The operator had changed the aircraft manufacturer's 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 this occurrence, the operator changed its go-around procedure to reflect that of the aircraft manufacturer. The aircraft manufacturer enhanced its published go-around procedures to emphasise the critical nature of the flight crew actions during a go-around.

Between 2010 and 2012, the operator had four events in which there were difficulties experienced during the conduct of a go-around. These included:

- One event where the first officer, as pilot flying, did not call for flaps during the initial stages of the go-around. The first officer had about 300 hours experience on the A320, and prior to the go-around was experiencing a high workload during a visual approach that they had not conducted before.[18]
- Three events where the first officer, as pilot monitoring, selected an incorrect flap setting and/or did not call a positive rate of climb.

Based on such events, one of the operator's internal investigation reports stated:

> … go arounds performed unexpectedly due to a significant and rapid change in flight crew perception of aircraft state induces a relatively high workload environment where crew do not adequately complete the go around procedures, in particular the necessary verbal calls.

Another internal report from June 2012 stated:

> Feedback from Jetstar A320 pilots states that when performed properly, the procedure flows seamlessly. However, if it is interrupted by error or omission, it can be difficult to re-commence the interrupted flow of activity…
>
> There is evidence that the go-around manoeuvre is [sometimes] a poorly performed one, either as a result of, insufficient exposure/recency/familiarity or unnecessarily complex procedural expectations…

As a result of these problems, the operated initiated safety actions to improve go-around performance (see the section titled *Safety issues and actions*).

[17] ATSB investigation AO-2007-044, Go-around event, Melbourne Airport, Victoria, 21 July 2007, VH-VQT, Airbus Industrie A320-232. Available at www.atsb.gov.au. This occurrence was also included as one of the 16 occurrences reviewed in detail in the BEA 2013 study.

[18] ATSB investigation AO-2011-089, Incorrect aircraft configuration, Melbourne Airport, Victoria, 28 July 2011. Available at www.atsb.gov.au.

Safety analysis

Introduction

During a visual approach to runway 15 at Cairns, Queensland the Airbus 321 crew initiated a go-around soon after passing 500 ft. The decision to go around was timely, and the go-around was initiated in accordance with the relevant procedure, resulting in the aircraft climbing in the correct configuration and with the autopilot engaged.

Soon after passing 1,000 ft, the crew's application of the go-around procedure broke down, resulting in the aircraft exceeding the maximum speed for the flap setting (V_{FE}) and the aircraft climbing through the 2,000 ft limit assigned by air traffic control (ATC). The aircraft did not approach terrain, the V_{FE} exceedance was minor and, although the aircraft reached 2,700 ft, there were no other aircraft in the vicinity. Nevertheless, the aircraft was in an undesired state and an analysis of the occurrence is useful to help minimise the possibility of a similar occurrence on other occasions where there may be a greater potential for a more serious outcome.

Application of the go-around procedure

Overall, a go-around requires a methodical sequence of many actions by both the pilot flying and the pilot monitoring. During a go-around from low altitude, the aircraft transitions quickly from descending at relatively low thrust to climbing at high thrust with a changing configuration. The tempo of the sequence is relatively rapid compared to other normal in-flight manoeuvres, and tempo management and crew coordination take on even greater importance when planning to level off at a low altitude. It is widely agreed that the go-around procedure for the A320 fleet will flow well if performed correctly. However, it can be a challenging task and the crew can experience a high workload, particularly if there are disruptions to the procedure.

The initial actions of the A320/A321 go-around procedure, up until the landing gear is raised, are generally performed in a closely-knit sequence. There is often then a pause until the next action, which for an all-engine go-around requires the pilot flying to move the thrust levers from the take-off go-around (TOGA) detent to the climb (CL) detent when the aircraft reaches the thrust reduction altitude. This action performs the important role of activating the auto-thrust system and reducing the amount of engine thrust.

In the case of the occurrence flight, the first officer's attention became focussed on other tasks during the pause after the landing gear was raised. In particular, they started focussing on managing the airspeed, which was rapidly approaching V_{FE}. In response, the first officer initially pulled the speed selector knob on the Flight Control Unit (FCU) and subsequently disengaged the autopilot and raised the aircraft's pitch attitude. These actions were ineffective as the thrust levers were still in the TOGA detent. Disconnecting the autopilot also meant that the auto-flight system was no longer set to capture the crew's selected altitude of 1,500 ft.

