

The Airbus safety magazine

January 2014

#17

Safety first

Content:

- » Airbus Brake Testing
- » Hard Landing, a Case Study
for Crews and Maintenance Personnel
- » Aircraft Protection
during Washing and Painting
- » Flight Data Analysis (FDA),
a Predictive Tool for Safety
Management System (SMS)
- » Flying a Go-Around,
Managing Energy

Safety first

**The Airbus safety magazine
for the enhancement of safe flight through
increased knowledge and communications**

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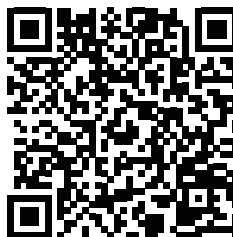
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A350 XWB
*A350 XWB over
the Pyrénées*

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Editorial



Yannick MALINGE

SVP, Head of Product Safety

Every New Year we have the opportunity to reflect on the past years achievements and also to raise some new objectives.

Looking at the safety records of the whole Air Transport Industry, and while still being extremely cautious and modest, we can all observe very good safety levels achieved with continuing positive trends. These positive achievements are particularly reinforced when we consider the steadily increasing volumes of traffic.

Such positive records result from hard work by a lot of safety professionals and involve a number of reasons: the provision by the latest generation of airplanes of additional safety nets, the progressive use of more modern training means, the increasing sharing of safety information amongst the various actors of the Air Transport Industry, and not least, the increasing number of proactive safety programs across the industry, are all having a positive effect.

There are also less visible reasons, but which are equally important. Amongst them, the lessons learned from a lot of actors who experienced very significant challenges and took the remedial actions and the fact that these lessons are being better communicated than ever before.

However there is one possible safety threat, which is not far ahead of all of us within the Air Transport Industry: complacency. Indeed, the good safety trends over the past years and the current very low accident rate could wrongly lead many to the feeling of being immune against safety risks. Yet, the Air Transport System and its environment are evolving: new entrants, traffic growth, strong economic constraints and all sorts of pressure. In such a dynamic environment, safety can never be taken for granted.

If there is one objective we should all keep in mind as we enter this New Year, and to be engraved as a permanent objective from one year to another, it is to relentlessly fight this risk of complacency.

With this in mind I invite you to enjoy a fruitful reading of this new issue of Airbus 'Safety first' magazine.

May I take this opportunity of wishing you, your family and colleagues a happy and safe New Year.

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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.

We would appreciate articles from operators, that we can pass to other operators through the magazine.

If you have any inputs then please contact Nils Fayaud at:

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Safety Information on the Airbus websites

On the AIRBUSWorld website we are building up more safety information for you to use.

The current and back issues of Safety first can be accessed on the home page of AIRBUSWorld by clicking on "News, Events and Publications" at **<https://w3.airbus.com/airbusworld/home/awhomepage.aspx>**.

Other safety and operational expertise publications, like the Getting to Grips with...brochures, e-briefings etc... are regularly released as well in the Flight Operations Community at the above site.

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



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News

SAVE THE DATE

20th Flight safety conference

Dubai, 24-27 March 2014

Another year has nearly passed since our last Flight Safety Conference in Bangkok. All the Airbus people who were present enjoyed very much the opportunity to network with our customers and to share ideas and news. This was also confirmed by all the feedback we received from airlines delegates who valued this great opportunity for sharing safety information.

We are pleased to announce that the 20th Flight Safety Conference will take place in Dubai, United Arab Emirates, from the 24th to the 27st of March 2014.

The Flight Safety Conference provides an excellent forum for the exchange of information between Airbus and its customers.

To ensure that we can have an open dialogue to promote flight safety across the fleet, we are unable to accept outside parties.

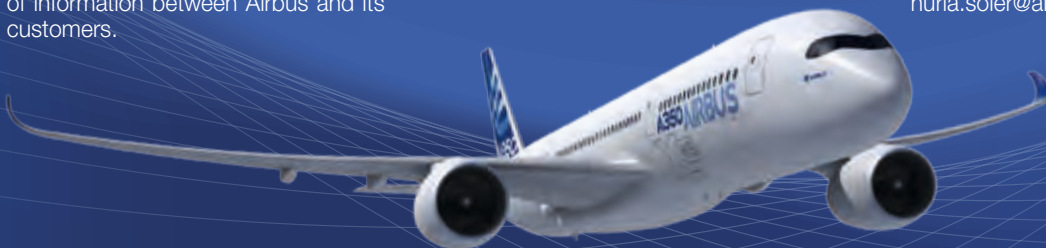
The formal invitations with information regarding registration and logistics, as well as the preliminary agenda have been sent to our customers in December 2013.

For any information regarding invitations, please contact Mrs. Nuria Soler, email **nuria.soler@airbus.com**

This year the conference is "themed" around one major area: the need and importance of Monitoring. In addition we will also be looking on some of the "hard to crack" issues that do not want to go away.

As always, we welcome presentations from our operators. You can participate as a speaker and share your ideas and experience for improving aviation safety.

If you have something you believe will benefit other operators and/or Airbus and if you are interested in being a speaker, please provide us with a brief abstract and a bio or resume at nuria.soler@airbus.com





Introduction

Regulatory aircraft performance is certified as a set of performance models and aircraft physical characteristics that are built and validated from flight test data. While the primary purpose of these models has always been to allow computation of aircraft performance for dispatch, the models used to determine the in-flight landing distances during approach preparation are derived from the same testing. Part of this model, affecting both the accelerate-stop computation at take-off and the landing distance computation, are the characteristics of the braking system installed on the aircraft.

This article explains which flight tests are involved in the identification of the system characteristics and how they are conducted.



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Airbus Brake Testing

Testing Method

There are several objectives for brake testing of a transport category aircraft.

The primary objective is the requirement to model and demonstrate the overall stopping performance, during rejected take-off, including the challenging Maximum Energy Rejected Take-Off (MERTO), and of course during landing.

Initially, during the early development, some fine-tuning of the braking logic may be required to optimise the system functioning and efficiency. Later in the aircraft life, subsequent modifications to braking systems or significant components (e.g. a

new carbon component or a tyre of new technology) may need further evaluation and certification. Then, there is the need to consider the possible degraded states of braking and aircraft systems that contribute to the overall aircraft deceleration (ground spoilers, reversers, etc).

To model accurately the overall aircraft stopping performance, an assembly of different performance models needs to be considered:

- A vertical loads model between the wheels during stopping, for effects of:
 - Aircraft centre of gravity position - At the most forward CG position, the non-braked nose gearwheels are

more highly loaded, the main gear braked wheels less so and therefore less overall braking effect achievable.

- Deceleration - The higher the deceleration, the stronger the load transfer from the braked main gear wheels to the non-braked nose wheels.
- An aircraft lift and drag model during the stop in the given aircraft configuration, including transients during the stop phase (e.g. ground spoilers deployment).
- An engine thrust model in forward idle and possible reverser settings, including transients (e.g. major transient in Rejected Take-Off (RTO) from engines in TOGA to forward idle or reverse thrust).

- The braking model itself with transients (e.g. brake onset with max pedal application or auto-brake initiation).

We will not explain here how vertical loads, lift and drag, and engine thrust models are built and justified. However, they are included in addition to the braking model in order to provide an accurate and validated global aircraft model. We will focus here only on the braking model development and justification.

Maximum braking performance tests are carried out in a specific and controlled manner, not to optimise the figures obtained, but to perform tests that are reproducible, as for any valid scientific experiment. This also applies to performance tests other than maximum braking, for example as validation of how auto-brake systems are performing at landing. To measure stopping distances and record deceleration very precisely, we use differential GPS, and calm wind conditions, with a typical maximum of 10 kt axial and 5 kt cross wind.

Airline pilot reaction times are defined conservatively by regulation and are added by computation into the model (except when aircraft particularities and testing demonstrate a longer test pilot reaction time).

Brake fans are an important facilitating element: they shorten cooling periods on the ground between tests. Alternatively, with an accurate assessment of energy absorbed by the braking system from the flight test installation, we can choose to cool the brakes in the air maintaining gear down, provided the performance calculation indicates sufficient energy margin when taking off with hot brakes to still allow for the possibility of a safe rejected take-off should there be a genuine test emergency that warrants such action. **It must be emphasised that this technique is a test technique only and not one recommended or allowed for “in-service use”. It requires detailed knowledge of brake energy consumption and remaining energy available.**

Rejected Take-Off (RTO) Tests

Rejected take-off performance measurements are done only on a DRY runway, with and without the use of the auto-brake system (in RTO mode) and without



Figure 1
A380 glowing brakes at stop of
Max Energy RTO on ISTRES AFB runway.

the use of thrust reverse. If done on an aircraft with a “light” flight test installation, V1 is set based upon current tower wind, and a calculation is made of the airspeed value required to give the precise ground speed needed to ensure the target energy into the brakes. On aircraft with a “heavy” or more developed flight test installation, the test pilots are provided with a dedicated speed scale display of ground speed: any wind shift will not alter the ability of the test pilot to accurately attain the target brake energy and the target V1 in ground speed.

