Safety First

The Airbus Safety Magazine

8

JULY 2009

AIRBUS

Editorial

 # 08 July 2009

Yannick MALINGE
Vice President
Flight Safety

Dear Customers and Aviation Safety colleagues,

June 2009 has been a very challenging month with the loss of both AF 447 and IY626 flights.

From an investigator's perspective, the challenge is to progress the investigations without the Flight Data and Cockpit Voice Recorders.

This could prevent the industry from understanding the complete chain of events that led to these accidents and as a consequence, to determine all lessons to be learned from them.

This points to the necessity of considering additional recording mediums to facilitate accident data retrieval.

Airbus is determined to look at all possible solutions, in cooperation with the industry, to come up with viable complementary means to today's FDR and CVR.

Beyond the focus of the current investigations, accidents associated with the landing and take-off phases remain statistically predominant.

Therefore this issue of Safety First highlights new system features, developed by Airbus, to help flight crews during these flight phases:

- The Runway Overrun Protection System (ROPS)
- The Take-Off Securing function (TOS)

The following articles focus on maintenance and refuelling practices:

- Computer mixability rules
- Into-plane refuelling.

To conclude, the next Airbus Flight Safety Conference will take place in Brussels, from the 13th to the 19th of March 2010, so please make a note of it in your agendas. We will provide more detailed information on the Conference in due time.

Yannick MALINGE

Vice President Flight Safety

Content

Safety First

The Airbus Safety Magazine
For the enhancement of safe flight through
increased knowledge and communications.

Safety First is published by the Flight Safety Department of Airbus. It is a source of specialist safety information for the restricted use of flight and ground crew members who fly and maintain Airbus aircraft. It is also distributed to other selected organisations.

Material for publication is obtained from multiple sources and includes selected information from the Airbus Flight Safety Confidential Reporting System, incident and accident investigation reports, system tests and flight tests. Material is also obtained from sources within the airline industry, studies and reports from government agencies and other aviation sources.

All articles in Safety First are presented for information only and are not intended to replace ICAO guidelines, standards or recommended practices, operator-mandated requirements or technical orders. The contents do not supersede any requirements mandated by the State of Registry of the Operator's aircraft or supersede or amend any Airbus type-specific AFM, AMM, FCOM, MEL documentation or any other approved documentation.

Articles may be reprinted without permission, except where copyright source is indicated, but with acknowledgement to Airbus. Where Airbus is not the author, the contents of the article do not necessarily reflect the views of Airbus, neither do they indicate Company policy.

Contributions, comment and feedback are welcome. For technical reasons the editors may be required to make editorial changes to manuscripts, however every effort will be made to preserve the intended meaning of the original. Enquiries related to this publication should be addressed to:

Airbus
Flight Safety Department (GSE)
1, rond point Maurice Bellonte
31707 Blagnac Cedex - France
Contact: Marie-Josée Escoubas
E-mail: marie-josee.escoubas@airbus.com
Fax: +33 (0)5 61 93 44 29

Safety First
08 July 2009

Safety First is published by Airbus S.A.S
1, rond point Maurice Bellonte
31707 Blagnac Cedex / France

Editor:
Yannick Malinge,
Vice President Flight Safety

Nils Fayaud,
Director Product Safety Information

Concept Design by
MULTI MEDIA SUPPORT 20090563

Computer Graphic by Quat'coul

Copyright: GSE 420.0221/09

Photos copyright Airbus
Photos by
ExM: Hervé Berenger, Philippe Masclet, Hervé Goussé.
Photo copyright Germanwings

Computer rendering by ABAC

Printed in France by AMADIO

Information

Magazine distribution

If you wish to subscribe to Safety First, please fill out the subscription form that you will find at the end of this issue.
Please note that the paper copies will only be forwarded to professional addresses.

Your articles

As already said, this magazine is a tool to help share information.
Therefore, we rely on your inputs. We are still looking for articles from operators that we can help pass to other operators through the magazine.
If you have any inputs then please contact us.

Contact: Nils Fayaud
nils.fayaud@airbus.com
Fax: +33 (0) 5 61 93 44 29

Safety Information on the Airbus websites

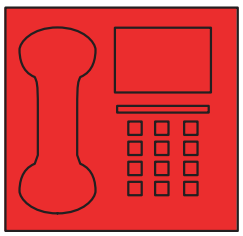
On the different Airbus websites we are building up more and more safety relevant information for you to use.

The present and previous issues of Safety First can be accessed to in the Flight Operations Community- Safety and Operational Materials chapter-, at https://w3.airbusworld.com

If you do not yet have access rights, please contact your IT administrator.

Other safety and operational expertise publications, like the Flight Operation Briefing Notes (FOBN), Getting to Grips with…brochures, e-briefings etc… are regularly released as well in the Flight Operations Community at the above sites.

The FOBN, referred to in some articles in this issue, may as well be found on the Safety Library room of the general public Airbus website at http://www.airbus.com/en/corporate/ethics/safety_lib/



Flight Safety

Hotline:
+33 (0)6 29 80 86 66
E-mail:
account.safety@airbus.com

The Runway Overrun Prevention System

By: Armand JACOB
Experimental Test Pilot

By: Robert LIGNÉE
Flight Test Engineer

By: Fabrice VILLAUMÉ
Multi-Program Project Leader

1 | Introduction

Airbus has developed the Runway Overrun Prevention System (ROPS) as a response to runway overrun events during the landing phase. The ROPS is presently being certified for the A380, under a new specific EASA performance regulation, in conjunction with the Brake To Vacate system.

Runway excursions during the landing phase now represent the largest category of accidents in air transport, amounting to approximately 20 percent of all reported occurrences.

This article will describe how the system:

- Keeps the pilots informed during approach, through its intuitive interface, so that they can better make the necessary decision on whether or not to go-around
- Assists and warns the crew after touch down on the necessary actions to reduce the risk of runway overruns, or to limit the overrun speed.

2 | Main contributing factors

There are many contributing factors to runway overruns during the landing phase.

One of the major contributors has been and remains, unstable approach, to which the industry has responded by emphasizing training and procedures.
In an unstable condition, without actual information on the risk of a consequent runway overrun, the crew may be tempted to continue an approach in the belief that they may recover the situation, or that they have sufficient landing distance margins.

Other identified factors contributing to overruns at landing are:

- Wind shift at low altitude
- Long flare
- Long de-rotation
- Late selection of engine thrust reversers
- Cancellation of reversers at 70 knots
- Runway friction coefficient lower than expected (contaminated runway, snow, ice or runway more slippery than reported)
- Late/weak manual braking
- Technical failures affecting the landing distances during the landing (tyre burst, braking system failure…).

Following in-service experience, the Certification Authorities have recognized the need to create new regulations for the in-flight computation of the Landing Distances published in the Airplane Flight Manuals.

This led to the creation of the Take-off and Landing Performance Assessment Aviation Rulemaking Committee (TALPA ARC), an industry group, in which regulators, airlines, airport operators, associations and manufacturers, including Airbus, were represented.

The Committee has now finalized its proposal for new regulation for in-flight landing distance assessment.

The ROPS computation algorithms are already consistent with these proposed regulation changes.

The content of these new proposals will be detailed in an article included in the next release of Safety First (issue #9) in January 2010.

From BTV to ROPS

The ROPS represents a development of the Airbus Brake-to-Vacate (BTV) system.

During the approach preparation, the BTV automatically displays the landing distance that can be reasonably achieved, under normal operating conditions, on the selected landing runway.
This landing distance is based on predicted data. If that runway's Landing Distance Available (LDA) is lower than the displayed landing distance, initiating an approach is not advised, and a change of runway or diversion should be considered.

The automatic display of the operational landing distance allows the crew to select, during the landing preparation, a desired runway exit.
An exit that provides an available landing distance shorter than the displayed landing distance achievable on a dry runway cannot be selected, as it would not be achievable in normal conditions.

During the landing roll, the BTV ensures that the aircraft is decelerated to taxi speed, when the requested exit is reached, while optimizing the deceleration profile.

The main advantages of this system reside in an increase in passenger comfort, combined with a reduction of brake wear and temperature, thrust reversers usage and runway occupancy time.

For a detailed description of the BTV, please refer to the July 2009 issue of the Airbus FAST magazine.

Airbus decided to use the BTV as the basis for the development of safety functions intended for the prevention of runway excursions
The ROPS was born.

3 | Description of the ROPS

The ROPS assists the flight crew, during the approach and roll-out, in preventing runway overruns.

The system integrates two functions:
- A warning function, called Runway Overrun Warning (ROW), which applies in flight and is go-around oriented.
- An active protection function, referred to as Runway Overrun Protection (ROP), which applies on ground and is stop oriented.

The following description assumes that the ROPS is working in BTV mode, as it allows the operation of all available system functionalities.