In many circumstances, speed management of modern generation Airbus aircraft involves manipulation of the auto-flight system rather than physical manipulation of the thrust levers. The first officer's attempts to control aircraft speed therefore probably reflect reversion to well-learned and instinctive responses, which is symptomatic of high workload or time pressure.

Although movement of the thrust levers to the CL detent occurs during almost every take-off, the first officer did not realise that they had omitted the action on this occasion. Omitting a step in a task is one of the most common types of human error (Reason 2002), and errors of omission are often difficult to detect by the people who make them (Sarter and Harrison 2000). The LVR CLB annunciation on the Flight Mode Annunciator (FMA) would have been flashing after the aircraft passed about 700 ft, prompting the first officer to move the thrust levers to the CL detent. However, the first officer's attentional focus on speed indications meant that the FMA was not being scanned or interpreted at this stage. A well-known effect of high workload or time pressure is a reduction in the number of information sources a person will access and the frequency that they are accessed (Staal 2004).

In addition to the FMA indication, the captain also twice called for the first officer to reduce power. The second prompt resulted in the thrust levers being moved back to the flexible take-off/maximum continuous thrust (FLX/MCT) detent but not all the way to the CL detent. It is possible that due to their high workload at the time the first officer defaulted to a simplistic action of pulling the thrust levers back one detent, which would occur during most take-offs, rather than pulling them back to the required setting (see also the section titled *Supervision and monitoring*). Alternatively, the action may have been related to the fact that during a one engine inoperative go-around, which is more commonly practiced in training, the thrust levers are only pulled back to the FLX/MCT detent.

Expectancy

In terms of why the first officer became focussed on airspeed management and did not correctly execute the go-around procedure, the investigation considered a range of factors. These included expectancy, skill decay and supervision.

Pilots expect certain types of abnormal events to occur during simulator training sessions, and they are generally well prepared to respond to them. Research shows performance is slower, less effective and more variable when the abnormal event is not expected (Casner and others 2013, Hendrickson and others 2006), and the same applies during line operations.

Go-arounds are rare events and therefore they are generally not expected. In this case, the fine in-flight conditions and the fact that the approach had generally been well flown further reduced the first officer's expectancy that a go-around would be necessary. The first officer's inexperience with the specific approach being flown and relatively low level of experience on the A321 probably also meant that they were directing some attention to these aspects and less attention to other preparatory tasks.

Problems with a low level of expectancy have been associated with many previous go-around-related occurrences. To help overcome such problems, flight crew guidance material discusses the importance of being 'go-around minded' and 'go-around prepared'. However, for a visual approach, there are usually no specific track or altitude requirements to brief in case of a go-around, and no specific requirements for crews to discuss go-around aspects during an arrival briefing. If the crew had discussed go-around aspects in more detail, this could have raised the first officer's anticipation of a go-around and reduced the potential problems with a surprise requirement. A more detailed discussion during the arrival briefing would also have provided a specific prompt to discuss or mentally rehearse aspects of the go-around procedure itself.

Although ideal, a detailed revision of the go-around procedure on every flight could result in the revision becoming perfunctory in nature. Nevertheless, each pilot does need to mentally rehearse or self-brief the go-around procedure on a regular basis, as with a number of other rarely-performed procedures. If the first officer had mentally rehearsed the procedure on this occasion, they would have been better positioned to execute the procedure, reducing crew workload and increased their capacity to conduct their tasks.

Skill decay and recurrent training

Skill decay refers to the loss of trained or acquired skills or knowledge after periods of non-use (Arthur and others, 1998). In addition to being rarely performed during line operations, there are several aspects of the go-around task that make it susceptible to skill decay unless it is regularly practiced during recurrent training.

Firstly, go-arounds are 'procedural' tasks or tasks consisting of a set of discrete actions. Casner and others (2014) noted that hand-eye skills were quite resistant to forgetting but decay was more significant for '…the set of cognitive skills needed to recall procedural steps, keep track of which steps have been completed and which steps remain, visualize the position of the aircraft, perform mental calculations, and recognize abnormal situations.' In addition, skill decay is more significant for procedural tasks with many steps and the steps have to be recalled in a specific order (Wisher and others 1999). Go-arounds are also generally only learned to a proficiency level in initial training, whereas research shows that resistance to skill decay increases if skills are overlearned, or practiced significantly after reaching a proficiency level (Arthur and others 1998).

