Australian Government
Australian Transport Safety Bureau

Automation related incidents

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Overview

- Why investigate serious incidents?
- Two examples of serious incidents involving automated systems issues
- Research report of the flight deck automation working group

Why investigate serious incidents?

- ICAO requires it
- Investigating a ‘close call’ provides a ‘free lesson’ in safety
- Essential for major accident preparedness

Automated systems issues

Worldwide, errors associated with the use and management of automatic flight systems have been identified as a contributing factor in more than 20% of approach and landing accidents.

Flight Safety Foundation ALAR Briefing Note 1.2 - Automation

Automated systems issues

Automation surprise

- What is it doing?
- Why is it doing that?
- What will it do next?

Mode error

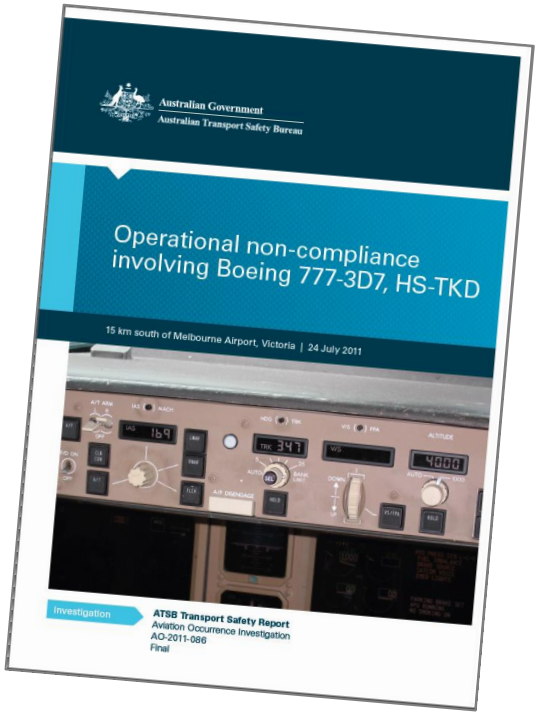
A mode errors occurs when an operator loses track of which mode the device is in, or confuses which actions are appropriate in a particular mode

Two serious incidents involving automated systems issues

- Boeing 777 descent below approach path
- Airbus A320 mishandled go-around

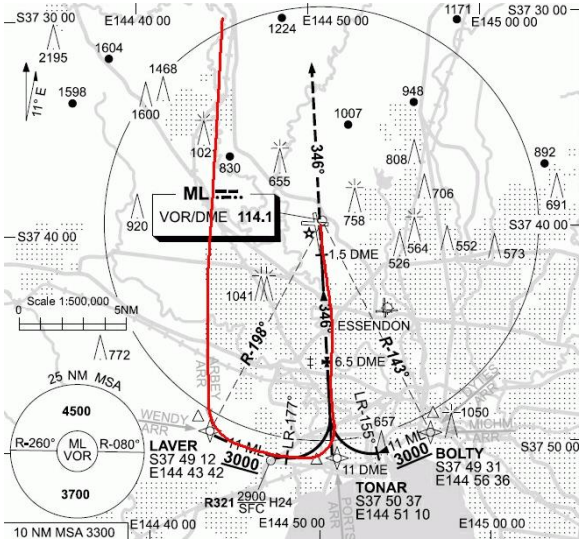
ATSB Investigation AO-2011-086
Descent below approach path

- B777 low on approach to Melbourne, Vic
- Tower controller asked the crew to check their altitude and then instructed the crew to go-around
- Crew caught by surprise by the aircraft's automation



VNAV mode change

On descent through 3,300 ft, the vertical navigation mode (VNAV) changed from speed (SPD) to path (PTH) and the aircraft pitched up to level flight to intercept the required approach path



