

The Airbus Safety Magazine

July 2014

#18

Safety first



Safety first

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iOS (iPad & android)

editorial



YANNICK MALINGE

SVP, Head of Product
Safety

Measuring safety has always been a challenge. Why is it so? By lack of appropriate tools to measure it or is it due to the very nature of safety? Most probably the second, especially when it comes to a complex and dynamic system such as the air transport system.

Should we then measure the “non-safety” through actual events and more precisely accidents? This is a shortcut commonly used. We all came across headlines saying “Year 20** was very safe! There were only X fatal accidents”. If this statement sounds intuitively reasonable, reality is a bit more complex...

Indeed, fortunately, aviation accidents are rare events and there is a random dimension to their occurrence. Therefore, if the number of accidents or the accident rate increases by a factor two from one year to the next, it would be too simplistic a statement to consider that the safety level was divided by two.

Numbers, rates, statistics can be counterintuitive when it comes to rare events and can become misleading if not interpreted correctly.

Yet, they can be useful and powerful to identify trends and drive safety initiatives. They have always helped us focus our safety efforts, including our safety communication topics, on safety relevant areas.

This year, for the first time ever, Airbus published an accident statistics brochure to share with you not only the figures, rates and meaningful trends, but also to qualify and demystify what lies behind the numbers.

A useful complement to the more practical topics addressed in this new issue of Safety first!

A handwritten signature in black ink, appearing to read 'Y Malinge', with a stylized flourish at the end.



A makeover for Safety first!

A new layout to improve the reading experience and to ease the identification of subjects of interest:

Sections: each article is now allocated to one specific, colour coded, section:

- **Procedures**
- **Aircraft**
- **Training**
- **Operations**
- **General**

Domains: pictograms at the beginning of each article characterize the domain(s) addressed:



Flight operations



Engineering



Maintenance



Ground operations

The entire Safety communication team hopes that you will enjoy these changes, and wishes you a happy reading!

SAVE THE DATE NEWS

21st FLIGHT SAFETY CONFERENCE – 2015

We are pleased to announce that the 21st Flight Safety Conference will take place in Paris, France, from the 23rd to the 26th of March 2015. The formal invitations with information regarding registration and logistics, as well as the preliminary agenda will be sent to our customers in December 2014.

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

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.

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





Safety first #18

PROCEDURES

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Control your speed... at take-off

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Safe operations with
composite aircraft

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pallets movement

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Parts Departing from Aircraft (PDA)



Flight operations



Maintenance



Engineering



Ground operations



Control your speed... at take-off

One of the most critical decisions that every line pilot may potentially encounter during every take-off is to continue or abort the procedure; hence the essential need to properly monitor the airspeed during this phase.



**LORRAINE
DE BAUDUS**

A320/A330/A340 Flight
Operations Safety
Enhancement



**PHILIPPE
CASTAIGNS**

Experimental Test Pilot

Overlooking the airspeed during take-off or conducting a take-off with an inappropriate speed are directly associated to the following main risks: a lateral or longitudinal runway excursion, maximum brake energy exceedance resulting in a brake fire, tail strike, lack of lateral control once the aircraft is airborne, or obstacle clearance trespassing.

This article aims at providing some reminders on the ways the various take-off characteristic and limit speeds are elaborated from the certification requirements to the flight test validation, and how they can be implemented in daily operations.

We will offer a series of articles on this topic, in the present and future issues of our magazine, aiming to detail everything you always wanted to know about speeds... but were afraid to ask. The lines that follow are focusing on the take-off phase.

SECURING YOUR TAKE-OFF: UNDERSTANDING SPEEDS

Characteristic speeds are intended to provide reference points that can be used by pilots as a guide in making judgement in a very dynamic situation. In this respect, they need close supervision. What speeds exactly should be monitored? What do these speeds mean and where do they come from? What happens if such speeds are exceeded?

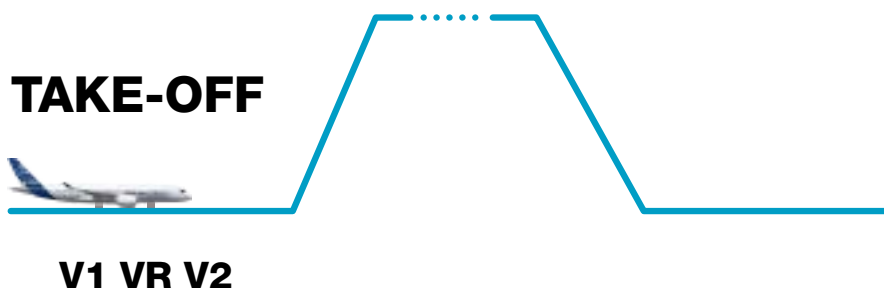
Our objective is to highlight the design and operational considerations underlying all recommendations Airbus has issued to flight crews regarding speed monitoring during take-off.

Take-off operating speeds V1, VR and V2 very precisely frame the air-

craft take-off performance limits and the margins that exist in the event of a failure **(fig.1)**.