In this case, the first officer had performed all-engine go-arounds in their initial training and on the line without apparent problems. They had not conducted a go-around for 6 months and had not conducted an all-engine go-around for 8 months, and such time periods are not unusual. The available evidence indicates that the first officer knew how to do the task. However, with limited recent practice, there is clearly a potential for a reduction in fluency, which means the task needs to be conducted with more attentional resources and is therefore more susceptible to the effects of workload and distraction.

The development of a recurrent training syllabus is a complex process and, as well as meeting specific regulatory requirements, involves operators making decisions about which of many important tasks and situations need to be included in each session. Go-arounds with one engine inoperative are typically conducted in every recurrent training session, and there has been increasing recognition that regularly practicing all-engine go-arounds is also important. Although the procedural steps are fundamentally the same, the increase in energy and time pressure associated with an all-engine go-around provides different challenges. The operator had significantly increased the amount of all-engine go-arounds in its recurrent training program in recent years, although as with most operators they were still not conducted every session.

There are many permutations of the go-around task that need to be covered in recurrent training. A lesson from this occurrence and many similar occurrences is that flight crews should be regularly exposed to the time pressure and challenge of conducting all-engine go-arounds to capture a low-level altitude. They also should regularly conduct the full go-around procedure, with some emphasis on the importance of moving the thrust levers to the CL detent for an all-engine go-around at the appropriate time. In addition, as trainees generally know what to expect in each training session, some element of surprise in the requirement to conduct a go-around should be incorporated. Consistent with many operators, the operator's training had some emphasis on these aspects at the time of the occurrence but the emphasis was limited.

Although the inclusion of more go-around training including these aspects will reduce the overall risk associated with go-arounds, it is difficult to conclude that they would necessarily have reduced the likelihood of this occurrence. The first officer was unfortunately at about the maximum time period since a recurrent training session, and as previously noted they had a low level of expectancy for a go-around on this occasion.

Supervision and monitoring

After instructing the first officer to go-around, the captain was required to perform pilot monitoring duties associated with the go-around procedure, communicate with ATC to establish a suitable clearance and supervise the actions of the first officer. The captain initiated communication with ATC about 20 seconds after the go-around commenced. This would have seemed like an opportune moment given that the initial go-around actions were complete, and the aircraft was climbing and accelerating, though still well short of the intended level-off altitude of 1,500 ft and still well below V_{FE}. Without some instruction from ATC, the crew were committed to continuing to climb visually to the south-east on runway track in accordance with the generic visual approach go-around procedures. Continuing to the south-east would quickly have made a left turn and visual circuit at 1,500 ft impractical due to surrounding terrain.

The captain was monitoring the actions of the first officer and identified that the first officer had deviated from the go-around procedure by not retarding the thrust levers to the CL detent. It was not unreasonable to attempt coaching rather than take over at that stage, and the captain twice called for the first officer to reduce power. The second prompt resulted in the thrust levers being moved back one detent but not all the way to the CL detent. It is possible that a more specific instruction, such as ‘pull the thrust levers to CLIMB’, may have been more effective. However, this is difficult to assess given the extent of the first officer’s attentional narrowing at that point.

As the airspeed increased towards V_{FE}, the captain’s workload was significantly increasing. The last step of the go-around procedure requires the flaps to be repositioned to flap position 1 when the speed reaches the minimum flap selection speed. As the captain endeavoured to manage the flaps in a manner that avoided or minimised a flap overspeed, they stepped the flap selector from position 3 to position 2, then paused for about 15 seconds before selecting position 1. Had the flaps been reselected directly to position 1, which is normal practice for a go-around or take-off, the flap overspeed would probably not have occurred. However, the captain’s attention was being diverted by other tasks on this occasion.

After acknowledging the ATC clearance and moving the flaps to position 1, the captain decided to take control of the aircraft from the first officer. By that time, the V_{FE} overspeed had occurred and the aircraft had exceeded the ATC cleared altitude of 2,000 ft. The point at which a captain should take over control is subjective and dependent upon a wide range of variables, including the progress of various tasks, time constraints, the complex nature of the social interactions, and the captain’s assessment of the existing and predicted safety margins. There would be a natural tendency to complete tasks already in progress prior to taking over, such as moving the flaps and acknowledging the ATC clearance. However, in general tasks such as communicating with ATC should be afforded a low priority in this type of situation.