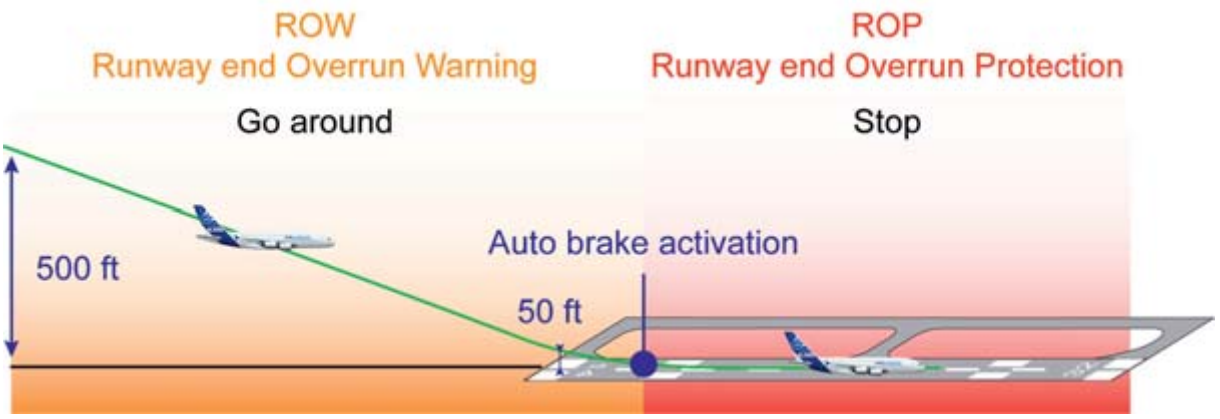


Figure 1: ROW/ROP functions

Note: On the A380, if Ground Spoilers are extended, Auto-Brake activation of the braking corresponds to the Nose Landing Gear touchdown, or 5 seconds after Main Landing Gear touchdown, whichever comes first. If thrust reversers are selected at touch-down, go-around is no more an option, and therefore ROW alerts are inhibited.

3.1 The Runway Overrun Warning

From 500ft Radio Altitude (RA) until Auto-Brake activation, the Runway Overrun Warning (ROW):
- Computes and displays predicted DRY and WET lines on the Navigation Display (ND)
- Triggers alerts in case of predicted runway overrun conditions.

3.1.1 ROW: The DRY and WET lines on the ND

The DRY line provides a landing distance that can be reasonably achieved, under normal operating conditions, on a dry runway. This distance assumes:
- A realistic manual or automatic landing, normal flare and de-rotation technique

- A deceleration equivalent to Auto-Brake in High mode
- A realistic dry runway with normal rubber contamination
- Idle reversers
- Margins for the system's accuracy.

The WET line provides a landing distance that can be reasonably achieved, under normal operating conditions, on a wet runway. This distance assumes:

- A realistic manual or automatic landing, normal flare and de-rotation technique
- A deceleration equivalent to Auto-Brake in High mode
- A realistic wet runway with normal rubber contamination
- Max reversers
- Margins for the system's accuracy.

Above 500 ft RA

The computation of the DRY and WET lines is based on predicted data, in the frame of the Brake To Vacate achievable operational landing distance check function described in the "**From BTV to ROPS**" box.

Whenever a significant change of conditions occurs after the Brake to Vacate preparation and operational landing distance check (TWR wind change inserted in FMS for appropriate speed managed, RWY condition change), a quick new operational landing distance check is possible with minimal crew workload.

Below 500 ft RA

The computation of the DRY and WET lines is based on measured data, by computing the operational landing distance realistically achievable, in real time.

This landing distance is calculated by taking account of the aircraft weight, ground speed, wind conditions, landing configuration and vertical/horizontal trajectory with respect to the runway threshold.

Note: In Auto-Brake modes other than BTV, the DRY and WET lines are not displayed. On the A380 in BTV mode, the DRY and WET lines can be checked on the Navigation Display (ND)

Above 500 ft RA:

In PLAN mode and in Airport Navigation range, as soon as the landing runway is selected during the BTV preparation, then with BTV mode set

Below 500 ft RA:

In ARC mode and in Airport Navigation range (below 5NM), with BTV mode set.

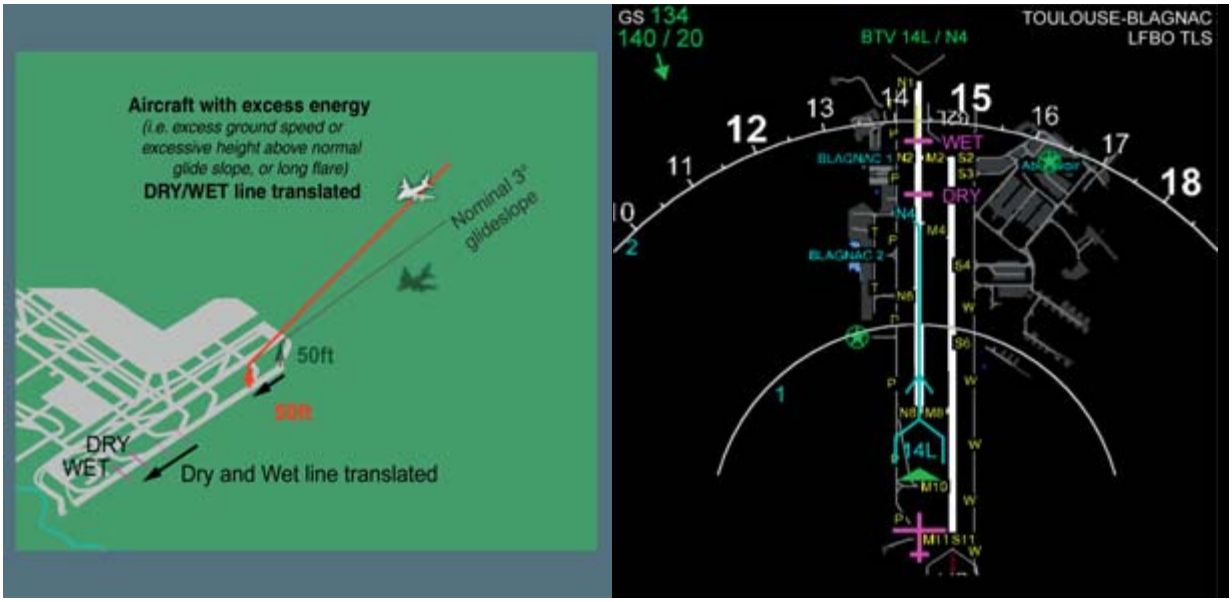


Figure 2: Illustration of DRY and WET lines
Left:impact of excess energy approach at landing (without overrun risk)
Right: example of ND in ARC mode and Airport Navigation range

3.1.2 ROW: The Runway overrun alerts

If the WET line moves beyond the end of the runway, it turns amber on the Airport Navigation Display and a "**IF WET : RWY TOO SHORT**" caution is displayed on the PFD.

Figure 3: Illustration of PFD and ND (ARC mode in Airport Navigation range) in case of "Wet" ROW alert

If the DRY line moves beyond the end of the runway, the DRY and WET lines turn red on the Airport Navigation Display, and a "**RWY TOO SHORT**" warning is displayed on the PFD. In addition, a "RUNWAY TOO SHORT!" repetitive audio callout triggers below 200ft.

Figure 4: Illustration of PFD and ND (ARC mode in Airport Navigation range) in case of "Dry" ROW alert

3.2 The Runway Overrun Protection

From Auto-Brake activation until the aircraft stops, the Runway Overrun Protection (ROP) will:

- Compute and display a stop bar on the Navigation Display
- Automatically increase the braking to maximum braking and trigger appropriate alerts under predicted runway overrun conditions.
  This braking is equivalent to that developed in a rejected take-off by the Auto-Brake in RTO mode, which represents the maximum physical braking capacity of the system.

3.2.1 ROP: The stop bar on the ND

The green stop bar indicates the best possible estimation of the remaining landing roll-out distance, integrating the current aircraft ground speed, deceleration rate and distance to the runway end. It is continuously updated taking account of the actual braking conditions (runway friction and slope, thrust reversers, anti-skid, etc…).

Figure 5: Illustration of ND (ARC mode in Airport Navigation range) in normal condition

3.2.2 ROP: Automatic braking increase and alerts

If the landing is performed despite the ROW warnings, or if the aircraft's deceleration is not sufficient, the ROP stop bar will appear, or move, beyond the end of the runway. In this situation, the path and stop bar turn red on the Airport Navigation Display, and a "**MAX REVERSE**" warning is displayed on the PFD.

Max physical braking is automatically applied (if Auto-Brake or BTV selected).

In addition, a repetitive "MAX REVERSE!" aural alert is triggered if max reversers are not both selected. This message will be repeated until the crew selects both max reversers.

The "**MAX REVERSE**" warning remains on the PFD as long as the stop bar shows a runway overrun condition, whether or not Max Reverse is set.

If the stop bar still shows a runway overrun condition at 80 knots, a "KEEP MAX REVERSE!" audio callout is triggered once, to warn against undue Max Reverse de-selection as recommended in SOP.