For Rejected Take-Off (RTO) tests, the aircraft is positioned so that braking is planned to start on a runway portion not significantly contaminated by heavy rubber deposits (typical on touch-down zones). The most demanding of these tests being the Max Energy RTO (fig. 1).

As a progressive approach to this test point, we perform some so-called ‘interrupted RTOs’ in order to ensure that the braking performance in the highest speed range is correctly identified for a precise and correct V1 speed target prediction for the final Max Energy RTO certification brake test. During these “interrupted RTOs”, the pilot applies several seconds max braking from close to the max energy limited value. He then

stops braking and decelerates the aircraft using only reverse thrust, limiting the total energy absorption of the brakes to below tyre deflation values. For this test, Airbus uses the 5,000 meters (16,600 ft) runway of the ISTRES AFB, in the south of France. Obviously this special exercise requires the full length of that runway.

For the unique max energy RTO test, performed at MTOW, the aircraft demonstrates the capacity to absorb the certified max energy into the brakes. Regulatory conditions require that tyres must all be in 90% plus worn condition and, for a successful test, no intervention by the fire crews is allowed for a period of 5 minutes post RTO.

The test is typically done with auto-brake RTO mode selected and with the most critical engine cut (when there is a critical engine) at a target V1 (in ground speed): PM cuts the fuel to the critical engine whilst PF simultaneously slams the thrust levers to Idle **without selecting Reverse**. During the deceleration, the Flight Test Engineer monitors brakes function and should any brake unit fail he calls “Dead Brake”. In this case, the capacity to absorb energy by the remaining brakes is insufficient, and the PF has to disconnect the auto-brake and select max reverse, delaying braking. Hence the reason for using the longest

possible runway available to the Airbus test teams (ISTRES AFB).

If all functions correctly, the auto-brake brings the aircraft to a halt. Then, as we cannot block the ISTRES runway, we need to taxi clear before the wheel fuse plugs melt, typically 2 minutes after the stop. We come to a final halt on the pre-assigned safe parking area with minimum additional use of braking (as little brake capacity remains).

The V1 speed for thrust reduction and brake application has to be precisely calculated, as there is little margin for error. With a dedicated speed scale in ground speed, an accuracy within two tenths of a knot at a typical V1 of 160 kt plus is regularly achieved. The wheels and brakes are intentionally and effectively written off, so the Max Energy RTO is classed as a high risk test. Fire crews are pre-positioned to the side of the runway, listening on the tower frequency, but will only intervene in case of extreme necessity (engulfing fire) and only on flight test crew request: their intervention before a 5 minute period invalidates the test.

Intervention before braked wheels tyres are deflated is highly risky. In case of a wheel burst, pieces of metal of all sizes could be sent at high energy in

all directions ricocheting off gear legs and aircraft structure (it has happened). Therefore, the fire trucks are specifically configured to cool the brakes from a safe distance: hoses are set on fire truck front bumper, and cabin windshields are reinforced. Respect is rightly due to the fire crews, whose lives may be at risk should they be required to assist the flight crew in an evacuation.

At the end of the mandated 5 minutes period, with all tyres deflated, fire crews approach the aircraft and spray the gear with water, in order to rapidly cool the brakes and reduce the need for major aircraft repair beyond wheels, brakes and axles. The whole sequence is filmed for safety reasons and this film is part of the certification process as evidence of the 5 minute hold-over period.

Brake fans are never used during Max Energy RTO, as they come as an option on Airbus models. The parking brake is never set on during aircraft max energy tests to limit risk of hydraulic leaks at brake piston level, but it is demonstrated during max energy bench tests.

Finally, this test is always performed at the very end of the certification, as this minimises the risk to the certification program, since it could cause significant

airframe damage and render a critical and valuable test asset inoperable.

Should the test fail, as happened with one brake manufacturer during the A340-600 test campaign (due to a combination of detrimental factors, including a landing in extreme overweight the same morning at ISTRES AFB), then modifications to the brake and wheel assembly will be required to ensure compliance with the certification criteria. A second test will then be required with the embodied modifications.

Landings Tests

The ground distance from main gear touchdown to full stop is demonstrated by flight test only on a DRY runway. Measurements are done both with and without the use of the auto-brake system (in relevant modes) and without the use of thrust reverse (fig. 2).

Heavy rubber deposits (typical on touchdown zones) have a detrimental effect on brake performance. So, prior to a campaign of brake testing, historically, it was usual practice to clean the runway surface to get a reproducible optimum reference. This is no longer done due to the impact of a full week

Figure 2
A350 Landing performance test
on TOULOUSE DRY RWY



runway closure for rubber removal at our primary operating airport (TOULOUSE BLAGNAC). A second reason is that the rate of rubber contamination has been significantly reduced by the use of modern anti-skid systems. For braking tests, we use the normal threshold when the rubber contamination is normal. When the touchdown zone is contaminated with rubber, enough for the airport to consider a rubber removal plan as per ICAO requirements, we displace our touchdown point beyond the contaminated zone.

The touchdown rate should be on the firm side (3-4 ft/sec), to avoid any bounce and asymmetry on the main gear and in order to have an unambiguous unique touchdown point. The aircraft must be positioned and maintained on the centreline, to avoid the braked wheels running over the painted centreline, which will reduce measured performance (or, in the case of an aircraft with a braked central gear such as A340-600, to allow for the slight loss of performance from the painted centre line). Engines must be at idle at touchdown, with the throttles chopped to idle at the "RETARD" automatic call out. At touchdown, manual braking is immediately applied to maximum pedal deflection, and maintained to the full stop, or auto-brake is left to control the

aircraft deceleration. Pilot control of the de-rotation, in order to minimise load upon nose-wheel touchdown, may be needed as max brake is applied through the derotation. Once on three points, the stick then has to be released for the rest of the ground roll whilst max braking or auto-brake is maintained, in order to avoid undue credit for nose-up elevator position, which would improve performance figures.

Thrust reverse is not used, except for those tests required to validate the reverse thrust model. This is obtained from separate tests with reversers used without braking.

Validation of Performance Models for WET and CONTAMINATED Runways

All flight tests are done on a DRY smooth runway. However analytical models for WET and more slippery runways (CONTAMINATED) are developed and validated.

The reference frictions for WET or CONTAMINATED runways are defined by regulation, EASA §25.109 for WET

and EASA §25.1591 for the defined CONTAMINATED runways (Compacted Snow, Loose Dry or Wet Snow, Standing Water and Slush of more than 3 mm depth, and Ice). Differences of this regulation with TALPA ARC recommendations are minor. These reference frictions are a compilation of historical data on research aircraft. The manufacturer, with a validated wheel loads model for the useful full range of decelerations and aircraft configurations, applies these legal reference frictions to its validated wheel loads models to obtain the appropriate RTO and landing distance performance.

The only additional flight test validation required from us is the anti-skid efficiency on a WET smooth runway, up to the highest ground speed values that will be met in-service during RTO (which also covers the landing speed range). This is done through several RTO or landings in WET conditions (fig.3). They are not direct performance measurements as such, but provide the validated anti-skid efficiency value obtained from analysis. By regulation, the highest efficiency that can be claimed for a fully modulating anti-skid system is 92%. This efficiency has an effect on the certified RTO performance and on the provided landing distances on a WET runway.



Figure 3 | A380 Landing over WET runway for WET anti-skid efficiency determination

If the manufacturer is not able to perform these tests, he can opt for a conservative default anti-skid efficiency value defined by the regulation, function of the anti-skid type being used.

In-Flight Landing Distances

Airbus took the initiative to develop and use the concepts of Operational Landing Distance (OLD) and Factored Operational Landing Distance (FOLD) for aircraft landing performance assessment on arrival. This initiative was based on an industry-wide consensus, forged by the FAA mandated TALPA ARC (Take-Off and Landing Performance Assessment Aviation Rulemaking Committee), and was described in Safety first Issue 10, August 2010.

From September 2012, these more realistic landing distance performance figures have been available to Airbus operators. They are now referred to in the Airbus documentation as Landing Distance (LD) and Factored Landing Distance (FLD).

To cater for minor operational deviations, Airbus and TALPA ARC recommend a 15% factor be applied to the LD. With the resulting FLD, crews should now feel confident that the performance figures used operationally, with Airbus aircraft, are realistic for all runway conditions. This is provided correct assumptions have been made about the weather, aircraft and runway status and that there is no excessive abuse of normal approach and landing procedure.

Effective Friction (including anti-Skid Efficiency) used for Computation of RTO Distances, Dispatch and In-Flight Landing Distances

The DRY runway friction and associated ground braking distance identified in the above tests is used directly for DRY RTO computations, and through regulatory coefficients for Dispatch computations towards DRY and WET runways. It is reduced by 10% for the determination of the in-flight LD towards DRY runways (to mitigate for heavier runway contamination by rubber than on legacy test runways).