Automation surprise

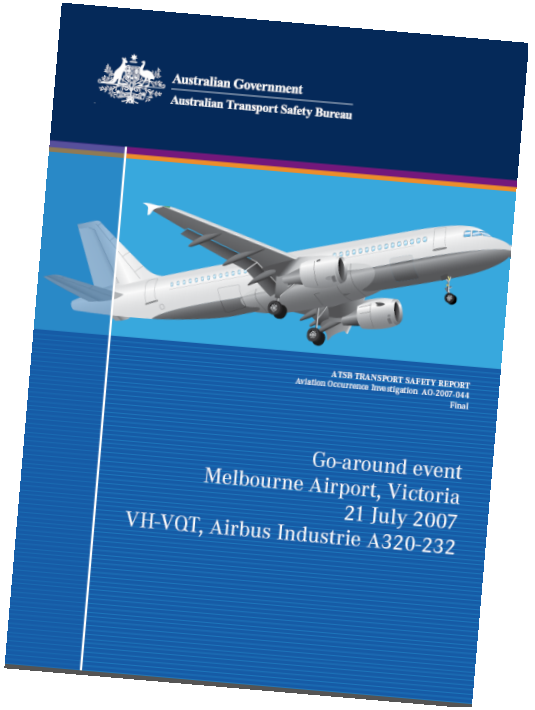
- The crew did not anticipate the aircraft pitching up and selected flight level change (FLCH) mode to continue the descent
- The crew thought the pitch up may have indicated a system fault and were unsure if VNAV would function normally if reselected

Descent below approach path

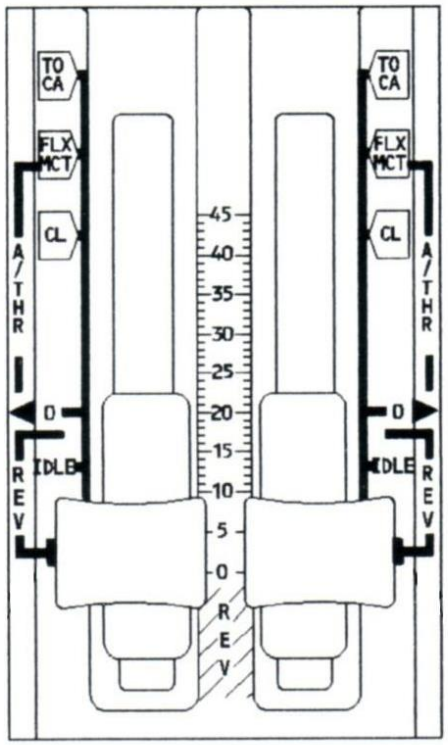
- The aircraft was subsequently flown below the approach path, down to an altitude of 984 ft at 6.4 NM from the threshold
- When instructed to go around, there was a delay of about 50 seconds before the crew selected TOGA thrust and commenced to climb
- The aircraft subsequently landed safety

ATSB Investigation AO-2007-004
Mishandled go-around

- A320 missed approach into Avalon, Vic, due to fog
- The crew mishandled the go-around and were unaware of the aircraft's flight mode
- The aircraft descended to within 38 ft of the ground before climbing