Whenever the stop bar comes back inside the runway, and no longer predicts a runway overrun condition, the ROP reverts and allows normal BTV braking operation to resume.

Figure 6: Illustration of PFD and ND (ARC mode in Airport Navigation range) in case of ROP alert

3.3 Synthesis of the Runway Overrun Protection System

	ND (< 500 ft)	PFD (< 500 ft)	Audio (< 200ft)	Actions
ROW (WET)	WET line DRY line	IF WET, RWY TOO SHORT	None	GA decision (crew)
ROW (DRY)	WET line DRY line	RWY TOO SHORT	RWY TOO SHORT !	GA decision (crew)
ROP	RED stop bar	MAX REVERSE	MAX REVERSE ! KEEP MAX REVERSE ! (< 80 KIAS)	Max Braking (Auto) Max REV (crew)

4 | Implementation of the ROPS

As outlined earlier, the ROPS combined with the BTV mode allows the operation of all available system functionalities:

- The system is informed of the landing runway selected by the crew during the approach preparation
- Until 500ft RA, the crew may benefit from the display of the "predicted" DRY and WET lines on the ND
- From 500ft RA, the crew will benefit from the display of the "real time" DRY and WET lines
- From 500 ft RA, the crew will benefit from the ROW alerts
- At Auto-Brake activation, the crew will benefit from all ROP functions: STOP bar display on the ND, automatic braking assistance and PFD / audio alerts.

When landing in classic Auto-Brake mode, without the BTV:

- The system is not informed of the selected landing runway until it automatically detects it in short final
- The crew will only benefit from the ROW alerts once the landing runway is identified
- The DRY and WET lines will not be displayed on the ND
- All ROP functions, however, will be available at Auto-brake activation.

The ROW/ROP functions are available:

- For all aircraft landing configurations (weight, CG, slats/flaps configuration, etc.)
- Without any wind or visibility limitations
- For all airports available in the Airport Navigation database.

Thanks to the runway shift function, the system is able to integrate a temporary change of available runway length (NOTAM, Land & Hold Short Operations for instance).

5 | Summary and way forward

The Runway Overrun Prevention System proposed by Airbus, through the BTV/ ROPS option on the A380, is a comprehensive tool to:

- Help the crew in the go-around decision making process, in flight
- Assist and warn the crew during the ground phase, on the required actions to reduce the risk of runway overruns, or limit the overrun speed.

The system is expected to be certified, under a new specific EASA performance regulation, by summer 2009 on the A380. It will be available through a software change.

In the near future, the protection offered by the ROPS will be available as well in manual braking mode. This "manual ROPS" is expected to be proposed on the A320 and A330/A340 families by 2011/2012.

The ROPS will be basic on the A350XWB.

The extension of the ROPS capabilities to contaminated runways is currently under study.

The Take-Off Securing function

By: Stéphane PUIG
Project Leader, Safety Initiatives Engineering

1 | Introduction

The utilization of erroneous parameters, during the flight preparation, have resulted in tail strikes, high speed rejected take-offs and runway overruns.

This triggered the elaboration by Airbus of pack one of the Take-Off Securing function (TOS), which automatically checks the entered data for consistency.

The second pack, currently under development, will offer more safety enhancing functionalities. One of them is the real time Runway length / Remaining distance on runway function, whose objective is to reduce the probability of take-off runway excursions.

This article is a presentation of both packs of this new safety enhancing function.

2 | Possible errors and their consequences

The take-off preparation by the pilots entails the computation of the aircraft weights (Zero Fuel Weight, Take-Off Weight) and respective CG positions, as well as the calculation of the different Take-Off speeds (V_1, V_R, V_2) and thrust rating.

These data may be obtained either by using load sheets and take-off charts, or by means of non-aircraft software applications (i.e. flight operations laptops).

Three types of errors may be performed during this process:

- Parameters entered into the tables or into the programs may be wrong (carried load, outside temperature, runway length etc…)
- Computations may be inaccurate (wrong interpretation of charts, bug in the software etc…)
- The data entry process into the Flight Management System (FMS) may be incorrect (distraction, stress etc…).

Figure 1: Minimum Unstick Speed (VMU) determination during flight test

Each of these types of errors may have consequences on the Take-Off speeds:

- A too low V_R inserted through the Multipurpose Control & Display Unit (MCDU), may lead to a tail strike
- A too low V_2 may lead to the flight path not clearing the obstacles in an one engine out condition
- A set of too high Take-Off speeds may lead to a runway overrun or too high energy rejected take-off (RTO).

Other possible consequences:

- An error on the A/C configuration at take-off (CONF/TRIM setting) may lead to an "auto rotation" or a nose heavy condition
- A take-off from a different runway from the intended one, or even from a taxiway, may lead to:
  - A collision on ground with another aircraft, vehicle or obstacle
  - A collision in the air with an obstacle
  - An overrun if no lift-off before the end of the runway (even more so if combined with a high temperature FLEX take-off)
  - A low or high energy runaway overrun (in case of RTO)
- A wrong thrust rating may result in a tailstrike, a runway overrun or a shift of the climb path.

3 Description of the Take-Off Securing function (TOS)

The TOS has been developed to detect, to the best extend possible, wrong data entered into the FMS.

The aim of the function is to perform consistency checks between several take-off parameters.

The function is composed of two packages of modifications:

- The first one, TOS pack 1, is already implemented on the A320 family (except the PITCH TRIM / MCDU / CG disagree alert), and is under development for the A330/A340 and A380 (target 2011).
- For the A320 family, TOS pack 1 will be updated to include the PITCH TRIM / MCDU / CG disagree alert that already exists on the A330/A340 and A380
- The second package, TOS pack 2, is under development for the A350 and will later be applied on the A380.

3.1 TOS pack 1

The first Take-Off Securing package is implemented on the A320 family of aircraft equipped with FMS release 1A.

The Thales system checks:
- The Zero Fuel Weight (ZFW) range
- The Take-Off speeds consistency.

The Honeywell system checks:
- The Zero Fuel Weight (ZFW) range
- The Take-Off speeds consistency
- The Take-Off speeds limitations.

3.1.1 Zero Fuel Weight range

As soon as a ZFW value is entered, a range check is performed:

ZFW / ZFWCG
140.0 / 25.0

$ZFW_{MIN} \leq$ 140.0 $\leq ZFW_{MAX}$

The ZFW entry is rejected and an "**ENTRY OUT OF RANGE**" caution message appears on the MCDU scratchpad when the check is not fulfilled.

Figure 2: MCDU scratchpad message for ZFW range check

Note: The previous very broad range check has been refined, under TOS pack 1, to be more relevant to each aircraft type.

3.1.2. Take-Off speeds consistency

This check is performed as soon as all Take-Off speeds are inserted in the PERF take-off page, or each time a take-off speed is modified.
A "**V1/VR/V2 DISAGREE**" caution message will appear on the MCDU scratchpad when the following condition is not fulfilled:

$$V_1 \leq V_R \leq V_2$$

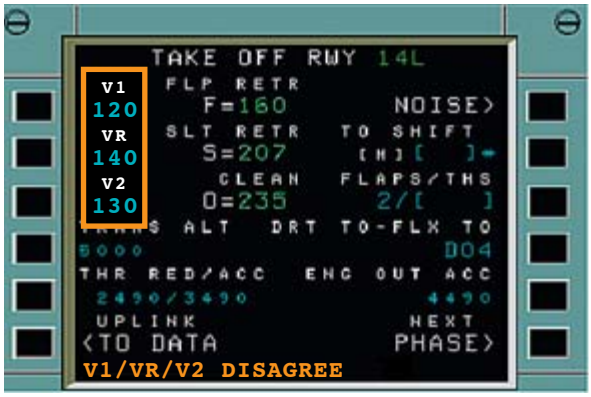


Figure 3: MCDU scratchpad message for TO speeds consistency check

3.1.3 Take-Off speeds limitations

V_{MC} and V_{S1G} limitations checks are launched when:
- ZFW, BLOCK and CONF are entered on the MCDU
- ZFW, BLOCK, CONF or take-off thrust setting are modified
- Engines are started.

V_{MC} limitation check:

$$V_1 \geq V_{MCG}$$
$$V_R \geq 1.05\ V_{MCA}$$
$$V_2 \geq 1.10\ V_{MCA}$$

V_{S1G} limitation check:

$$V_R \geq K_{VR} * V_{S1G}$$
$$V_2 \geq K_{V2} * V_{S1G}$$

(K_{VR} and K_{V2} are margin coefficients)

Minimum values are derived from V_{MC} and V_{S1G} and computations are based on pilot entered take-off data.

In case of an abnormal TO speed, the "**TO DATA/TOW DISAGREE**" caution message appears on the MCDU scratchpad.