The determination of the ground distance for the RTO and In-Flight LD WET computations is not based on specific flight tests, but is computed using a reference friction defined by regulation CS/FAR25.109. This reference friction, based on a compilation of historical flight test data (fig.4), is multiplied by a demonstrated WET runway anti-skid efficiency.

The Dispatch and In-Flight LD computations towards CONTAMINATED runways is likewise based on reference frictions, which are based on a compilation of historical flight test data. These are defined in EASA AMC to CS25.1591 and adjusted, in some cases, for In-Flight Landing Distances as per the proposed TALPA ARC guidance to FAR25.125 B.

Ground roll Distance basis	RTO	Dispatch	In-Flight LD
DRY	Demonstrated DRY runway friction		Demonstrated DRY runway friction reduced by 10%
WET⁽¹⁾	WET runway friction model as per CS/FAR 25.109(c) multiplied by demonstrated WET runway anti-skid efficiency	Not defined ⁽³⁾	WET runway friction model as per CS/FAR 25.109(c) multiplied by demonstrated WET runway anti-skid efficiency
CONTAMINATED⁽²⁾	Contaminated runway friction model as per AMC to CS25.1591	Contaminated runway friction model as per AMC to CS25.1591	Friction model as per proposed TALPA ARC guidance to FAR25.125 B

Figure 4
Reference friction used for ground roll distances

- (1) The In-Flight Performance Level corresponding to WET runway is GOOD. The specific credit for ground roll distances on WET Grooved or PFC (Porous Friction Course) runways will not be discussed here.
 (2) The In-Flight Performance Levels corresponding to CONTAMINATED runways are expressed as GOOD TO MEDIUM, MEDIUM, MEDIUM TO POOR and POOR.
 (3) Dispatch landing performance on WET is derived from the Dispatch Landing Distance on DRY and thus no specific WET friction definition is provided in the regulations.

Conclusion

The primary objective of brake testing is to fulfil the requirement to model and demonstrate the aircraft's overall stopping performance during rejected take-offs as well as landings.

This entails the determination, on a DRY runway, of the maximum capabilities of the braking system through a series of tests like the Max Energy RTO assessment and landing performance evaluation.

A combination of these flight tests and of analytical models derived from the compilation of historical flight test data, is utilized to calculate the braking performance on DRY, WET and CONTAMINATED runways for RTO, Dispatch as well as In-Flight Landing Distances determination.



Nicolas BARDOU
Director, Flight Safety



David OWENS
Senior Director Training Policy

Introduction

In this article, Airbus would like to take you through a case study and use it to learn some lessons and share our safety first culture.

The article is split into three distinct parts:

- The first will describe the event
- The second, targeted at flight crews, will discuss and develop the stabilization criteria and present a prevention strategy against unstable approaches. It will also insist on the need to use the appropriate level of automation at all times.
- The third part, targeted at maintenance personnel, will illustrate the need to always use the Aircraft Maintenance Manual (AMM) as the source document for maintenance operations.

Hard Landing, a Case Study for Crews and Maintenance Personnel

Description of the Events

Approach and Landing

An A330 is on an ILS in rain. The Captain is PF, with AP1, both FDs and A/THR engaged. At 6 NM from touchdown the aircraft is in flap configuration 3, on glide slope and localizer at Vapp. ATC provided the flight crew with latest weather information: 10 kt tailwind with windshear reported on final.

Passing 1,500 ft, AP and A/THR are disconnected and the approach is continued manually. An initial LOC deviation of ¼ of a dot is corrected by PF. Passing 1,000 ft,

the crew report runway in sight. Passing 500 ft, several flight parameters (localizer, glide slope, vertical speed, pitch, bank...) briefly exceed the published "approach stabilization criteria" but each is corrected by PF.

However, by 150 ft radio altitude, the aircraft is above the glide by more than one dot and two nose-down inputs are applied. The rate of descent increases to -1,100 ft/min and the EGPWS alert "SINK RATE" sounds twice, the second time below 50 ft. Despite a nose up input during the flare the aircraft impacts the ground at -1,260 ft/min with a vertical acceleration of 2.74 g.

After Landing

The flight crew reported the hard landing in the tech logbook and passed the information to the station's maintenance.

The technician applied customized technical notes that specified that in the absence of load report 15 - generated by the Aircraft Condition Monitoring System (ACMS) in case of hard landing - and if the Data Management Unit (DMU) is functioning properly, no aircraft inspection was required and the DAR disc was to be replaced and kept in the aircraft for further analysis at the home base.

On that particular case the DMU was considered to be functioning because messages had been received by the home base during the flight. Load report 15, however, was not transmitted via ACARS until the following day, due to an internal failure known as a DMU lock up (REF A).

The aircraft was cleared to be dispatched for the return flight.

After take-off, due to the damage sustained during the hard landing, the landing gear failed to retract and the flight crew elected to perform an In Flight Turn Back after enough fuel was burnt to land below MLW. The aircraft landed safely.

Operational Recommendations

Stabilization criteria

The Flight Crew Training Manual (FCTM) and Flight Crew Operating Manual (FCOM) both state that deviation from the normal stabilization criteria should trigger a call-out from Pilot Monitoring. These calls should in turn trigger, at the very least, an acknowledgment from PF, and, where necessary, corrective action. The criteria vary from type to type but typically a call should be triggered if:

- The speed goes lower than the speed target by 5 kt, or greater than the speed target by 10 kt.
- The pitch attitude goes below 0°, or above 10°.
- The bank angle exceeds 7°.
- The descent rate becomes greater than 1,000 feet/min.
- Excessive LOC or GLIDE deviation occurs: ¼ dot LOC; 1 dot G/S.

There are generally considered to be three essential parameters needed for a safe, stabilized approach:

- Aircraft track
- Flight Path Angle
- Airspeed

What could the crew have done to prevent this event?

Preventing unstable approaches

The prevention strategy against unstable approaches may be summarized by the following key words:

- | | |
|---------------------|------------------|
| – Train | – Correct |
| – Anticipate | – Decide |
| – Detect | |

Train

Prevention can be emphasized through dedicated training for:

- Stabilized approaches
- Pilot Monitoring
- Difficult and unexpected reasons to initiate a go-around as part of recurrent training – not just go-around from minima, “nothing seen!” Try introducing a sudden, late wind shift...

Anticipate

First, define and brief a common plan for the approach including energy management and the use of automation.

Then, identify and discuss factors such as non-standard altitude or speed restrictions, approach hazards, system malfunctions.

Finally, brief several scenarios in readiness for anticipated ATC requests or other needs to change your initial plan: What if?

Detect

Make time available and reduce workload by avoiding all unnecessary / non pertinent actions, monitor flight path for early detection of deviations and provide timely and precise deviation call-outs. Be alert and adapt to changing weather conditions, approach hazards or system malfunctions.

Correct

It is very important to correct as early as possible any deviation throughout the approach. To do that, various strategies can be used such as using speed brake to correct excessive altitude (not recommended in final approach), early extension of landing gear to correct excessive airspeed or extending the outbound or downwind leg will provide more distance for approach stabilization.

Acknowledge all PM call-outs for proper crew coordination and take immediate corrective action before deviations develop into a challenging or a hazardous situation.

Decide

Assess whether stabilized conditions will be recovered early enough prior to landing, otherwise initiate a go-around.

Be go-around-prepared:

Discuss the go-around maneuver during descent preparation and approach briefing. Keep it in mind while monitoring the descent, task sharing... Be ready to challenge and change plans as necessary.

Be go-around-minded:

“Let’s be prepared for a go-around and we will land only if the approach remains stabilized, and we have adequate visual references to make a safe landing”

In this regard the flight crew need to:

- Maintain stable approach criteria throughout the approach and into the landing flare.
- Ensure that the necessary ATC clearances have been received in a timely way.
- Ensure that the visual references below DH or MDA are maintained.
- Ensure that the runway is clear.
- Be open and ready for a go-around until the thrust reversers have been selected.

Remember - a go-around is always possible until the reversers have been selected. Up to that point, it is never too late to go around.

Appropriate Use of Automation

Before and during that approach there were plenty of clues that should have warned the crew of the high probability of a challenging approach. Indeed, the crew subsequently reported that they had to, “fight to maintain the airplane on track”.

Passing 1,500 ft, PF disconnected AP and A/THR, thereby depriving himself of additional help that automation offers. Keeping A/THR engaged longer would have reduced the workload of the flight crew in the management and control of the airspeed.

During the very last part of the approach, the tailwind may have been seen as a threat as regards idle thrust values and slow spool up times in the event of a go-around. The use of A/THR in this situation might have stabilized the thrust more quickly than a pilot could using manual thrust, especially with such high workload. This would have resulted in a higher thrust setting, above idle and enabled a more rapid thrust response in the event of a go-around.

The issue here is that the workload required to maintain stability became excessive at a very late stage, when the crew experienced the rapidly changing winds on short final, making the last part of the approach rather difficult to

handle in terms of trajectory and speed. But there were clues that the workload was building throughout, long before it became critical. In other words, the workload had become so great that the crew had lost their capacity to fly the aircraft at the required level of precision!