A320 thrust lever positions



TO/GA Detent

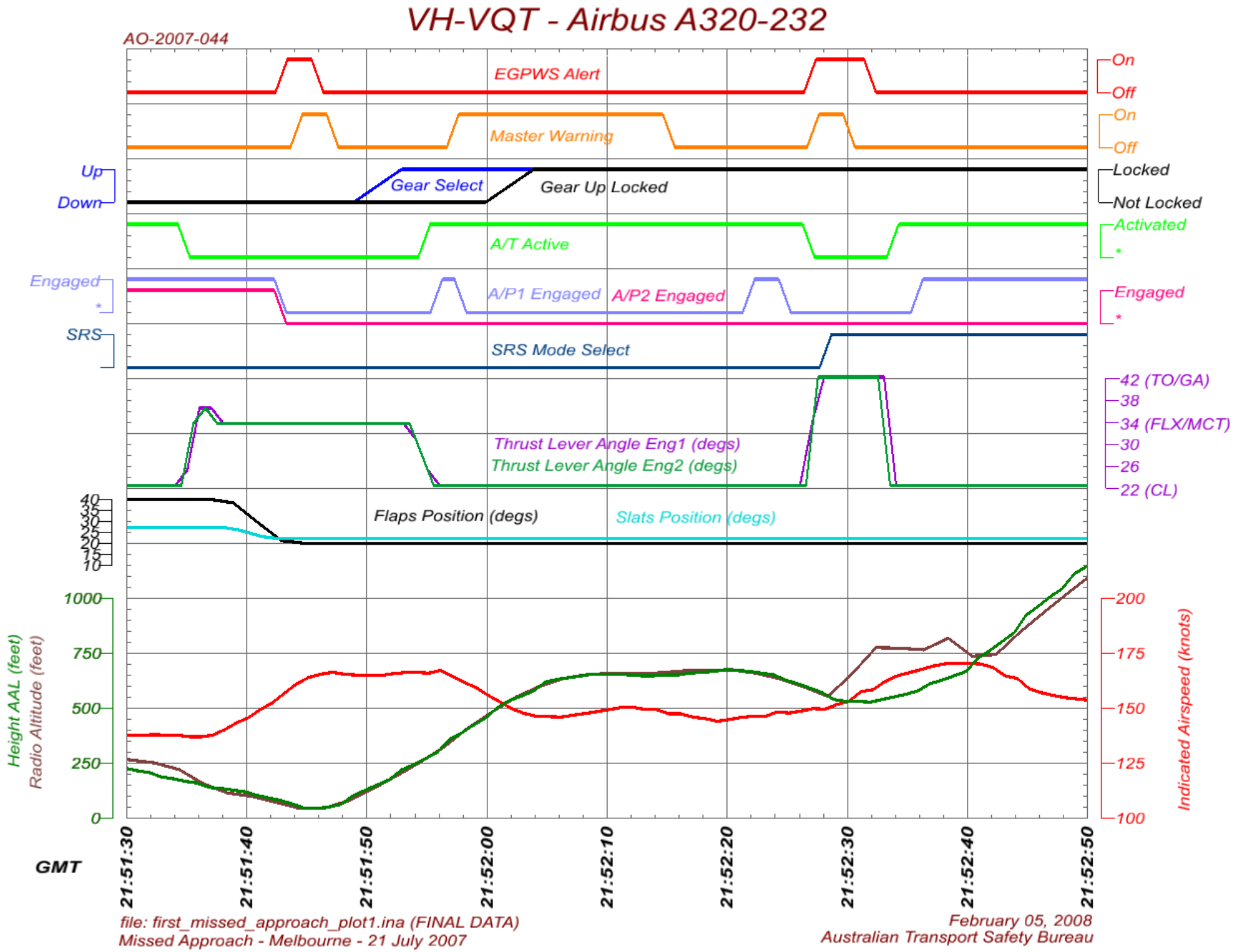
FLX/MCT Detent

CL Detent

Idle Detent

Reverse Thrust Range

‘TOGA tap’


VH-VQT - Airbus A320-232
AO-2007-044
EGPWS Alert
On
Off
Master Warning
On
Off
Up
Down
Gear Select
Gear Up Locked
Locked
Not Locked
A/T Active
Activated
*
Engaged
*
A/P1 Engaged
A/P2 Engaged
Engaged
*
SRS
SRS Mode Select
42 (TO/GA)
38
34 (FLX/MCT)
30
26
22 (CL)
Thrust Lever Angle Eng1 (degs)
Thrust Lever Angle Eng2 (degs)
40
35
30
25
20
15
10
Flaps Position (degs)
Slats Position (degs)
1000
750
500
250
0
Height AAL (feet)
Radio Altitude (feet)
200
175
150
125
100
Indicated Airspeed (knots)
GMT
21:51:30
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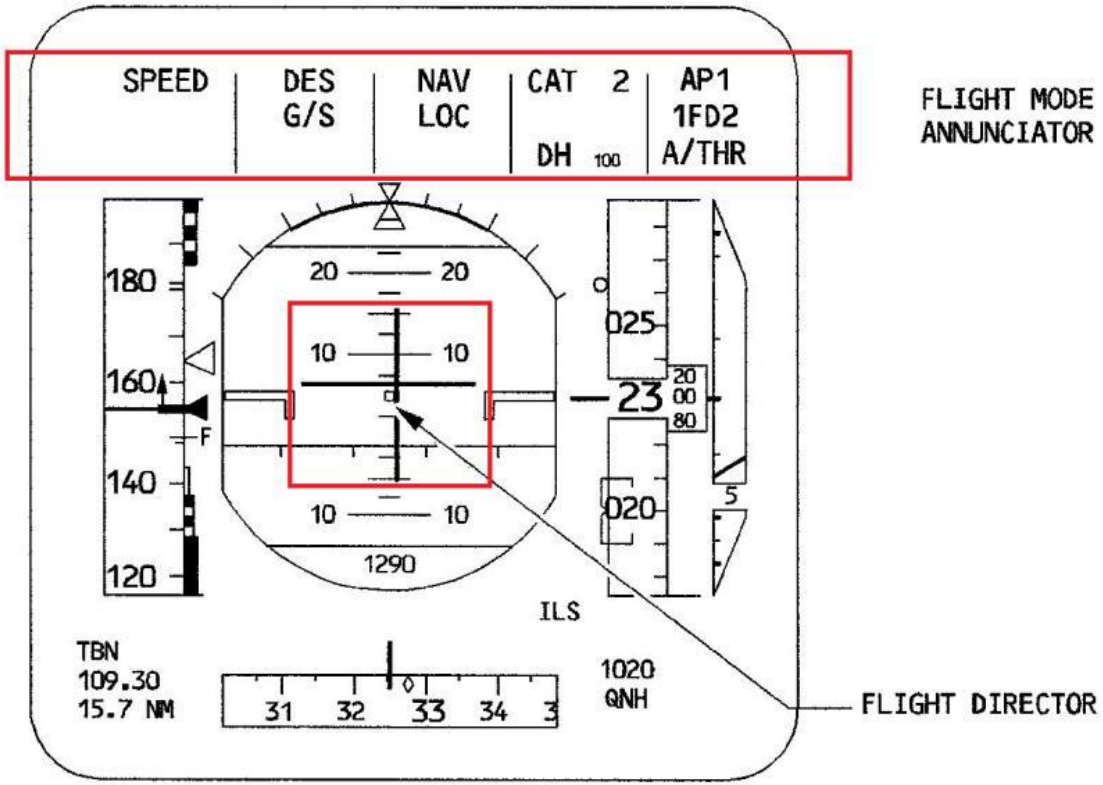
21:51:50
21:52:00
21:52:10
21:52:20
21:52:30
21:52:40
21:52:50
file: first_missed_approach_plot1.ina (FINAL DATA)
Missed Approach - Melbourne - 21 July 2007
February 05, 2008
Australian Transport Safety Bureau