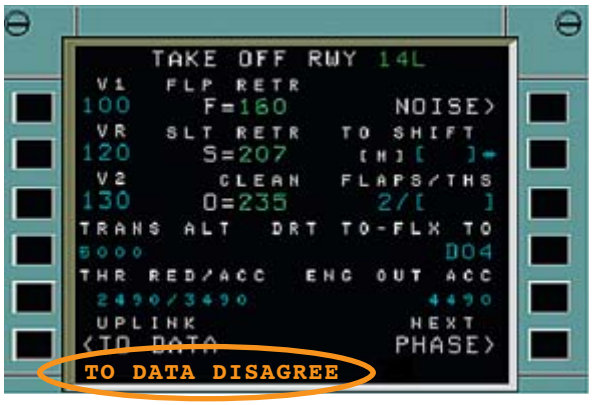


Figure 4: MCDU scratchpad message for TO speeds limitations check

3.1.4 PITCH TRIM / MCDU / CG disagree alert (for A320 family)

This check is performed when the TO Config Push Button is pressed, and during flight phase 3.

The following three parameters are checked for consistency:

- The Trimmable Horizontal Stabilizer (THS) setting (TRIM) entered in the FMS
- The theoretical TRIM calculated from the CG by the Flight Augmentation Computer (FAC)
- The real position of the TRIM from flight controls.

When one of these parameters differs from the two others by more than 1.3° of THS, the **PITCH TRIM / MCDU / CG DISAGREE** caution is displayed on the ECAM and a single chime aural alert is triggered.

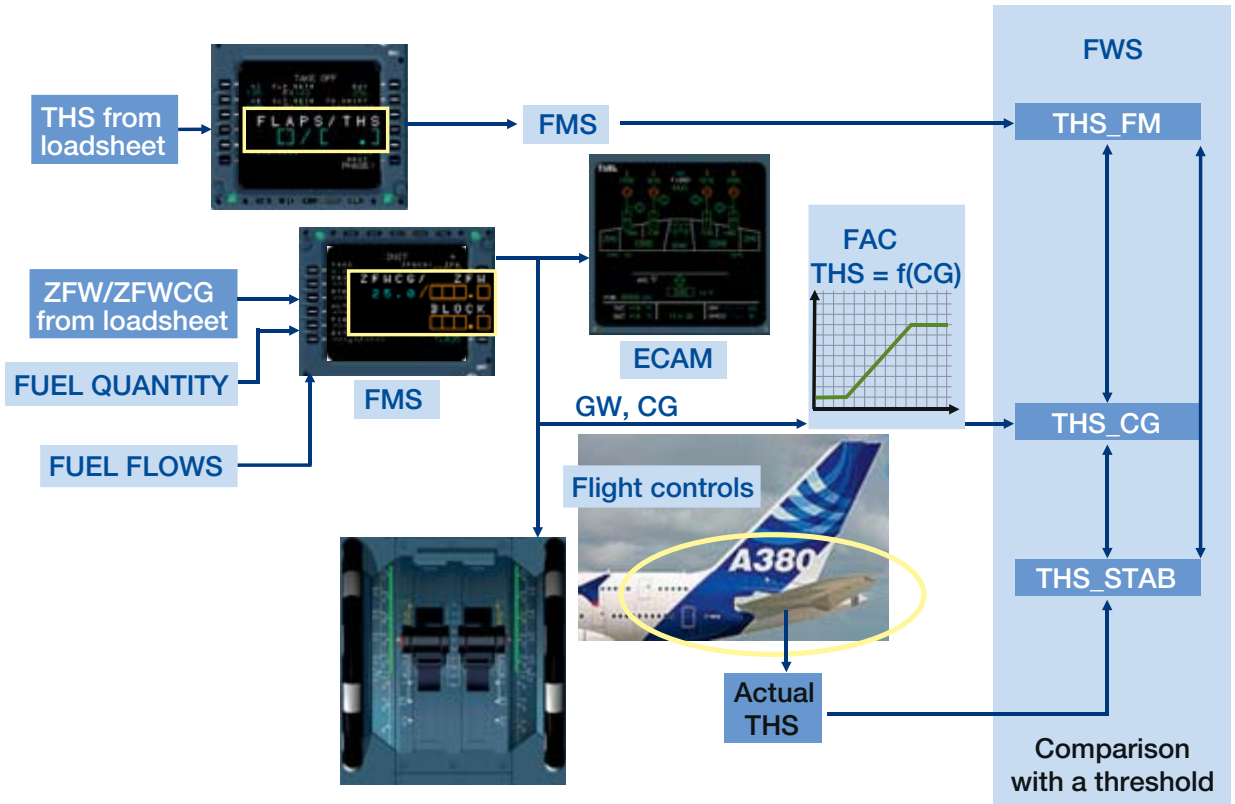
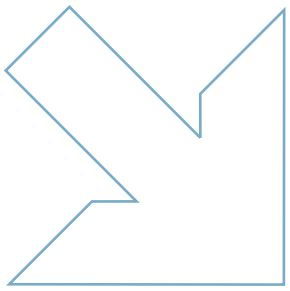


Figure 5: PITCH TRIM / MCDU / CG disagree check schematic



Summary of TOS pack 1 checks:

CHECKS	Risks covered	Implementation
TO speeds consistency	Inversion between two speeds and gross erroneous input of one TO speed	FMS release 1A THALES and HONEYWELL
ZFW refined range	Gross erroneous ZFW input in the FMS	
V_{S1G}/V_{MU} limitation ($V_2 > V_{2min}$ and $V_R > V_{Rmin}$	Erroneous input of too low V_2 and V_R in FMS and inconsistency between TO weight/CONF/THRUST and V_2/V_R for any weight. TO performances computation with erroneous parameters	FMS release 1A HONEYWELL
V_{MC} limitation ($V_1 > V_{1min}$, $V_2 > V_{2min}$ and $V_R > V_{Rmin}$	Erroneous input of a too low TO speed in FMS (taking into account thrust rating)	
PITCH TRIM / MCDU / CG DISAGREE alert on 320 family	Incorrect TRIM setting, Auto rotation, nose heavy	EIS S9.0, FAC 621 and FWS H2 F6 standards

Note:

V_{MU} *minimum unstick speed, is the calibrated airspeed at and above which the aeroplane can safely lift off the ground, and continue the take-off.*

V_{MCG} *minimum control speed on the ground. It is the calibrated airspeed during the take-off run, at which (when the critical engine is suddenly made inoperative) it is possible to minimize the deviation of the airplane by the use of the primary aerodynamic controls alone, to enable the take-off to be safely continued using normal piloting skill.*

V_{MCA} *minimum control speed in the air. It is the calibrated airspeed at which, when the critical engine is suddenly made inoperative, it is possible to minimize deviation of the airplane with that engine still inoperative, and maintain straight flight with an angle of bank of not more than 5 degrees.*

V_{S1G} *speed that corresponds to the maximum lift coefficient (i.e. just before the lift starts decreasing).*

3.3 TOS pack 2

TOS pack 2 will offer a more complete safety net against erroneous take-off parameters entered in the FMS. It will supplement the protection offered by TOS pack 1.

TOS pack 2 will offer the following additional checks:

- Take-Off speeds availability
- Runway limitation and remaining runway length
- Aircraft position on runway
- FLEX temperature setting.

3.3.1 Take-Off speeds availability

The objective is to avoid a take-off without Take-Off (TO) speeds (due to a last minute change, for example).
The system checks that the TO speeds have been inserted during the flight preparation.
It is launched when the crew checks the aircraft configuration before take-off.
It is relaunched automatically at take-off power application.
If the TO speeds are not available, the TO CONFIG test will be invalidated. This will trigger a "NO FMS TO SPEEDS" caution message on the ECAM and a single chime aural alert.

Figure 6: MCDU scratchpad message for runway limitation check (MCDU)

3.3.2 Runway length / Remaining distance on runway

The objective is to reduce the probability of runway overruns.
To achieve this, the system performs the following:

- During the pre-flight phase, the system checks that the inserted TO data are consistent with the planned departure runway. The estimated lift-off run distance is compared with the distance available on the runway (including TO shift)
- During the take-off phase, the system compares the estimated lift-off run distance with the remaining distance on the runway, taking into account the real time position and speed of the aircraft.

If the system detects a risk of runway overrun during the pre-flight phase, a caution message is displayed on both the MCDU scratchpad and the ECAM.

Figure 7: MCDU scratchpad message for runway limitation check (MFD)

Figure 8: ECAM alarm when the Lift-off run check detects a risk of overrun at take-off (take-off power condition is false)

If the system detects a risk of runway overrun during the take-off phase (thrust levers set in a position higher than the Climb (CLB) detent), a "**RWY TOO SHORT**" warning is displayed on the ECAM and a single chime aural alert is triggered.

Figure 9: ECAM alarm when the Lift-off Run check detects a risk of overrun at take-off (take-off power condition is true)

3.3.3 Aircraft position on airport

The objective is to prevent a take-off from:
- A taxiway
- A wrong runway.

As soon as the thrust levers are set in a position higher than the CLB detent, the system compares the position of the aircraft with the FMS navigation database.