Stability is therefore not just a matter of numbers (speed, pitch etc) but also the effort PF is applying to maintain stability. If that effort equals or exceeds his ability, a go-around must be immediately performed. On this approach, an appropriate use of automation might have allowed the flight crew to better gauge the need to go around, thereby avoiding the hard landing.

This is lesson one, in fact, the appropriate use of automation is one of our Golden Rules (fig. 1), presented in issue 15 of this magazine in January 2013.



Figure 1
Airbus Golden Rule for Pilots #2 states
"Use appropriate level of automation at all times"

Lesson number two can be considered as follows.

Perhaps we would now summarize the criteria for a stabilized approach in a slightly different way. We can now take the three essential quantitative parameters needed for a safe, stabilized approach plus one additional qualitative consideration:

- Aircraft track
- Flight Path Angle
- Airspeed
- Workload Capacity

Note: The first three are "classical" measures of achieved performance. The last is a judgment of how hard the PF is working to control the aircraft. Achieving all the numbers is only fine if the crew are still capable of dealing with something else unexpected. Capacity will be reduced in cases of high manual workload. Therefore, using the right level of automation helps.

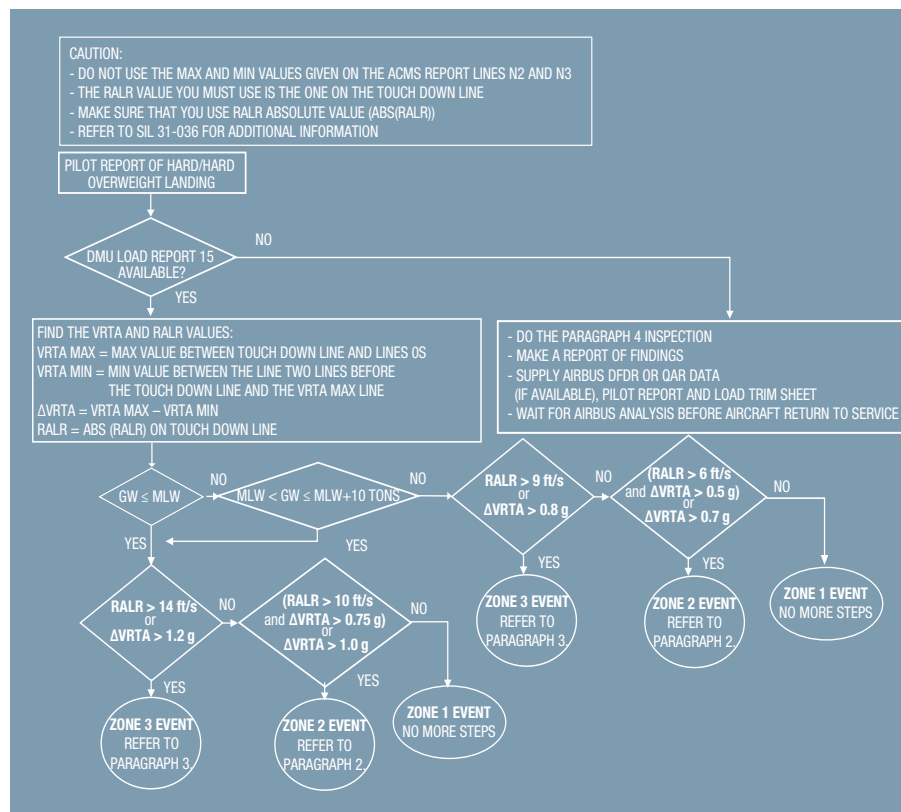


Figure 2
Hard landing flowchart to be added to the A330/A340 AMM in April 2014

Maintenance Recommendations

In this event, customized technical notes were used by the operator, instead of the Airbus originated AMM and as a result the aircraft was cleared to be dispatched for the return flight.

The AMM states that the primary source for a suspected hard landing is the flight crew. From this point on, a hard landing situation has to be fully considered until damage is assessed and it is clearly proven that there are no "downstream effects".

This will trigger some aircraft inspections defined in AMM 05.51.11 that could be alleviated by using load report 15 or DFDRS (DFDR, QAR, DAR...). The load report 15 should not be used to confirm a hard landing but used in a way to determine easily the level of inspection that may be needed.

At the time of this event, AMM 05.51.11 B(2)(b) "Procedure to Confirm a Suspected Hard/Hard Overweight Landing", stated:

"If you do not (or if you cannot) read the landing impact parameters from the load report 15, or the DFDRS, do these steps before the subsequent flight:

- Supply DFDR or QAR data (if available) to Airbus with the pilot report and the load trim sheet.
- Do the inspection in paragraph 4 and make a report of damage or what you find.
- Airbus will do an analysis of the incident to find if the aircraft can return to service. (The aircraft cannot return to service without Airbus decision)."

To avoid any possible confusion, A330/A340 AMM 05.51.11 will be amended in April 2014 to include:

- A modified wording of the first phrase of the above procedure, which now reads: "If load report 15 or the DFDRS data are not available or you cannot read them..."
- A flowchart to guarantee the same level of readability as on the A320 Family AMM (fig 2).



Figure 3
Damage on the aircraft following the hard landing:
aircraft's Landing Gear

The load report 15 is generated automatically by the ACMS memory right upon landing and should be available via the MCDU / ACMS MENU / STORED REPORTS.

DMU reports can be obtained by 4 non-exclusive manners:

- Manual print out by crew
- Automatic print out (depending of equipment via MCDU (AMM task 31-36-00) or ACMS (ground programming vendor tool)
- ACARS transmission
- ACARS request (depending on A/C configuration)

Operators are encouraged to review their policy to optimize the access to the load report 15, by being made aware of the four alternative ways that the DMU report can be accessed.

Note: The DMU is not a No Go item. An aircraft can be dispatched with none operative and the repair interval is fixed at 120 calendar days in the MMEL.



Figure 4
Damage on the aircraft following the hard landing: ripples on the fuselage

Conclusion

This in-service case study allowed to illustrate three messages that ought to be highlighted:

- Use the appropriate level of automation at all times
- There are four essential parameters needed for a safe, stabilized approach:
 - Aircraft track
 - Flight Path Angle
 - Airspeed
 - Workload capacity, which may be reduced in case of high workload
- Always use the Airbus AMM as the base documentation for maintenance operations.

Reference:

A: Technical Follow-Up (TFU)
ref 31.36.00.070 LR Honeywell DMU
Lock-up issue

Introduction

Non-adherence to the correct aircraft washing/cleaning and painting procedures regularly generate safety events.

This article will illustrate, through real in-service occurrences, that even activities performed primarily to improve the appearance of the aircraft and better display the airline logo may affect the safety of operations.

The lessons learnt from these events are common: washing or painting an aircraft must be done according to the published procedures and using the correct equipment. These are specified in the Aircraft Maintenance Manual (AMM), Structure Repair Manual (SRM) and Tool and Equipment Manual (TEM).



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Aircraft Protection, during Washing and Painting

Case Study n°1

What happened?

An A320 performed a landing with the Nose Landing Gear (NLG) in a position of about 90° from the aircraft centreline (fig. 1). The aircraft landed safely and stopped on the runway. The NLG was damaged.

Why did it happen?

Inspection of parts confirmed traces of water in the Nose Wheel Steering (NWS) feedback sensors and water ingress inside the NLG turning tube.

During the flight, the water froze and blocked the sensors. The sensors could therefore no longer provide the correct feedback on the NLG position. The Brake System Control Unit (BSCU) tried to align the NWS to the aircraft centreline. In absence of a correct feedback signal, the NWS was rotated further until the steering system was detected as faulty. The hydraulic supply to the steering system was shut-off, but the NWS was already at an almost 90° position from the centreline and could not be re-centred mechanically.

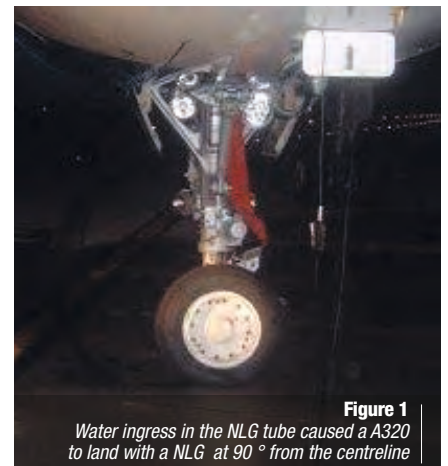


Figure 1

Water ingress in the NLG tube caused a A320 to land with a NLG at 90° from the centreline

Further investigation on the maintenance history revealed that the aircraft had a scheduled maintenance check just few flights prior to the reported event. During the check, the maintenance provider performed aircraft external cleaning using a high pressure jet device. Consequently, water entered into the NLG and feedback sensors through a vent hole located at the top of the NLG.

Lessons learned

Pay special attention to the instructions and cautions requesting to use protective devices as required in the AMM procedures for external cleaning of the aircraft.