Fatigue

Fatigue can have a range of adverse influences on human performance, such as slowed reaction time, decreased work efficiency, reduced motivational drive, increased variability in work performance, more lapses or errors of omission and increased willingness to accept risk (Battelle Memorial Institute 1998). In addition, most people underestimate their level of fatigue.

It is generally agreed that most people need at least 7–8 hours of sleep each day to achieve maximum levels of alertness and performance. A review of relevant research (Dawson and McCulloch 2005) concluded that obtaining less than 5 hours sleep in the previous 24 hours is inconsistent with a safe system of work. Thomas and Ferguson (2010) found that the occurrence of crew errors was higher, and performance at managing threats was poorer, during flights when the crew included a captain with less than 6 hours sleep or a first officer with less than 5 hours sleep. Road safety research has also shown that less than 6 hours sleep is associated with significantly more risk of an accident than 7–8 hours sleep (Williamson and others 2011).

Many studies have shown that early starts decrease the amount of sleep obtained as it is generally difficult for people to successfully go to sleep earlier than normal. A recent study of Australian airline pilots found that their amount of sleep increased as the rostered start time became later, with an average of about 5.5 hours for a 0400–0500 start (Roach and others 2012).

In the case of the occurrence flight, the first officer appeared to have adequate rest. The captain reported having only about 4 hours sleep during the evening prior to the occurrence flight and they also reported being tired. Accordingly, it is reasonable to conclude that they were probably experiencing a level of fatigue known to have at least some effect on performance. Factors such as time awake, time of day and sustained workload were unlikely to have exacerbated this level of fatigue.

Although the captain was probably experiencing a level of fatigue, there was insufficient evidence to indicate that it contributed to the problems in the application or monitoring of the go-around procedure. As previously discussed, the captain’s decision to conduct the go-around was timely, and they were aware of the developing problem and promptly attempting actions to address the problem. Given that the captain had 3 days off duty prior to the occurrence flight, the ATSB did not examine fatigue management aspects in detail.

Additional comments

High-reliability systems need to have controls in place to minimise the likelihood of human error as much as possible. Even with such controls, errors will inevitably occur and systems also need controls to help identify the errors and manage the consequences of the errors. All-engine go-arounds in modern transport aircraft can be a challenging and high workload task in some situations, such as when there is a requirement to level-off at a low altitude. The experience from this occurrence and many others shows that errors do occur, and successful performance of the go-around manoeuvre has limited tolerance for such errors.

Ideally the solution to this situation would be to reduce the go-around task's complexity and or minimise the potential for time pressure problems, at least in certain situations. The French Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile (BEA) have recently made recommendations toward this end (see the section titled *Safety issues and actions*). In the meantime, operators and flight crews need to ensure that they are appropriately prepared to conduct a go-around.

Findings

The following findings are made with respect to the flap overspeed and altitude exceedance during go-around involving Airbus A321, registered VH-VWY, near Cairns Airport, Queensland on 3 September 2012. These findings should not be read as apportioning blame or liability to any particular organisation or individual.

Safety issues, or system problems, are highlighted in bold to emphasise their importance. A safety issue is an event or condition that increases safety risk and (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 operating environment at a specific point in time.

Contributory factors

- The first officer had a low level of expectancy that a go-around would be required and they were not mentally prepared to conduct the go-around manoeuvre.
- After conducting the initial steps of the go-around procedure, the first officer's attention focussed on airspeed management and they did not retard the thrust levers to the climb detent in order to reduce thrust.
- After the initial breakdown in applying the go-around procedure, the crew was experiencing a high workload, which significantly limited their capacity to resolve the situation.
- When moving the flap selector to position 1, the captain paused at position 2 for a significant time period while they completed other tasks.

Other factors that increased risk

- **All-engine go-arounds in modern air transport aircraft are often a challenging task when there is a requirement to level-off at a low altitude, and many pilots have had limited preparation for this task. (Safety issue)**
- Due to a limited amount of sleep in the previous 24 hours, the captain was probably experiencing a level of fatigue that has been demonstrated to have an influence on performance.

Safety issues and actions

The safety issue identified during this investigation are listed in the Findings and Safety issues and 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 directly involved parties were provided with 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.

Go-around preparedness

Number:	AO-2012-116-SI-01
Issue owner:	Jetstar Airways
Type of operation:	Aviation – Air transport
Who it affects:	All operators and flight crew of modern air transport aircraft

Safety issue description:

All-engine go-arounds in modern air transport aircraft are often a challenging task when there is a requirement to level-off at a low altitude, and many pilots have had limited preparation for this task.