A320 Flight Mode Annunciator (FMA)



Aircraft manufacturer's standard go-around procedure

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

Operator's changed go-around procedure

A318 / A319 / A320 / A321 Flight Crew Operating Manual	STANDARD OPERATING PROCEDURES GO AROUND	3.03.23 SEQ 110	P 1 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
J directed by the SRS pitch command bar.

– 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

Airbus Safety First Magazine

Capt. Dr. Christian NORDEN
Training Policy and Development – In Service Fleet

Go Around handling

1. Introduction

Recent serious incidents involved improperly conducted Go Around maneuvers. This article will briefly describe two of these occurrences. It will then make a short number of simple and important recommendations to help avoid the re-occurrence of this critical type of events.

2. Description of incidents

2.1. First event

On a hazy morning with low patches of cloud (Vis 3000m, SCT002, BKN003), the crew conducted a manual (flight and thrust) ILS approach. The crew had no visual contact at MDA (200 ft AAL). The Captain (PF), considering a low missed approach altitude of 170ft AAL, advanced the thrust levers progressively (within 5 seconds) but stopped the action when in the FLX/MCT notch. He increased the pitch to about 6° Aircraft Nose Up. The aircraft stopped descent at 150ft RA and CONF3 was selected. 4 seconds after setting the levers in the FLEX/MCT detent, the Autopilot (A/P) was engaged and the landing gear retracted. The aircraft – still in LAND mode, due to the lack of TOGA selection – immediately conducted a rapid pitch down to regain the glide slope. PF moved the thrust levers to the CLB detent. At 127ft RA and a pitch of 3.9° Nose Down, the EGPWS audio "SINK RATE" sounded. The PF disconnected the Auto Pilot and pulled almost full back on the stick. The aircraft had reached a minimum height of 76ft RA at an airspeed of 182kts, in CONF3, gears up.

2.2. Second event

On a foggy day the crew conducted an ILS approach A/P and ATHR on. There was no contact at the minimum. The crew initiated a Go Around at a Radio Altitude of 185ft, but the thrust levers were momentarily moved only to a position just forward of, before being retarded to the FLX/MCT detent. Three seconds later the Flaps were retracted to CONF3. The Captain disconnected the Autopilot at 57ft simultaneously EPGWS "DON'T SINK" alert sounded. The aircraft reached its lowest RA of 38ft.

3. Technical considerations

On the Airbus Fly By Wire (FBW) aircraft, the common Go Around flight guidance modes of the Auto Flight System (AFS) are triggered by setting the thrust levers to TOGA. If the crew decides to go around and fails to set TOGA, the AFS status will depend on the type of approach:

- For an **ILS approach**, the A/P remains engaged in the currently selected AFS mode
- For a **managed Non Precision Approach** (FINAL APP), the AFS remains in FINAL APP mode. Disengage the Autopilot 50 ft below minimum and revert to the basic modes (depending on Mod Status)
- For a **fully or partially selected NPA**, the A/P remains engaged in the selected mode.