The instructions and cautions are applicable for all sensors and probes such as Angle of Attack sensors, pitot probes, temperature sensors, static probes, ice detection probes,...

In particular, do not use high pressure jets or vapour for cleaning. This type of equipment can force water and moisture into the parts and cause damage to them.

References:

- AMM 12-21-11 Page Block 301, "External Cleaning"
- AMM 32-11-00 Page Block 701, "Main Gear Cleaning / Painting"
- AMM 32-21-00 Page Block 701, "Nose Gear Cleaning / Painting"
- Operators Information Transmission (OIT), ref. 999.0067/13, dated 26 Sep 2013

Subject: ATA 34 – Protection of Angle of Attack (AoA) sensors during aircraft exterior cleaning. This OIT reminds operators of the AoA sensor protection to be used during aircraft exterior cleaning and the importance of respecting this guidance.

- Operator Information Transmission (OIT), ref. SE 999.0042/10, dated 06 May 2010

Subject: ATA 32 – Water ingress in nose wheel steering feedback sensors.

Case Study n°2

What happened?

An aircraft was re-painted by a third party maintenance organisation. The operator discovered, before the aircraft



Figure 2
A clear plastic film over the static ports was left on the aircraft when it was handed back to the operator

was returned into service, that there was a clear plastic film over one of the static ports that was almost impossible to detect visually (fig. 2, 3 & 4).

If the clear plastic film had not been discovered and removed, it would have caused incorrect indications on the related cockpit instruments

Why did it happen?

Inadequate protections were applied during aircraft painting in such a way that they were difficult to see from the ground. As a result, they were not removed after the painting job was done.

The transparent plastic was only noticed because of the presence of air bubbles under the film.

Lessons learned

Follow the AMM and SRM instructions for stripping, paint removal, cleaning and painting as summarised below:

Aircraft Maintenance Manual (AMM)

In AMM chapter 51-75-11 PB 701 – Stripping/paint removal – cleaning/ painting, the following Warning and Caution are included:

- The "Caution" provides a list of materials, areas, and parts for which a correct protection from chemical paint strippers are required. This list includes:

Rubber, all composite parts, acrylic materials, aerodynamic smoother, metal bonded edges, pitot tubes, sensors, static ports, engine air intake, pre-cooler air outlet screen, engine exhaust duct, APU exhaust, APU intakes and outlets, air conditioning ram air inlets, landing gears, door seals, access doors, cabin window and windshield panels and seals, electrical equipment and cables, plastic materials, external ski panel joints, high strength steel parts, drain holes, vents, and all antennas.

– The “Warning” notice highlights that adhesive tapes must not be applied on the probes, ducts, and sensors (static, pitot, TAT, AoA). Only specified tools should be used to seal the aircraft, which will ensure:

- Correct protection of the aircraft equipments
- Good visibility from the ground
- Ease of removal

The Warning notice also explains how the incomplete removal of tapes or tape adhesive from probes, ducts or sensors may lead to incorrect indications on the related cockpit instruments.

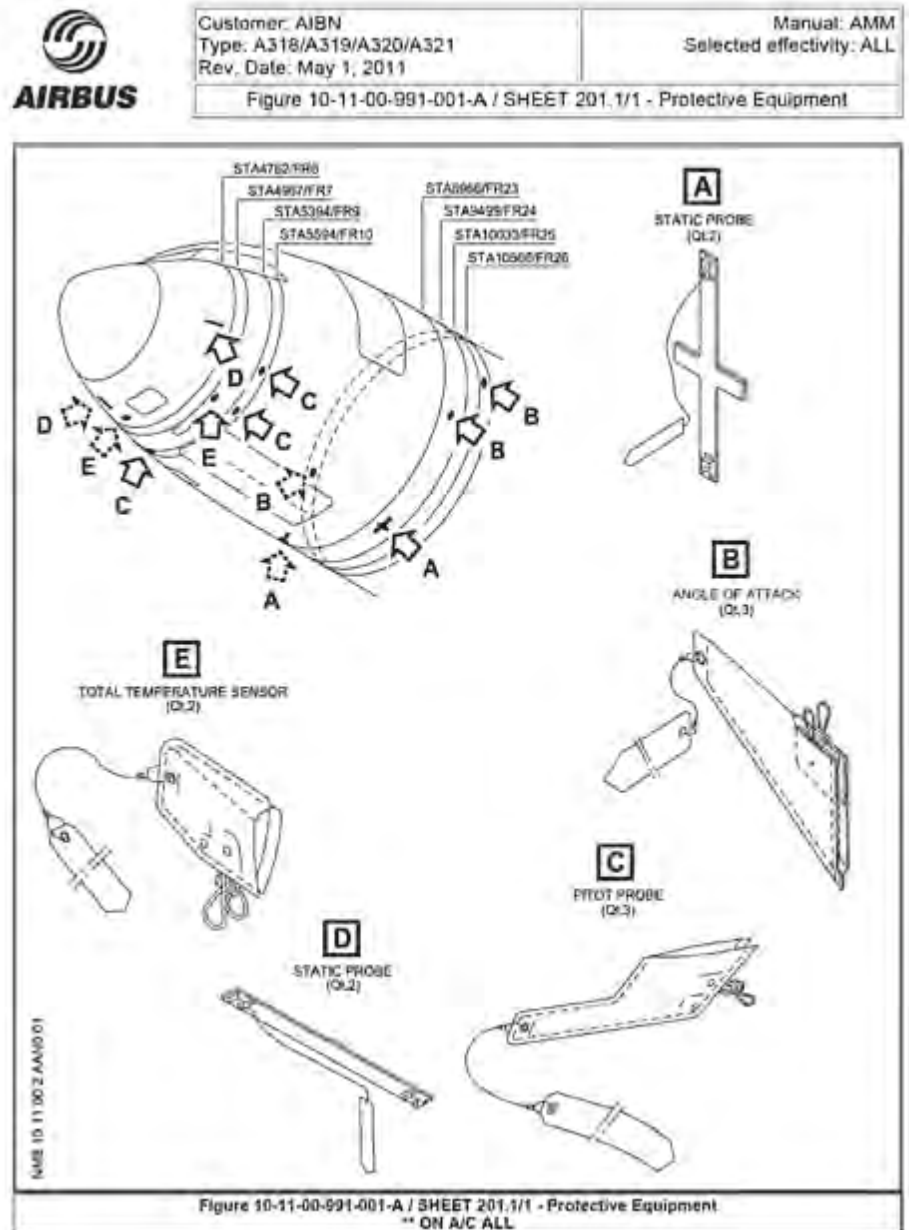
Tool and Equipment Manual (TEM)

The description of the protective equipments is given in the Tool and Equipment Manual (TEM)

Structure Repair Manual (SRM)

Chapter 51-75-11 contains recommendations for stripping and paint removal. The SRM provides also cautions in chapter 51-75-12, Repair of Paint Coatings, about the materials, areas and parts affected by the painting activities, which must be properly protected. A caution includes instructions to remove all masking materials upon work completion, with a special attention to pitot heads and static ports.

Figure 3
The aircraft protection equipment to be used for the static probes is given in the AMM chapter 10-11-00 Page Block 201



Part No.	98D10103500001(FAPE3)
Designation	COVER-STATIC PROBE
Description	This tool is used to blank the static probes. Note: this tool is in the flight kit.
See drawings	98D10103500 COVER STATIC PROBE
References	AMM 10-11-00 AMM 12-21-11 AMM 34-21-00

Figure 4
Fig 4: TEM description of the static probe cover

Conclusion

In-service experience has taught us that even activities performed on the aircraft mainly for cosmetic reasons, like washing or painting, may have an impact on the safety of operations.

The in-service incidents described in this article illustrate the need to carefully follow the indicated instructions available in the Aircraft Maintenance Manual, Structure Repair Manual as well as Tool and Equipment Manual.



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Flight Data Analysis (FDA), a Predictive Tool for Safety Management System (SMS)

Introduction

A Flight Data Analysis (FDA) program, also known as Flight Data Monitoring (FDM) or Flight Operation Quality Assurance (FOQA) is designed to enhance Flight Safety by:

- **Identifying an airline's operational safety risks**

FDA is based on the routine analysis of data recorded during revenue flights. These data are compared against pre-defined envelopes and values, to check whether the aircraft has been flown outside the scope of the standard operating procedures (safety events).

- **Taking the necessary actions to reduce these risks**

When a safety event is highlighted by the program, statistical analysis will assess whether it is isolated or part of a trend. Appropriate action is then taken in order to take corrective actions if needed.

This article briefly describes the recorders evolution, which allowed evolving from a reactive to a predictive hazard identification methodology. Each step of an FDA program will then be detailed and for each step, best practices will be highlighted.

History of Recorders

During World War II the US National Advisory Committee for Aeronautics (NACA) installed recorders in fighters, bombers and transport aircraft to collect indicated airspeed and load factor data in order to improve structural design.