For every aircraft type, V1, VR and V2 are computed by Airbus on the basis of design speeds and evidence collected during the certification testing of the airplane.

“ For every aircraft type, V1, VR and V2 are computed by Airbus on the basis of design speeds and evidence collected during the certification testing of the airplane. ”



(fig.1)

V1: Decision speed
VR: Rotation speed
V2: Take-off safety speed

V1: Decision speed

» Definition

V1 is the maximum speed at which a rejected take-off can be initiated in the event of an emergency.

V1 is also the minimum speed at which a pilot can continue take-off following an engine failure.

This speed is entered by the crew in the MCDU during flight preparation, and it is represented by a "1" on the speed scale of the PFD during take-off acceleration (**fig.2**).

» How is V1 determined?

If take-off is aborted at V1, the aircraft must be able to be stopped before the end of the runway, without exceeding the maximum energy the brakes can absorb.

In addition, if an engine failure occurs after V1, then the aircraft must be able to achieve safely take-off with TOGA or derated power (enough lateral control).

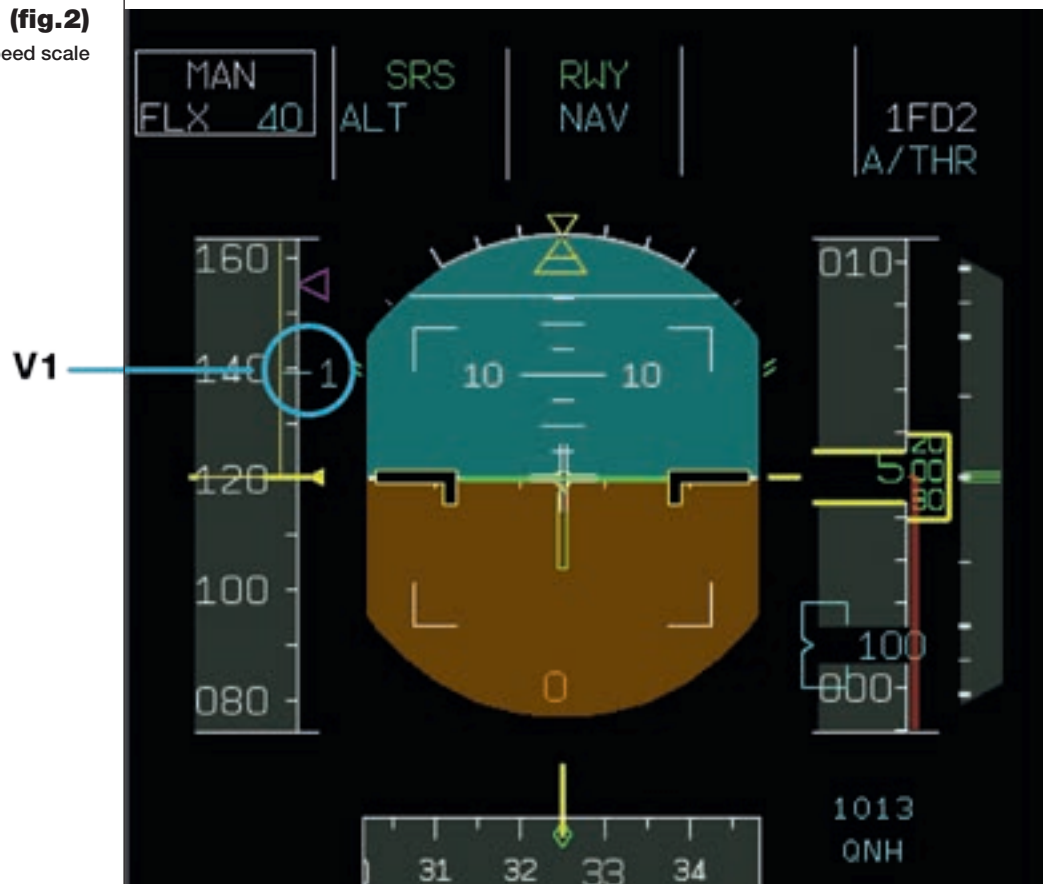
These two conditions require identifying:

- The ground speed at which maximum energy is put into the brakes, when a RTO is performed at MTOW. This limit speed is defined during Airbus flight tests and is called **V_{MBE} = Maximum Brake Energy speed**. V1 must be lower than V_{MBE}.

- The minimum speed during take-off roll at which the aircraft can still be controlled after a sudden failure of one engine (be it a two or four-engine airplane).

(fig.2)

V1 on the PFD speed scale



In such a case, and if the take-off is continued, only the rudder will be able to counteract the yaw moment that is generated by asymmetric engine(s) thrust. Therefore if a failure occurs before reaching this minimum speed, the take-off must be interrupted to maintain control of the aircraft. This limit speed is determined during Airbus flight tests and is called **V_{MCG} = Minimum Control speed on the Ground**. V_{MCG} mainly depends on engine(s) thrust and pressure altitude. V_1 must be greater than V_{MCG} .

- The maximum aircraft speed at which the most critical engine can fail

without compromising the safe completion of take-off after failure recognition. This design speed is called **V_{EF} = Engine Failure speed**.