Figure 1

4. Recommendations

4.1. Applying TOGA in the proper way

Setting TOGA in Go Around (and in any other maneuver where maximum thrust is required instantly) should be a one-step intuitive action i.e. pushing the thrust levers rapidly up to the full forward mechanical stop. Pilots must not count the mechanical detents (clicks), like in setting thrust on Take-Off. Instructors in pilot training could emphasize this movement by the description of "firewalling it", a term well known to most pilots from their early days of basic training. (Fig. 2)

4.2. Monitoring the basic flying parameters, pitch/thrust

Airbus Golden Rule N°2 "Fly, navigate ..." applies also to the G/A phase :

Initiation of a rotation to get a positive rate of climb has priority (on the A320 for example, this translates to 15° of pitch with all engines and approximately 12.5° if one engine is out). Only then follow SRS Flight Director pitch bars orders if consistent with the intended flight path, and if the FMA has been checked.

4.3. Checking and announcing the FMA

Airbus Golden Rule N°5 requires: "Know your FMA at all times". For the GA it means to verify that the expected mode (MAN TOGA/SRS/GA TRK or MAN TOGA/SRS/NAV) is displayed and announced immediately after the flap have been retracted one step and the flight path has been confirmed using raw data (see § 4.2).

4.4. Connecting the AP only when the FD shows the intended flight path

Before engaging the Autopilot (AP), the Flight Crew should follow the recommended practice: Fly the aircraft on the intended path, check on the FMA that the Flight Director is engaged with the appropriate modes.

4.5. Training recommendations

Academic training should ensure that crews understand that thrust levers in Airbus FBW have more than just the thrust function. They are not only used to control thrust in Manual or Auto mode, but serve also as "Mode Selectors" in certain stages of flight. The multiple additional functions of the thrust levers are for example the:

- Engaging of common modes when TOGA or FLEX (for T/O only) is set
- Sequencing of the FMS flight plan into the missed approach procedure when TOGA is set
- Retracting of the speed brakes, if extended when setting TOGA. (Fig. 3).

Figure 2

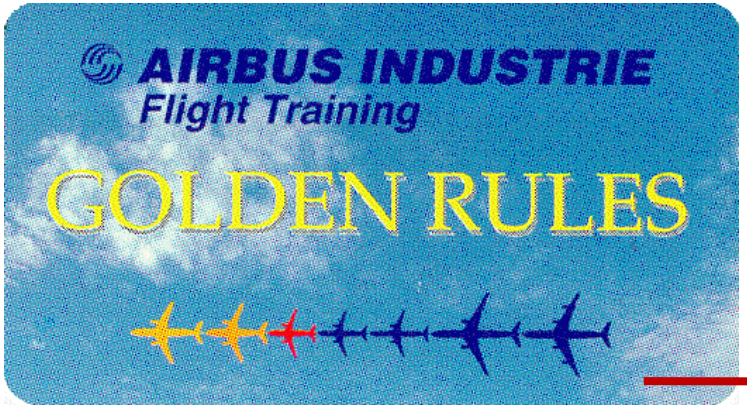
"Firewall it"

Thrust Levers
are also
Mode selectors

Figure 3

Airbus recommendations for go-around

- Firewall it!
- Thrust levers are also mode selectors
- Know your FMA at all times



Operational Use of Flight Path Management Systems

Design, training and use of systems for flight path management

- Autopilot
- Autothrottle/autothrust
- Flight director
- Flight management systems (FMS)

Flight deck automation working group
September 2013

Findings related to automated systems

- Pilots relied on automated systems too much, reluctant to intervene
- Autoflight mode confusion errors continue to occur
- Use of information automation (eg calculation, information presentation) increasing
- FMS programming and usage errors continue to occur

Recommendations related to automated systems

- Improved training and procedures for autoflight mode awareness
- Human centered design that,
  - Reduces the number and complexity of autoflight modes
  - Improves the feedback to pilots on mode transitions
  - Ensures that mode logic assists pilots' intuitive interpretation of failures and reversions

Summary

Automation related occurrences provide a good example of the potential safety benefit of investigating serious incidents

Thank you

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