Later in the sixties, regulatory authorities mandated the fitting of Flight Data Recorders (FDR) into large commercial aircraft for accident investigation. The first FDRs (fig.1) could only engrave 5 parameters onto a non-reusable metal foil: heading, altitude, airspeed, vertical acceleration and time.

Recorders technology then improved significantly - from analogue to digital on tape (fig.2), then to solid state (fig.3) able to record over 3,000 parameters. In the meantime, Flight Data Monitoring processes were encouraged and sometime requested by authorities.

Today, while Flight Data Recorders (FDR) or Digital Flight Data Recorders (DFDR) are dedicated to accident investigation (fig.4), Flight Data Analysis programs extract data from easily accessible Quick Access Recorders (QAR) or Digital ACMS* Recorders (DAR). QARs are exact copies of the DFDRs while DARs allow to customize the recorded parameters.



Figure 1
First generation, metal foil recorder



Figure 2
Second generation, tape recorder



Figure 3
Third generation, solid state recorder



Figure 4
Flight Data Recorders (FDR)

*Aircraft Condition Monitoring System

Hazard Identification Methodologies

The ICAO SMS Manual defines three methodologies for identifying hazards:

- **Reactive** - Through analysis of past incidents or accidents

Hazards are identified through investigation of safety occurrences. Incidents and accidents are potential indicators of systems' deficiencies and therefore can be used to determine the hazards that were both contributing to the event or are latent.

- **Proactive** - Through analysis of the airline's activities

The goal is to identify hazards before they materialize into incidents or accidents and to take the necessary actions to reduce the associated safety risks. A proactive process is based upon the notion that safety events can be minimized by identifying safety risks within the system before it fails, and taking the necessary actions to mitigate such safety risks.

- **Predictive** - Through data gathering in order to identify possible negative future outcomes or events.

The predictive process captures system performance as it happens in normal operations to identify potential future problems. This requires continuous capturing of routine operational data in real time. Predictive processes are best accomplished by trying to find trouble, not just waiting for it to show up. Therefore, predictive process strongly searches for safety information that may be indicative of emerging safety risks from a variety of sources.

As illustrated in the history paragraph above, FDR logically led to FDA and the reactive process evolved into a predictive process. The main asset of an efficient FDA is to be able to jump directly to the predictive process without passing through the incident or accident reactive process case. In other words, FDA prediction process aims at avoiding material and/or human costs by being ahead of any safety precursors before an incident or accident occurs..

FDA: the full Method and its best Practices

Flight Data
Recording



Flight Data
Downloading



Flight Data Recording

Information coming from aircraft sensors, onboard computers and other instruments is recorded into the dedicated FDA recorder (QAR, DAR ...). These Data are recorded as binary raw data files which are sequenced in frames and subframes. Each subframe is divided into a number of "words", each one with a fixed number of bits. A parameter is recorded on one or several bits of one or more words. To save memory space, a parameter value is generally not recorded as such, but converted using a conversion function defined by the aircraft manufacturer.

BEST PRACTICE

High ratio of monitored flights

- Flights should be monitored as much as possible to make the analysis as valuable as possible, 90% should be a minimum.

Calibrated data

- Depending of what data is available and what needs to be monitored, the choice of recorded parameters must be carried out carefully.
- These selected parameters should be recorded at the optimum frequency depending on the parameter sensitivity (sampling rate).

Recorders reliability

- A solid maintenance process must be implemented to maintain the recorders at a high level of efficiency through regular testing and calibrating.

Flight Data Downloading

When the aircraft arrives at the gate, data are either extracted by maintenance staff via optical disc or Personal Computer Memory Card International Association (PCMCIA) card, or automatically via a wireless link (fig.5 & 6).



Figure 5
Wireless ground link box

BEST PRACTICE

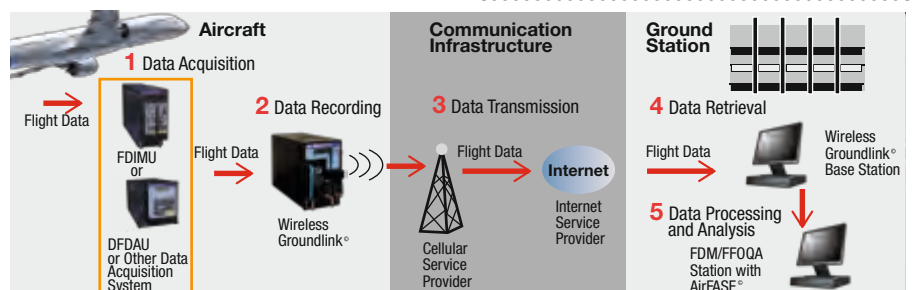
Recovering reliability

- The maintenance data recovery process should be secured through a useful and understood process.

Recommended automated wireless downloading

- It guarantees a high rate of downloaded flights by avoiding overloaded memories and thus partial loss of flight data.

Figure 6
Example of Wireless ground link system



Flight Data Processing

Flight Data Analysis

Safety Risk Management, Communication and Improvement Monitoring

Flight Data Processing

To transcribe the recorded parameters into exploitable values, raw data must be processed in order to recover the actual values (fig.7 & 8). An automatic filtering helps rejecting corrupted data. Some values must be derived from processed parameters because not recorded as such.

Events are automatically weighted according to risk (low, medium or high) with fine tuned algorithms. Several events can be associated to unveil an undesirable situation (for example: path high in approach at 1,200 feet + path high in approach at 800 feet + path high in approach at 400 feet = continuously high path during final).

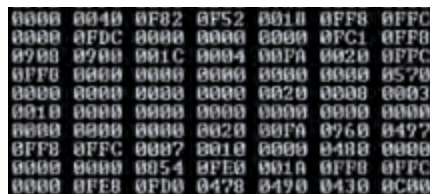


Figure 7
Example of Hexadecimal uncompressed raw data

BEST PRACTICE

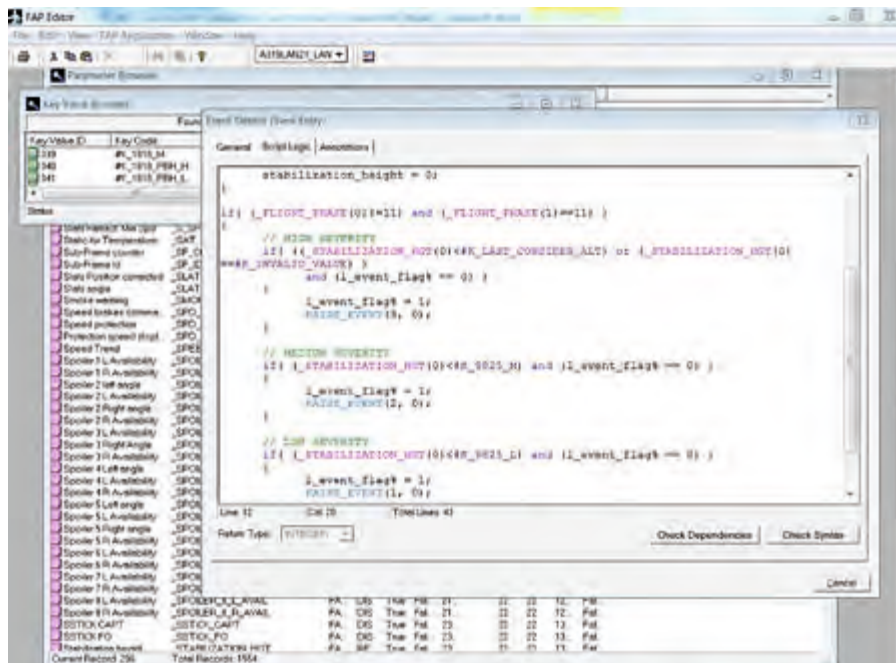
Good data resolution

- Selected data must be reliable and pertinent, they should benefit from a large number of measuring points (for example, to be able to trace the exact touch down point at landing, the vertical acceleration must be recorded at a high frequency ratio).
- The decoding program, used for actual exploitable values recovery, must be refined and validated by expert pilots for operational legibility.

Calibrated and validated event definition

- The event development and algorithms of computation need to be simple and operationally meaningful.
- Their detection thresholds need to be calibrated and verified by using various means like simulators, cross comparison and/or flights.

Figure 8
Example of event algorithm in development environment



Flight Data Analysis

Analysts manually filter the developed flights to reject the inconsistent ones and therefore guarantee the robustness of the data base.

They look for all high deviation magnitude events in order to assess any serious safety concern and take appropriate corrective action (fig.9 to 15).

Correlation with all other means like mandatory or voluntary reports for example, will multiply the analysis efficiency.

All reliable events are stored into the database and are investigated on a regular basis to highlight any trend that could show a latent or potential risk.

BEST PRACTICE

Appropriate analysis

- A filtering is necessary, it is usually difficult and time consuming (for example all non-revenue flights like training flights must be removed from the analysis data base in order not to induce wrong statistical figures – training flights more frequently generate some particular types of events).

- A single flight with high deviation level must be analyzed following the steps of the proactive process.