If the aircraft is not on a runway, an "**ON TAXIWAY**" warning is displayed on the Navigation Display (ND) (all the ranges are concerned) and an "ON TAXIWAY!" specific aural alert is triggered.

Figure 10: ON TAXIWAY message on ND.

If the aircraft is not on the runway selected by the pilot, a "**NOT ON FMS RWY**" caution message is displayed on the ND (all the range are concerned) and a "NOT ON FMS RWY!" aural alert is triggered.

3.3.4 Take-off FLEX temperature setting

The objective is to check the FLEX temperature setting upon selection of FLEX take-off.
On current aircraft, when the thrust levers are set on the MCT/FLX detent, the FADEC compares the entered FLEX setting with the outside temperature.
In case of incompatibility, the "**ENG THR LEVERS NOT SET**" caution, as well as the procedure to follow, are displayed on the ECAM and a single chime aural alert is triggered.
In the frame of TOS2, the above ECAM caution message will be changed to indicate "**SAT ABOVE FLX TEMP**".

4 | Conclusion

The Take-Off Securing function performs automatic consistency checks between several take-off parameters.

The function is composed of two packs for FMS inputs consolidation:
- The first one, TOS pack 1, is already implemented on the A320 family (except the PITCH TRIM / MCDU / CG disagree alert) and is under development (target 2011) for the A330/A340 and A380.
  For the A320 family, TOS pack 1 will be updated to include the PITCH TRIM / MCDU / CG disagree alert that already exists on the A330/A340 and A380.
- The second package, TOS pack 2, is under development for the A350 and will later be applied on the A380.

The TOS function represents a safety net against erroneous take-off parameters, and is expected to reduce the number of experienced tail strikes, runway overruns and loss of control during take-off.

Two more packs are under study, which will be dedicated respectively to the take-off monitoring and weight & CG estimations.

Computer mixability An important issue

By: Yannick VANHECKE
Group Manager Flight Control Systems
A300/A310 & A330/A340
Customer Services

1 | Introduction

Aircraft computers are subject to hardware and software evolutions, which generate different part numbers. Some of these are interchangeable, but are not necessarily mixable. Mixability, or compability, is about the ability of computers bearing different part numbers to interact correctly in a system. Part numbers, which are interchangeable but not mixable must therefore be changed as a set.

Non-compliance with this principle may lead to significant events, as illustrated by the three occurrences described in this article, where three aircraft were operated with an incorrect Flight Control Primary Computer (FCPC) configuration.

On review of these events, it appears worthwhile to repeat the importance of strictly adhering to the Illustrated Parts Catalog (IPC) when replacing any computer on an airplane.

2 | Description of the flight control computers operating mode

On the A330/A340 aircraft family, the flight controls are managed by five computers:

- Three Flight Control Primary Computers (FCPC or PRIM)
- Two Flight Control Secondary Computers (FCSC or SEC).

In normal operation, FCPC1 is declared to be master in law. It processes the pilot/ auto-pilot orders and sends them to the four other flight control computers (PRIM and SEC), which will then execute them on their related servo-controls.

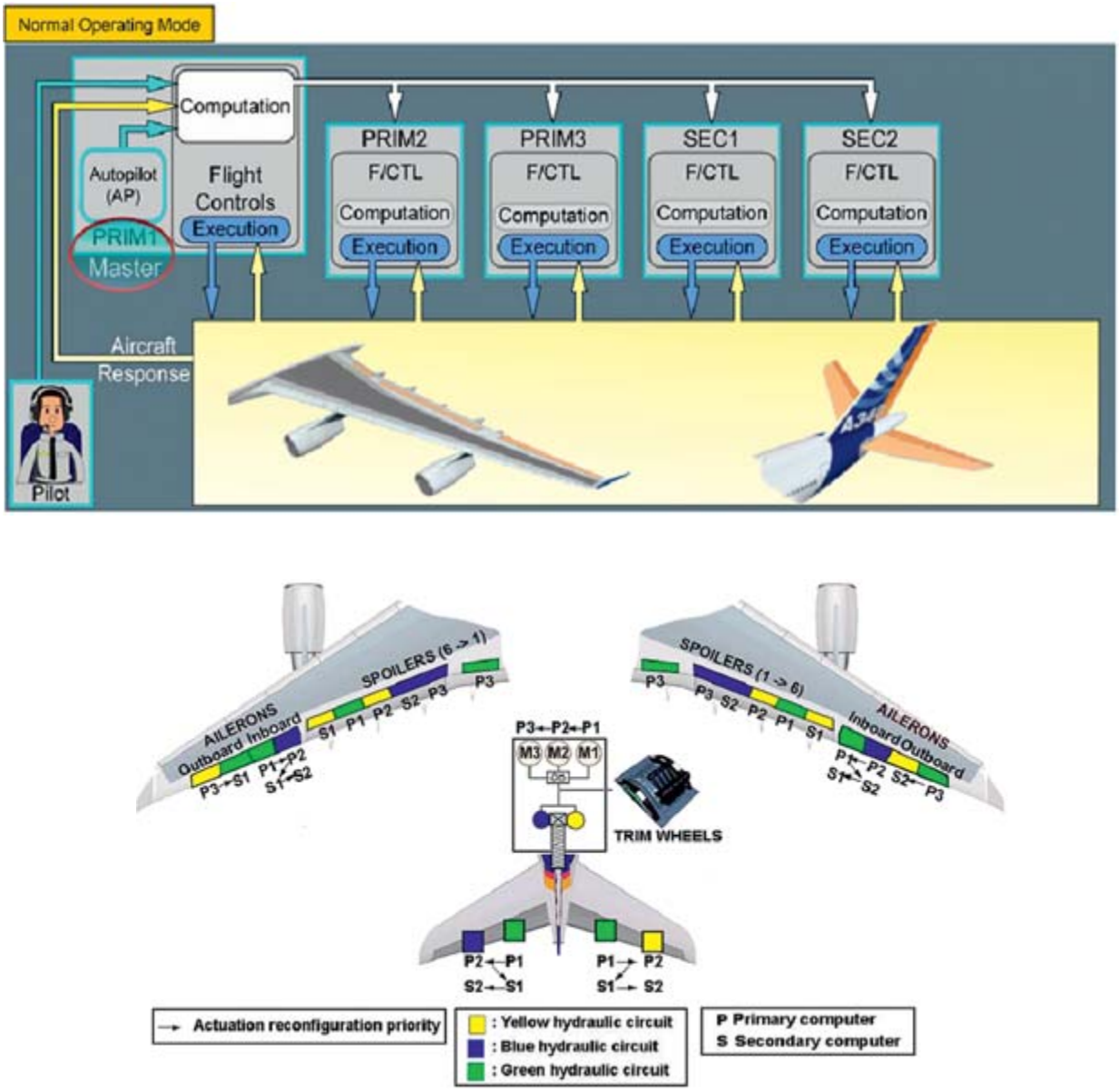


Figure 1: A330/A340 Flight control computers architecture

3 | Events

3.1 Untimely ground spoilers extension on ground

Two A340 operators reported events where all ground spoilers partially extended during the power-up sequence, whereas they should have remained fully retracted.

While troubleshooting the events, the following FCPC configuration was noticed:

- FCPC1: PN LA2K1A100220000 (Standard L15)
- FCPC2: PN LA2K1A100240000 (Standard L16A)
- FCPC3: PN LA2K1A100230000 (Standard L16).

According to the IPC and to the Airbus Service bulletins (SB), this mixed configuration was not authorized.

Indeed, in the above configuration, an incompatibility of the parameters exchanged between the three computers lead the "4 throttles in IDLE position" information sent by the two computers in standard L16/L16A to be interpreted as "Phased Lift Dumping (PLD) function activation" by the FCPC in standard L15.
According to the logics of the system, where a function is activated if ordered by at least two of the three FCPC, FCPC1 ordered the partial deployment of the ground spoilers (Fig 2).