Proactive safety action taken by Jetstar Airways

Action number: AO-2012-116-NSA-043

During mid-2012, Jetstar Airways commenced developing its next recurrent (cyclic) training session for A320/A321 flight crew, which was delivered from October 2012. This training included the introduction of at least one 'unscripted' go-around (that is, a go-around introduced at one of several points during the simulator session at the discretion of the check captain).

Training material presented during the cyclic session also included a detailed discussion regarding go-around requirements. The material discussed potential problems with high energy go-arounds, and highlighted the importance of moving the thrust levers to the climb (CL) detent without delay after the altitude capture (ALT*) mode engaged. Other key points included:

- Every approach, whether it be in the simulator or the aircraft should be viewed as a potential go-around!
- Consider a review of the go-around actions at some point during the approach
- Pushing the thrust levers fully forward will achieve TOGA thrust
- Be vigilant with flap lever selection.

ATSB comment in response

The ATSB is satisfied that these actions by Jetstar Airways will reduce the risk associated with this safety issue for its operations.

Safety action taken by the French Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile

Action number: AO-2012-116-NSA-044

As a result of their detailed review of go-around occurrences published in August 2013, the French Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile (BEA) issued many safety recommendations. These included recommendations to the European Aviation Safety Agency (EASA) as follows:

> EASA review the regulatory requirements for initial and periodic training in order to ensure that go-arounds with all engines operating are performed sufficiently frequently during training. [Recommendation FRAN-2013-022]
>
> EASA, in coordination with major non-European aviation authorities, amend the [Certification Specification] CS-25 provisions so that aircraft manufacturers add devices to limit thrust during a go-around and to adapt it to the flight conditions. [Recommendation FRAN-2013-025]
>
> EASA examine, according to type certificate, the possibility of retroactively extending this measure in the context of PART 26/CS-26, to the most high performance aircraft that have already been certified. [Recommendation FRAN-2013-026]

Current status of the safety issue

Issue status: Closed

Justification: The ATSB is satisfied that sufficient safety action is being taken to address the safety issue, both within Jetstar Airways and more broadly throughout the aviation industry.

Additional safety action

Jetstar Airways

Although not necessarily specifically in response to this incident, the operator issued additional guidance reinforcing the responsibilities of the captain with respect to supervision of first officers, particularly when the first officer is acting as the pilot flying. This guidance included reference to the importance of the captain being prepared to assume pilot flying duties promptly if required. Specifically, in September 2012 the operator reinforced comments in its Operations Manual with respect to take-over by the captain by adding:

> At any time the PIC [pilot in command] has concerns regarding the safety of the operation, they shall take prompt and immediate action to ensure the highest level of safety is maintained. This may necessitate immediate resumption of PF [pilot flying] duties.

Airbus

On 19 September 2014, the ATSB was informed that Airbus will review for consistency the slight difference in the go-around procedure sequence specified in the A320/A321 Flight Crew Operating Manual and the A320/A321 Quick Reference Handbook.

General details

Occurrence details

Date and time:	3 September 2012 – 0925 EST	
Occurrence category:	Incident	
Primary occurrence type:	Flap overspeed and altitude exceedance during go-around	
Location:	Cairns Airport, Queensland	
	Latitude: 16° 53.2' S	Longitude: 145° 45.3' E

Aircraft details

Manufacturer and model:	Airbus A321	
Registration:	VH-VWY	
Operator:	Jetstar Airways	
Serial number:	1408	
Type of operation:	Air Transport High Capacity	
Injuries:	Crew – Nil	Passengers – Nil
Damage:	None	

Sources and submissions

Sources of information

The sources of information during the investigation included:

- the flight crew
- Jetstar Airways
- Airservices Australia.

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Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003* (the Act), 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, Jetstar Airways, the Civil Aviation Safety Authority (CASA), the French Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile (BEA) and Airbus.

Submissions were received from Jetstar Airways, CASA and the BEA/Airbus. The submissions were reviewed and where considered appropriate, the text of the report was amended accordingly.

Australian Transport Safety Bureau

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; 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 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.

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.

Australian Transport Safety Bureau

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Investigation

ATSB Transport Safety Report
Aviation Occurrence Investigation

Flap overspeed and altitude exceedance during go-around
Airbus A321, VH-VWY Cairns Airport, Queensland,
3 September 2012

AO-2012-116
Final – 3 November 2014