- To understand and interpret the results properly, pilots who are conversant with flight data analysis and proficient on the aircraft type must be involved for their operational expertise.

- Statistics on a large number of flights must be done on a regular basis following the steps of the predictive process.

Competent Flight Data Analysis team members

- FDA team members should have an in-depth knowledge of SOPs, aircraft handling characteristics, aerodromes and routes to place the FDA data in a credible context

- All FDA team members need appropriate training or experience for their respective area of data analysis



Figure 9
Example of an FDA tool: AirFASE



Figure 10
Example of airport visualization



Figure 11
Example of arrival chart visualization

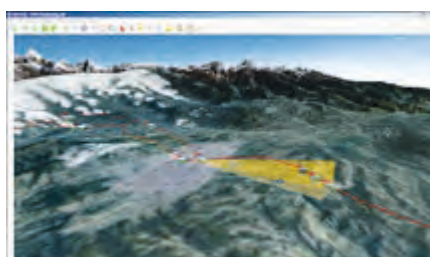


Figure 12
Example of RNP-AR arrival visualization

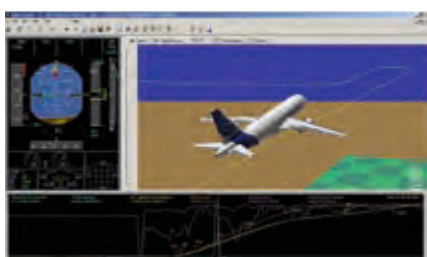


Figure 13
Example of flight replay

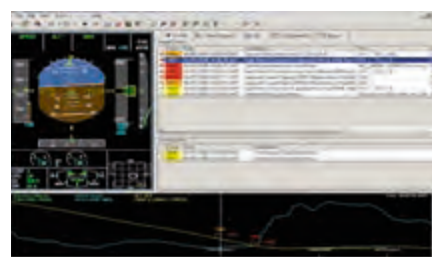


Figure 14
Example of flight replay



Figure 15
Example of list and trace



Figure 16
Example of statistical analysis

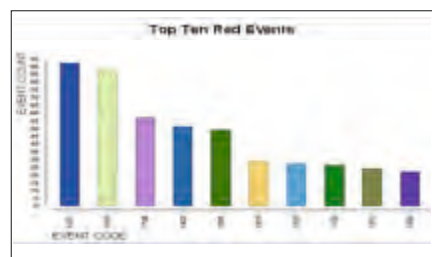


Figure 17
Example of statistical analysis

Safety Risk Management, Communication and Improvement Monitoring

The process starts with the identification of hazards and their potential consequences. The safety risks are then assessed against the threat of potential damage related to the hazard. These risks are weighted in terms of probability and severity (fig.16 & 17). If the assessed safety risks are deemed not to be tolerable, appropriate corrective action is taken.

When an issue emerges, when a mitigation action has been decided by competent people, it must be communicated to the whole air operation community to share all related safety information. Knowledge is a good protection against any potential risk.

On the other hand an adequate monitoring process must be started to validate the efficiency of the mitigation action. This aims to guarantee the effective closing of the loop.

BEST PRACTICE

Competent safety risk assessment team members

- The people in charge of assessing the safety risks must have a good knowledge and background on flight operations and must have been especially trained to perform an efficient risk assessment.

Feedback to operations

- Mankind survived and developed principally due to its ability to communicate and share any risk knowledge. It is still valid in the aviation environment and information on any safety concern must be widely spread out.

Conclusion

As part of an airline Safety Management System, Flight Data Analysis is a very powerful tool. This is true if used properly, which implies that All FDA team members are trained and competent in their area of analysis and risk assessment.

Amongst others practices it should be demonstrated that:

- The recorders health are monitored,
- High ratios of flights are recorded and analyzed,
- The analysis data base is filtered,
- Pilot expertise is used for to validate the decoding process and understand the fine analysis.

Finally, proper analysis / identification of right priorities / definition of mitigating actions and their associated action plan are the essential elements to obtain the maximum benefit from Flight Data Analysis tools and processes.



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Flying a Go-Around Managing Energy

Introduction

Airbus recently performed some research on the quality of go-around execution. This involved examining nearly 500,000 approaches flown by many airlines from around the world.

The results highlighted that in some cases crews are choosing not to apply the Airbus Standard Operating Procedure (SOP) for the go-around phase.

Particularly when a go-around was performed above 1,200 ft, the flight crew often decided to adapt the engines thrust selection instead of setting TOGA thrust. Feedback from operators also indicates a similar tendency. As a result, Airbus received several reports of unexpected aircraft trajectories and energy management techniques during the go-around procedure.

Therefore, it was decided to address these issues by:

- Better defining an optional thrust levers management technique during the a go-around, as per Airbus SOP.
- Developing a “Discontinued Approach” technique that would allow crews to effectively “abort” the approach without selecting TOGA detent.

The Flight Crew Training Manual (FCTM) and the Flight Crew Operating Manual (FCOM) were updated accordingly end 2013 (updates respectively in March and May 2014 for the A300/A310 and A380).

Feedback from Operators

Between 2010 and 2012, Airbus performed a survey on go-arounds that required a close examination of the approach phase of nearly 500,000 flights. The confidential survey gathered data from 12 airlines from all areas around the world. Amongst many facts that were established was the general go-around rate which was one go-around in 340 approaches for the A320 family fleet and one go-around in 240 approaches for the A330/A340 fleet.

The main outcome of this survey was that, above 1,200 ft AAL, over half of the go-arounds were performed without selecting the thrust levers to the TOGA detent (fig1).

Perhaps the most obvious result of this research was that with go-arounds at heights above 1,200 ft the adherence to the Airbus standard go-around procedure was only about 50%.

The reason is that crews are reluctant to use TOGA power, even briefly, if they only have a short climb to their FCU Altitude.

In addition to the figure above, several other discreet areas of go-around management were analysed. These included configuration management, speed control,

pitch control and the use of automation versus manual flight.

To initiate a go-around, Airbus has always recommended the application of the standard go-around procedure with the selection of TOGA detent. With an aircraft that is flown according to the SOP there is no particular difficulty with such a procedure. But if the pitch target is not achieved and a go-around with maximum thrust is applied to a light weight aircraft, this may give rise to an excess energy situation. So the questions being asked were: is there a solution to limit the excess aircraft energy, and is there an alternative to the standard go-around procedure for these "high altitude" go-arounds?

Recommendations on the Go-Around Procedure

To initiate a go-around, flight crews set the thrust levers to the TOGA detent. The engine thrust then increases to the maximum available thrust. Setting the thrust levers to the TOGA detent is important because the lever movement to TOGA engages the correct FMA modes and then, the FMS sequences the Missed Approach guidance that is pre-coded in the FMS Navigation Database.

When the flight crew performs a go-around SOP, they set the thrust levers to the TOGA detent.

This triggers the:

- **Disarming or disengagement of approach modes in the flight guidance**
- **Engagement of the go-around mode in the flight guidance (SRS – GA TRK)**
- **Engagement of the go-around phase in the FMS.**

However, in some cases, maximum thrust is often not required to perform a safe go-around and at some airfields the Missed Approach Altitude is quite low.

The SOP already mentioned that after having set the thrust levers to TOGA detent, if TOGA thrust was not required, the flight crew might retard the thrust levers as required. However, there was no additional recommendation for the flight crew on which position the thrust levers had to be set.

Airbus now specifies in the procedure:

If TOGA thrust is not required, the flight crew should set the thrust levers to the CL detent, after having selected them to TOGA position just at the go-around initiation point.

This action aims at limiting the aircraft energy during the go-around phase.

Discontinued Approach Technique

Some operators have developed their own customized go-around procedures. These procedures have resulted in unexpected aircraft trajectory and energy situations. Therefore, Airbus developed a technique, based on the knowledge of all associated aircraft systems, to achieve the objective of performing a go-around without applying TOGA thrust. The technique, called "Discontinued Approach", enables the flight crew to abort an approach without setting the thrust levers to the TOGA detent.

The main actions that flight crew have to perform are:

- De-selection of the approach mode
- Management of aircraft trajectory
- Selection of a new destination in the FMS, if required.