Note: The Phased Lift Dumping function allows the spoilers to deploy with a reduced deflection when only one main landing gear is on the ground and both throttles are in the idle/reverse position

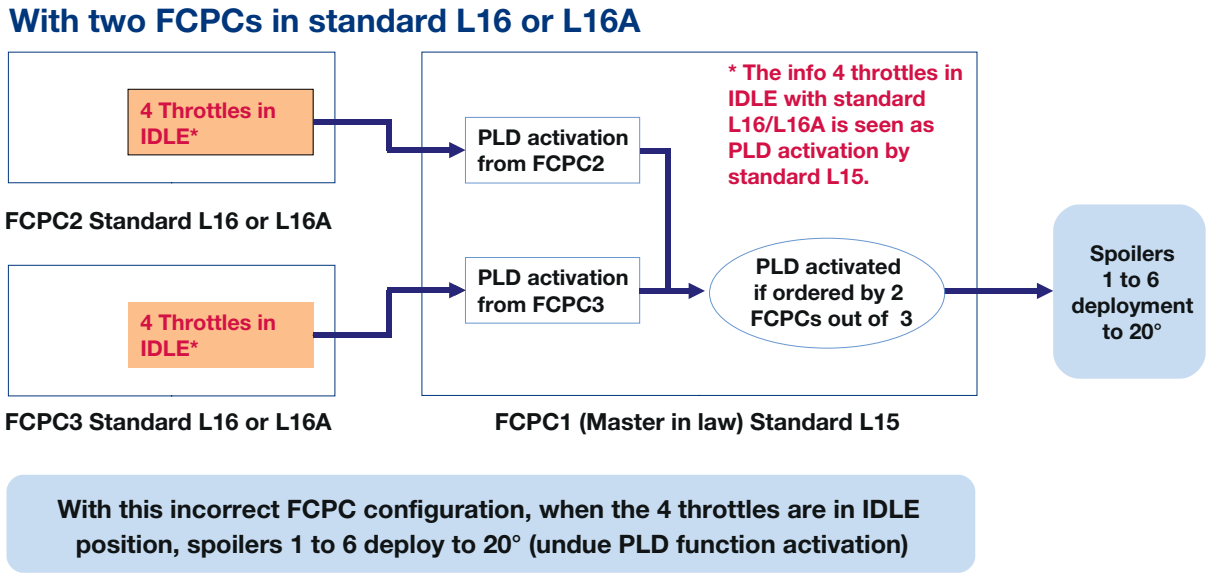


Figure 2: Untimely ground spoiler extension as a result of an unauthorized FCPC configuration

3.2 Hard landing

One A330 operator reported an event, which resulted in a severe hard landing and subsequent main landing gear replacement.

During the flare phase, the elevators remained in the neutral position for several seconds in spite of side stick pitch movement orders by the pilot.

Investigation revealed that while two FCPC - of the same standard and same part number - were fitted in the first and third computer installation position, the computer in the second position differed in both respects:

- FCPC1 and FCPC3: PN LA2K1A100DA0000 (Standard P8/M17)
- FCPC2: PN LA2K2B100D80000 (Standard P7/M16).

This incorrect FCPC configuration had no consequences on the elevators control during the flight as long as the flight controls were operating in "normal" mode.

In “normal” mode, the FCPC1 transmits the elevator movement orders to its related servo-controls. In parallel it sets the adjacent servo-controls, controlled by FCPC2, in “damping” mode.

In “damping” mode, the adjacent servo-controls ignore the permanent steady-state order sent by FCPC2.
Normal operation is illustrated in fig 3.

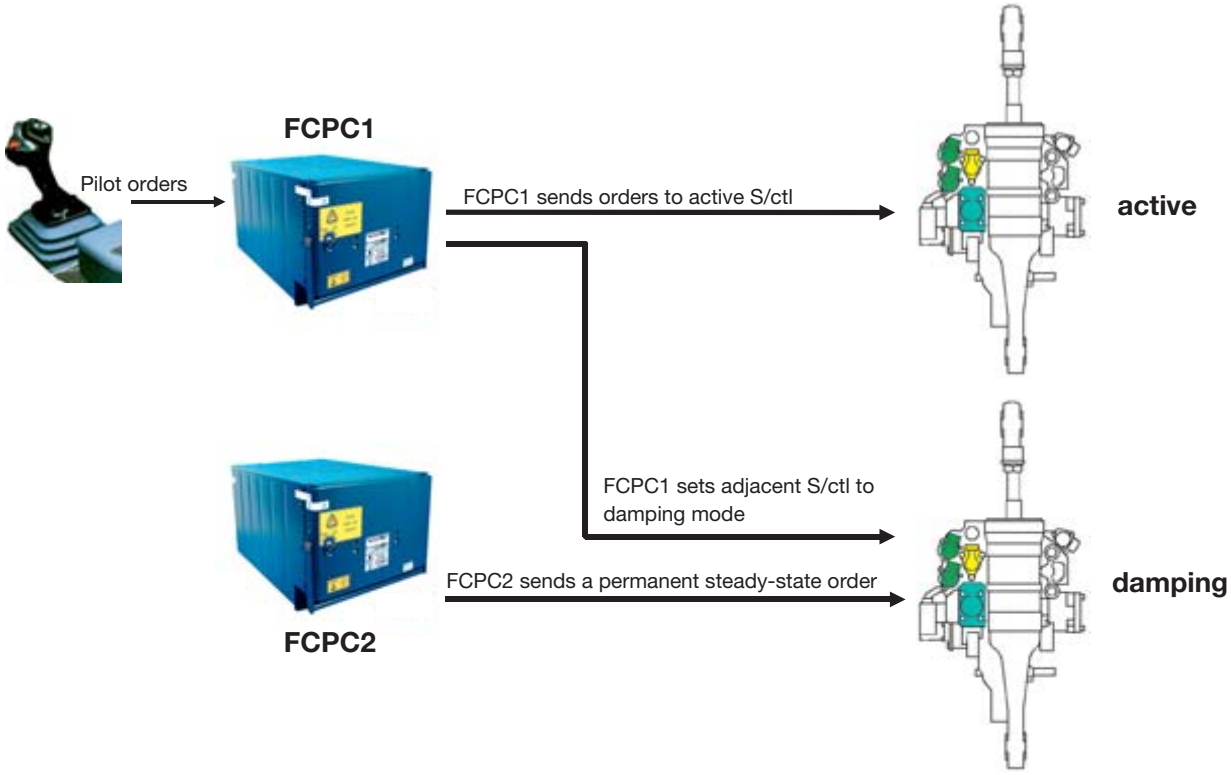


Figure 3: Normal operation

On landing, the Captain started the flare late (height of approximately 20-30ft) and pulled the stick Full Aft. This resulted in a commanded rate of elevator’s deflection of more than 30°/sec, and the consequent activation of the “double pressurization” mode.

In “double pressurization” mode, FCPC1 transmits the elevator movement orders to its related servo-controls and sets the adjacent servo-controls, controlled by FCPC2, in “active” mode. In parallel, it sends a request to FCPC2 to send elevator movement orders to its own related servo-controls.
Double pressurization operation is illustrated in fig 4.

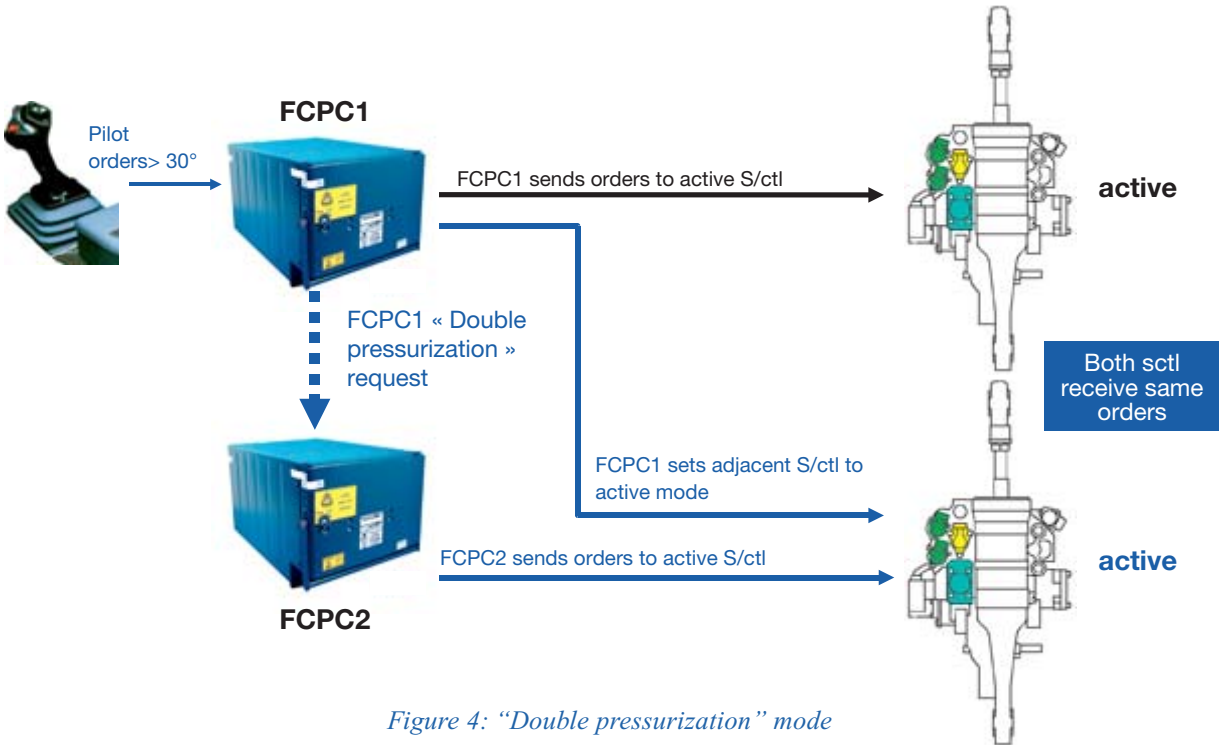


Figure 4: "Double pressurization" mode

In the described occurrence, FCPC2 did not receive the double pressurization request from FCPC1, because of the incorrect FCPC configuration.
FCPC2 therefore continued to send the "by default" steady state order to its servo-controls. This lead to "force fighting" between the elevator servo-controls receiving their orders from FCPC1 and those receiving theirs from FCPC2.

This "force fighting" prevented the elevators to move, thereby contributing to the hard landing. This "double pressurization mode" with incorrect FCPC configuration is illustrated in Fig 5.

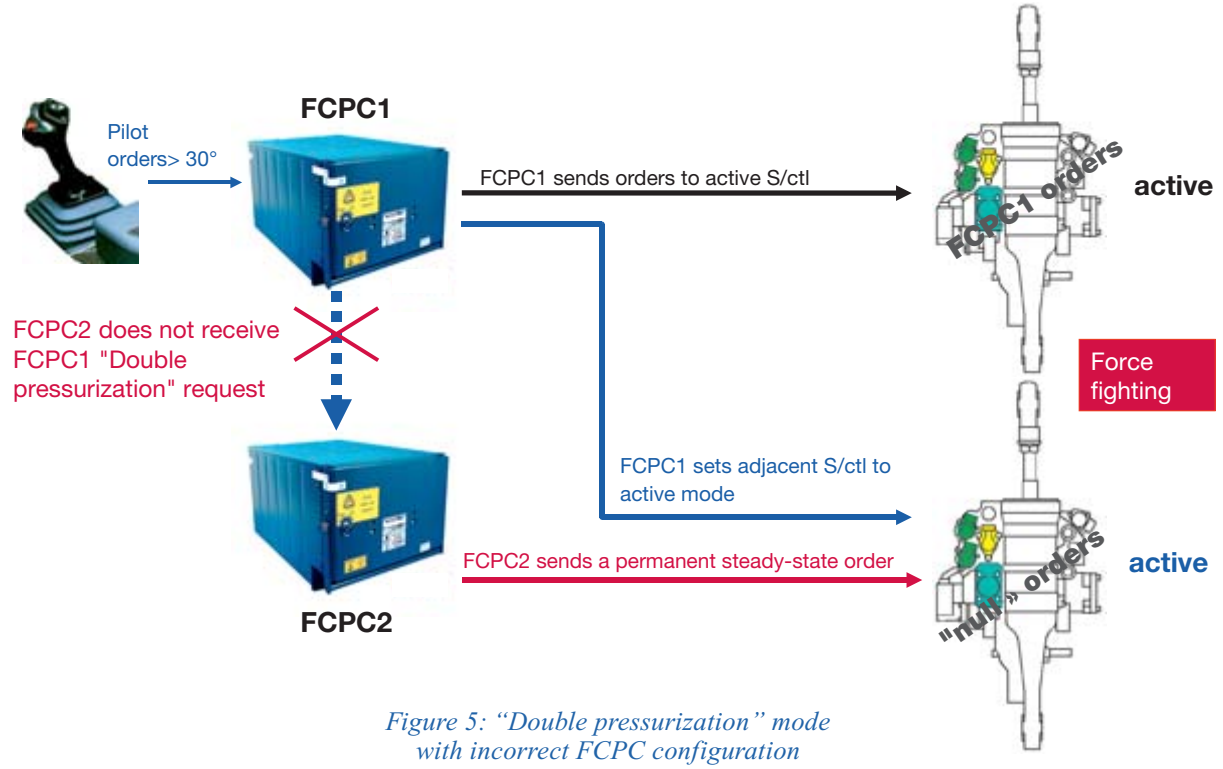


Figure 5: "Double pressurization" mode with incorrect FCPC configuration

4 | A330/A340 FCPC Enhancements

Airbus has developed a new FCPC mixability monitoring to avoid an incorrect FCPC configuration. This monitoring is based on a “compatibility” code exchanged and compared between the FCPC.

With this monitoring, the FCPC will not start with an unauthorized configuration.
A caution is triggered on the Electronic Centralized Aircraft Monitoring (ECAM), associated to a “FAULT” message on the Central Maintenance System (CMS).

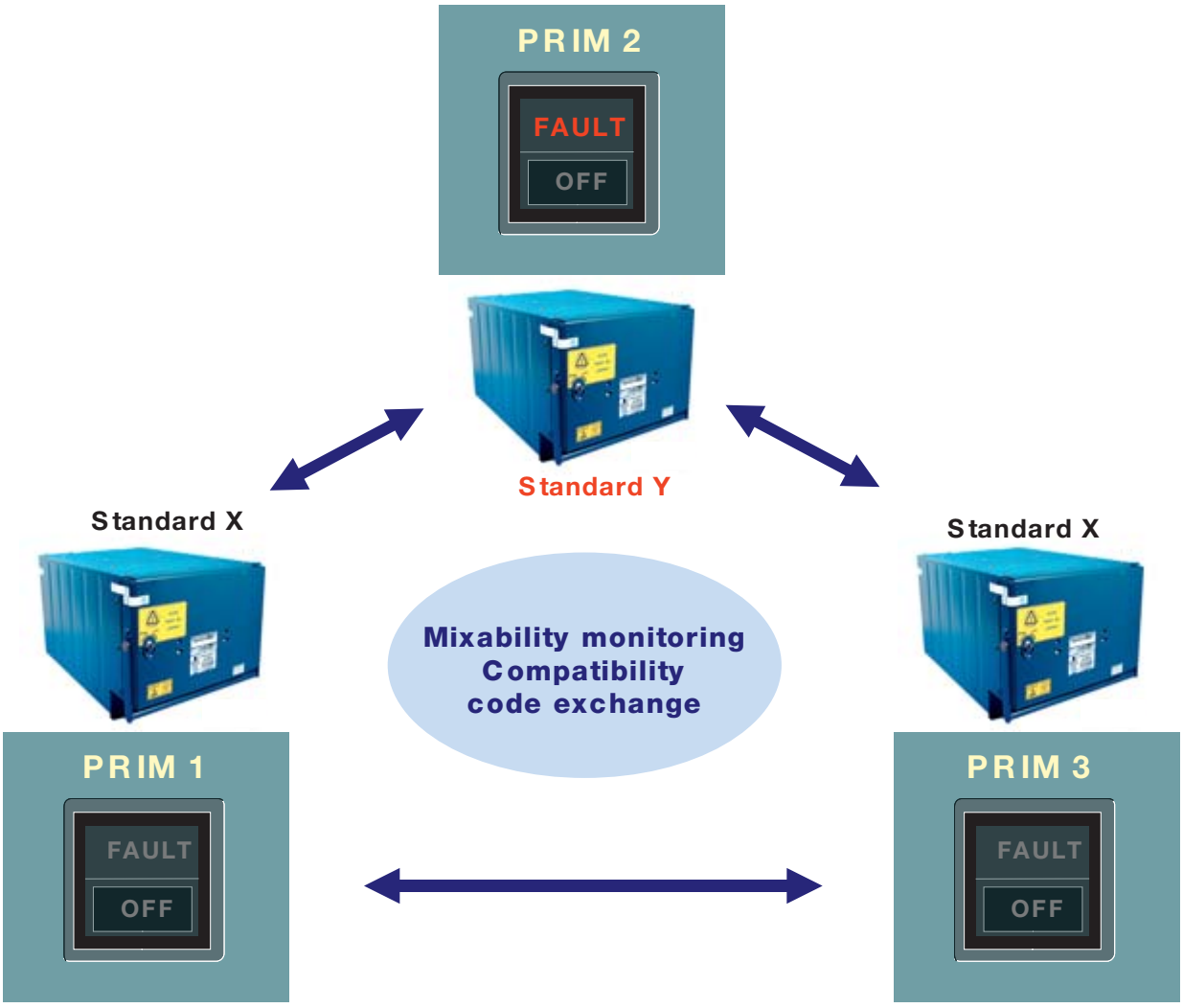


Figure 6: A330/A340 FCPC mixability monitoring

This new monitoring is currently available on all A340-500/600 (FCPC standard W9, PN: LA2K2B100G80000, since Oct. 2005).

Similar monitoring has been developed for all A330/A340 aircraft and will be available with the following FCPC standards:

	Basic (pre mod 49144)		Enhanced (post mod 49144)	
	A330	A340	A330	A340
FCPC standard	P10/M19	L20	P9/M18	L19
Service bulletin	27-3144	27-4144	27-3148	27-4148

Note: A similar monitoring is available on all A380 FCGU (Flight Control and Guidance Unit).

5 | Conclusion

Incorrect A330/A340 FCPC configurations may lead to undesirable operational situations. A new monitoring function has therefore been developed which will, in case of unauthorized configuration, prevent the starting of the FCPC.

SIL 27-150 with detailed flowcharts has been issued as an additional help to quickly determine the interchangeability status of the FCPC Part Numbers.