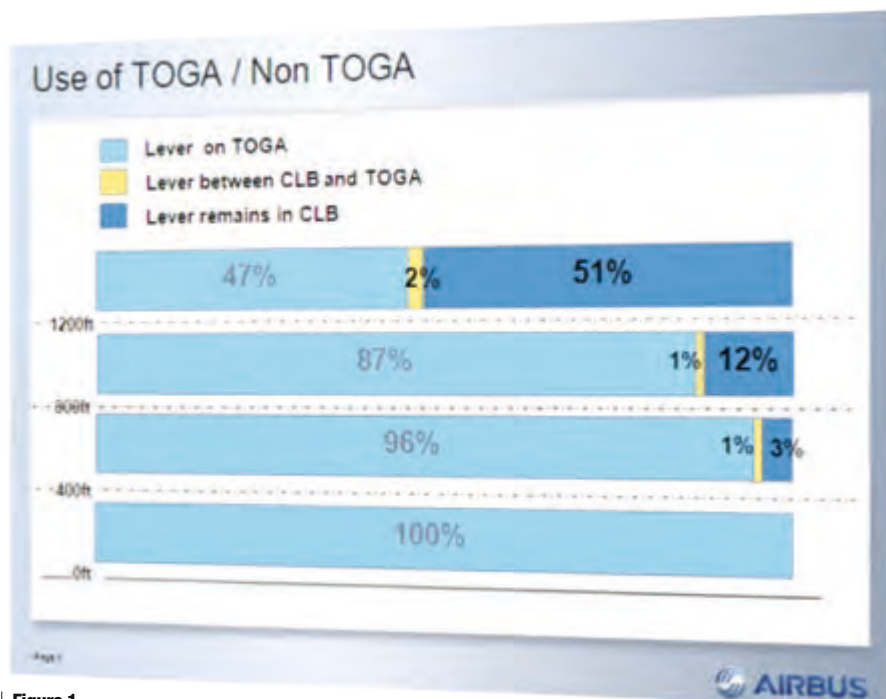


Figure 1
Airbus survey on the use of TOGA during go-around

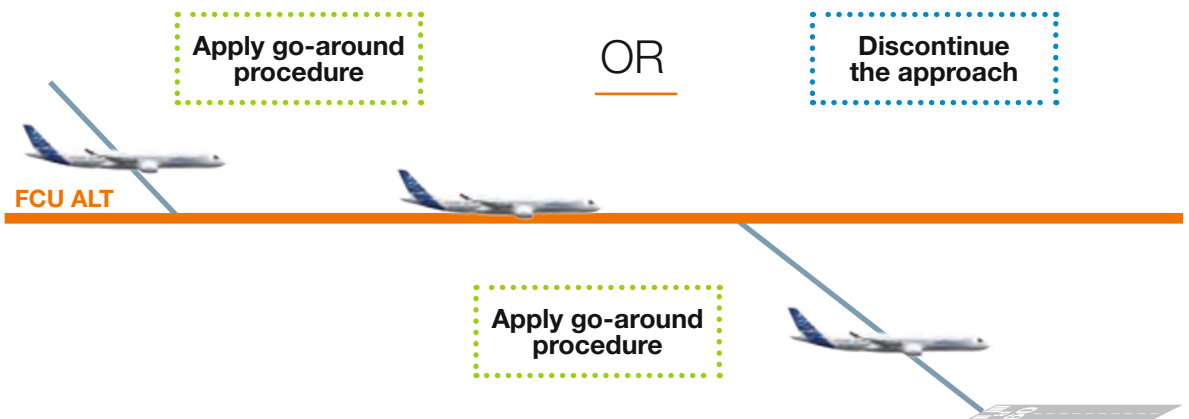


Figure 2
Depending on the altitude selected on the FCU, the flight crew may discontinue the approach.

The FCU altitude during a descent and approach is normally reduced in steps, with ATC clearance, until the initial approach altitude (typically 3,000 ft) is reached. At glide slope capture (G/S) or final approach commencement (FINAL APP) the FCU altitude is set to the missed approach altitude.

The flight crew uses this selected FCU altitude for the decision-making:

- At or above the FCU selected altitude: use either the go-around SOP for the Discontinued Approach Technique (fig. 2)
- When below the FCU selected altitude: use the go-around SOP.

If the flight crew wants to apply the discontinued approach technique, they must go through the **five** following steps:

1) Call "CANCEL APPROACH"

2) Leave the thrust levers in the CL detent

3) De-selects APPR mode(s)

To de-select the approach modes, the flight crew can use the applicable pushbutton: APPR or LOC (if a LOC only approach is being executed). In the case of an ILS approach, for example, both these actions disarm or disengage the LOC and G/S approach modes on the FMA. This action ensures that possible spurious LOC and/or G/S capture (fig. 3) are avoided.

4) Manage the aircraft trajectory in vertical and lateral axis.

- Depending on the ATC orders, select a

heading (HDG), or re-engage NAV if the intention is to fly the missed approach in the FMS Flight Plan (F-PLN).

- Select the appropriate vertical mode to descend or to level-off according to the altitude assigned by the ATC.
- Select a new speed according to the situation.

5) Enter a new DEST in the FMS, if required (fig. 4)

If the flight crew intends to fly the missed approach and overflies the last waypoint of the approach, the FMS considers that the "destination" in the F-PLN has been achieved. The flight crew will have to enter a new destination, which could be the same airport or a diversion airport.

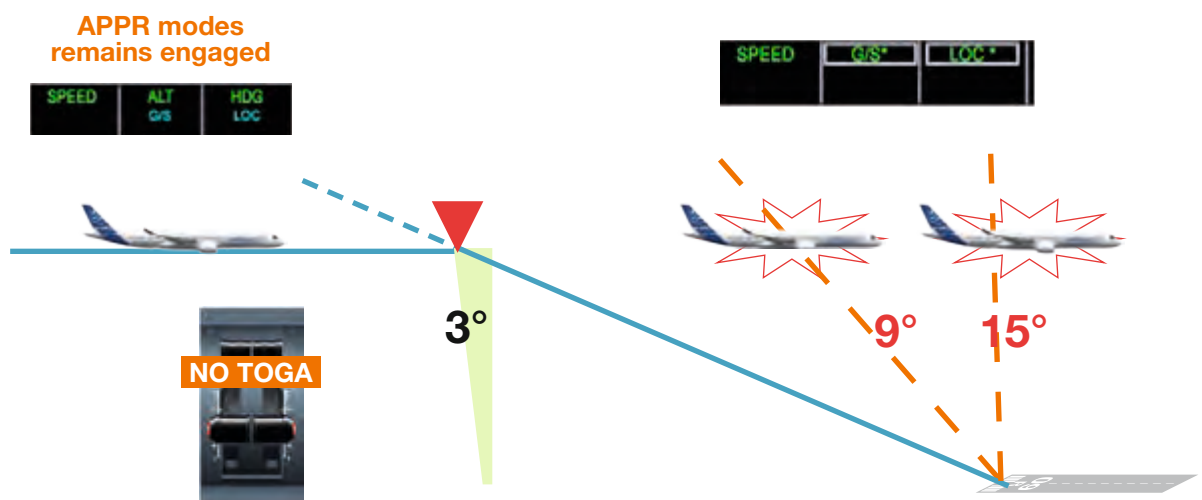


Figure 3
Spurious LOC and/or G/S capture

If a flight crew aborts an approach during an ILS approach without setting the thrust levers to the TOGA detent, the Auto Flight System remains in approach mode with LOC and G/S modes engaged. If the aircraft enters the capture zone of ILS (G/S beam), the aircraft may follow the trajectory of the ILS.

The "false" ILS trajectory could be based on the secondary beam of the ILS at 9 or 15 degrees. As a result, the aircraft can perform a very abrupt trajectory change to follow the secondary G/S beam.



Figure 4
The missed approach remains available when discontinuing the approach. However, the FMS may have “lost” the destination

Conclusion

A thorough go-around survey and in-service feedback highlighted that flight crews were applying customized procedures to interrupt the approach, instead of applying the Airbus go-around SOP procedure. This occasionally led to some poorly flown go-arounds with unexpected trajectories and some mis-configuration issues.

It was therefore decided, in order to avoid excess aircraft energy during the go-around, to:

- **Refine the go-around SOP** with a recommendation, if TOGA thrust is not required, to set the thrust levers to CL detent just after the TOGA detent selection.
- **Develop a new optional technique to discontinue the approach when at or above the FCU altitude**, without setting the thrust levers to TOGA.

This technique consists in the five following steps:

- 1) Call “CANCEL APPROACH”
- 2) Leave the thrust levers in the CL detent
- 3) De-selects APPR mode(s)
- 4) Manage the aircraft trajectory in vertical and lateral axis
- 5) Enter a new DEST in the FMS, if required.

It is important to remember that the standard go-around procedure remains the only procedure within the SOPs that addresses all the go-around requirements in term of performance. Therefore, if there is any doubt about the performance criteria (obstacles, climb gradients etc) during the intended go-around, the standard go-around procedure must be applied.

This article highlights the two recommendations that were introduced in the FCOM PRO-NOR-SOP “Approach General” and in the FCTM Normal Operations NO-180 “Approach” at the end of 2013 (updates respectively in March and May 2014 for the A300/A310 and A380).

Two ‘Safety first’ articles have in the past been devoted to the go-around procedure:

- The first, “Go-around Handling” issue 10, August 2010, highlighted that on Airbus Fly By Wire aircraft the go-around flight guidance modes of the Auto Flight System are triggered by setting the thrust levers to TOGA.
- The second, “The go-around Procedure” issue 12, July 2011, insisted on the need to fly and maintain the proper pitch and on the necessity to retard the thrust levers from TOGA to CL detent without delay in the event of an early capture of altitude.

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