A wide-ranging lesson may be learned from these particular occurrences, which pertains to all calculators aboard all types of aircraft:
It is important, when replacing computers, to adhere to the interchangeability and mixability rules laid out in the Illustrated Parts Catalog (IPC) and Service Bulletins.
This insures that the aircraft remains in a certified configuration. Deviation from these rules means flying in an uncertified configuration that may result in unexpected operation of the systems.

Operator Information Telex (OIT) Ref. 999.0085/04, Ref. 999.0079/08 and EASA Safety Information Bulletin Ref. 2008-86 were issued to remind operators of the importance of adhering to the interchangeability and mixability rules that are given in the IPC and Airbus Service Bulletins.

Fuel spills during refuelling operations

By: Christopher MCGREGOR
Director, Flight Safety

1 | Introduction

During 2008, Airbus received a report of significant fire damage following a fuel overspill from the wing NACA duct. The fire in the reported event was ignited by a passing service truck. No injuries were reported but the event highlights the risks associated with fuel spills.

This subject and the associated safety objectives are well documented. While legislation continues to develop, industry-working groups have established recognised procedures that can be applied as "standard" during all commercial into-plane refuelling operations. However Airbus continues to receive reports of fuel spills from the in-service fleet.

This article provides a reminder to the Airbus Operators community of the need to adhere to the published procedures and operational recommendations currently available within the industry.

2 | Consequences of a fuel spill

In the last 12 months there have been 11 fuel spill events reported to Airbus associated with aircraft refuelling.

In the worst case scenario the fuel spill presents a fire hazard in the vicinity of the aircraft, passengers and crew.

Reports from across the industry also record failure of the hose/refuel connector and incidents of refuel trucks driving away from the aircraft still connected to the aircraft. An accident in year 2001 associated with disconnection of the hose from the aircraft resulted in a fatality.

In addition to the stated safety hazards there is the potential disruption to the airline and airport operations.

The consequences of a fuel spill during refuelling include:

- Delay the aircraft departure
- Evacuation of the passengers
- Fire services on the scene
- Specialist services on scene to tidy the fuel spilll

In addition to the costs associated with disruption to the aircraft operation most airport authorities /companies will pass on the charges of the clean-up operation to the airline/refuel company involved.

3 | Guidance Material

As per design, should a tank(s) be overfilled, the vent system allows the fuel to spill into the surge tank. Should the excess fuel quantity be greater than the capacity of the surge tank, the fuel exits via the surge tank NACA duct onto the ground.

Under normal circumstances the auto-refuel will close the refuel valve at the requested fuel-on-board preselected value. High-level sensors within the fuel tank will also automatically close the valve if high-level is reached. If the high level sensors fail, then an additional overfill sensor in the surge tanks, if wet, will also automatically close the valve. A basic step requested in the AMM refuel procedure is the high level / overfill sensor test via the dedicated pushbutton on the refuel panel.

The majority of events reported to Airbus occur during manual refuel or defuel procedures or fuel transfers from one tank to another within the aircraft fuel system.

When manual refuel/defuel/transfer is required, care should be taken to ensure individual tank quantities are not exceeded. Individual tank quantities are provided in the Aircraft Maintenance Manual (AMM). Airbus recommends the use of the auto-refuel procedure.

3.1 Airbus

The following chapter highlights the procedural and guidance material available to Airbus operators and refuel companies. The recommendations contained in the referenced documents build on the lessons learnt. Note that the AMM remains the reference document for the necessary accomplishment tasks.

To assist refuelling operations, and troubleshoot the system in the event of a failure indication, Airbus Customer Services, in response to customer feedback, has published the following relevant guides;

- A300-600R, A310-300 Trim Tank System, Troubleshooting Guidelines (ref STE/948.1341/90)
- A330-A340, Refuel System, Description and Troubleshooting Guidelines (ref SEE31/951.1398)
- A340-600, Auto Refuel Checklist, Troubleshooting Guidelines (ref SEE21/2006-100182)

3.2 Joint Inspection Group

A feature of into-plane refuelling is the operation is performed by fuelling companies not the airline personnel. Several industry guides summarise safe operational practices. One of the most widely used is the Joint Inspection Group's "**Guidelines for Aviation Fuel Quality Control and Operating Procedures for Joint Into-Plane Fuelling Services**".

The Joint Inspection Group (JIG) comprising, BP, Chevron, ENI, ExxonMobil, Kuwait Petroleum, Shell, Statoil and Total, conducts yearly inspections at 120 Airport Fuelling Facilities worldwide, reporting on the level of compliance with all international standards and requirements in design and operation of fuel quality control and safety. JIG's inspection guidelines are also endorsed by the IATA Technical Fuel Group.

This document states:
"The majority of accidents can be attributed to lack of attention to, or failure to carry out, or deviations from prescribed procedures."

The guidelines place emphasis on training quoting: "The training and indoctrination of all personnel at all levels in all of the operational tasks they are normally required to undertake, and the tasks they would be expected to perform in an emergency, is of prime importance in seeking to achieve "accident-free operations"

Airbus also recommends that refresher training be given on a regular basis to ensure safety awareness is maintained.

This document provides recommendations and jointly agreed guidelines, which can be used to develop detailed quality control and aviation fuel handling procedures for into-plane fuelling services. Under the auspices of IATA membership, the fuel companies developed the guide to promote standard processes and procedures at airport facilities across the world.

3.3 IATA Technical Fuel Group

"Guidance Material on Standard Into-Plane Fuelling Procedures".

IATA Into-plane standard procedures were developed under the IATA umbrella to develop "standardised procedures" for personnel involved with and carrying out into-plane refuelling. As stated previously, aircraft refuelling is carried out by the refuel companies not airline personnel. Hence there is a level of shared responsibility during this operation to ensure safety standards are maintained.

One objective of this guide was to identify and where possible harmonise procedures across the various aircraft types to reduce variations in procedures, thus mitigating the risk of applying the wrong procedure for a given aircraft type. Chapter 2 of the guide is dedicated to safety precautions and specifies the split in responsibility between the airline and the fuel company. Airbus has, where possible, brought the AMM procedure in line with the IATA guidance material.

Also under the IATA umbrella is the IATA Fuel Quality Pool (IFQP). The IFQP is a group of airlines that actively share airport fuel facility inspection reports and the associated workload of the inspections at locations worldwide. The fuel facilities inspection remit is quality and safety.

For further information visit:
http://www.iata.org/whatwedo/aircraft_operations/fuel/

4 | Conclusion

Airbus received information of significant fire damage to a passenger aircraft following a fuel spill in 2008. While there were no injuries and all passengers evacuated safely, the event highlights the need to follow published procedures and recommendations.

In 2001, there was a fatality associated with a refuelling accident.

Into-plane refuelling requires co-ordination between the airline and the into-plane refuel company. Adherence to the published procedures and industry recommendations will significantly reduce the risk of fuel spills. As highlighted by the industry groups adequate training and refresher training is essential to ensure that procedures are followed.

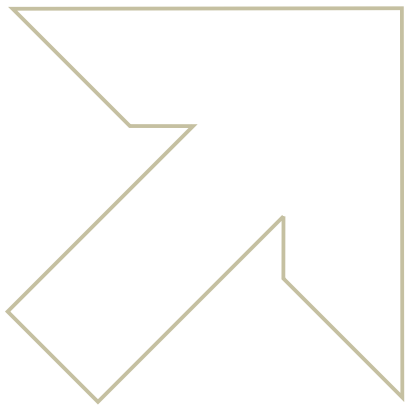
Airbus supports this approach, highlighting that all actors, the airline and the into-plane refuel company, must ensure the appropriate procedures are in place supported by an effective training plan.

REFERENCES

1/ Flight Safety Foundation, Airport Operations, In Aircraft Fuelling, Fire Prevention Requires Strict Compliance with Routine Procedures
2/ ATA Technical FuelGroup, Joint Inspection Group, Guidelines for Aviation Fuel Quality Control and Operating Procedures for Joint Into-Plane Fuelling Services
3/ IATA Technical Fuel Group, Guidance Material on Standard Into-Plane Fuelling Procedures

Safety First

Subscription form



SAFETY FIRST - The Airbus Safety Magazine

Subscription Form

To be sent back to

AIRBUS FLIGHT SAFETY OFFICE
Fax: 33 (0)5 61 93 44 29
Mail to:marie-josee.escoubas@airbus.com

Name . . . . . .

Surname . . . . . .

Job title/Function . . . . . .

Company/Organization. . . . . .

Address . . . . . .

. . . . . .

. . . . . .

Post/Zip Code . . . . . .

Country . . . . . .

Telephone . . . . . .

Cell phone . . . . . .

Fax. . . . . .

E-mail. . . . . .

Please send me the digital copy* ☐

Please send me the paper copy* ☐ *(Please note that paper copies will only be forwarded to professional addresses)*

* Please tick the appropriate case

AIRBUS

AN EADS COMPANY