Considering that it is generally assumed humans have a reaction time to an unexpected event (such as a failure) of 1 second, V_1 must be greater than V_{EF} .

In addition, if an engine failure happens at V_{EF} , then it must be possible to continue and achieve safely take-off with TOGA power. This means that V_{EF} must be greater than V_{MCG} .



» What are the operational implications of not respecting V_1 ?

Supposedly, there are two different ways of “disrespecting” the V_1 speed criteria:

- 1. The crew decides to continue take-off while an engine failure occurred before V_1 .**
Standard procedures encourage the crew to reject take-off if an engine fails before V_1 . If take-off is

continued despite this recommendation, then the aircraft can potentially exit the runway laterally, or be unable to take-off before the end of the runway.



BEST PRACTICE

In the event of an engine failure at low speed, any delay in reducing the thrust of the good engine(s) will lead to a loss of directional control and a very quick lateral deviation. Max rudder pedal and max manual differential braking may be required (refer to the new FCTM recommendation AO-020 “Low speed engine failure”).

- 2. An RTO is initiated above V_1 .**

Virtually, any take-off can be “successfully” rejected, on the proviso that the reject is initiated early enough and is conducted properly. In this respect, the crew must always be prepared to make a GO/ NO GO decision prior to the aircraft reaching V_1 .

Doing otherwise exposes the aircraft to an unsafe situation where there either may not be enough runway left to successfully stop the aircraft - therefore resulting in a longitudinal runway excursion-, or maximum brake energy is exceeded and brakes catch fire.

PROCEDURES

Control your speed... at take-off



BEST PRACTICE

As speed approaches V1, the successful completion of an RTO becomes increasingly more difficult. After V1, the crew must continue take-off and consider using TOGA thrust except if a derated take-off was performed (refer to FCOM PRO-ABN-10 operating techniques).

V1 IN A NUTSHELL

**Do not continue take-off
in the event of an engine failure below V1.
Do not initiate an RTO at speeds in excess of V1.**



VR: Rotation speed

» Definition

VR is the speed at which rotation can be initiated at the appropriate rate of about 3° per second. VR ensures that V₂ is reached at 35 feet above the runway surface at the latest, including in the event of an engine failure at V_{EF}. Therefore at 35 feet, the actual speed is usually greater than V₂.

» How is VR determined?

In principle, VR shall not be lower than V₁.

In addition, whenever pilots initiate the rotation at VR, they must be assured that the aircraft will be controllable once airborne, including when the most adverse engine has failed after V_{EF}.

On the upper end, if the rotation of the aircraft is started at VR at maximum practicable rate, lift-off must be possible at the end of the maneuver.

These concepts involve understanding the following limit speeds:

- The minimum speed in the second segment (take-off) at which the pilot is

still able to maintain lateral and directional control when the most adverse engine fails.

This limit speed is demonstrated by Airbus flight tests and is called **V_{MCA} = Minimum Control speed in the Air**. VR shall not be lower than 1.04 or 1.05 V_{MCA}, the factors 1.04 and 1.05 being defined by Airworthiness Authorities to ensure a safety margin.

- The minimum speed at which the aircraft becomes able to lift off and escape ground effect.

This limit speed is based on evidence collected during certification tests and is called **V_{MU} = Minimum Unstick speed**. V_{MU} is achieved by pitching the aircraft up to the maximum (tail on the runway, for aircraft that are geometrically limited) during the take-off roll. The speed at which the aircraft first lifts off is V_{MU}; therefore lift-off is not possible prior to V_{MU}.

V_{MU} is different from the design lift-off speed V_{LOF}, which applies to general case scenarios and is necessarily greater than V_{MU}, according to the following criteria:



NOTE

The multiplicative factors that were applied were specified by Airworthiness Authorities, in consideration of safety margins.

$$\begin{aligned} 1.04 \text{ or } 1.05 V_{MU(N-1)} &\leq V_{LOF} \\ 1.08 V_{MU(N)} &\leq V_{LOF} \end{aligned}$$



PROCEDURES

Control your speed... at take-off

In turn, V_{LOF} is limited by the design speed V_{TIRE} , which corresponds to the maximum tyre speed (tyre structural limit).

$$V_{LOF} \leq V_{TIRE}$$

Coming back to VR, if we consider that when a rotation is initiated at VR at the maximum practicable rate, it has to result in a satisfactory lift off speed, then VR must be limited by V_{LOF} .

$$\begin{aligned} V_1 &\leq VR \\ 1.05 V_{MCA} &\leq VR \\ VR &\leq V_{LOF} \end{aligned}$$

» What are the operational implications of not respecting VR?

One direct consequence of initiating a rotation before VR is a tail strike. Second, if the rotation is done at VR but too slowly, or if the rotation is initiated after VR, then the aircraft intrinsic

performance will very likely not allow it to reach 35 feet at the end of the runway, and/or not respect the clearway if the take-off speeds were limited by the runway length or obstacles.

VR IN A NUTSHELL

Do not start rotation below or above VR.

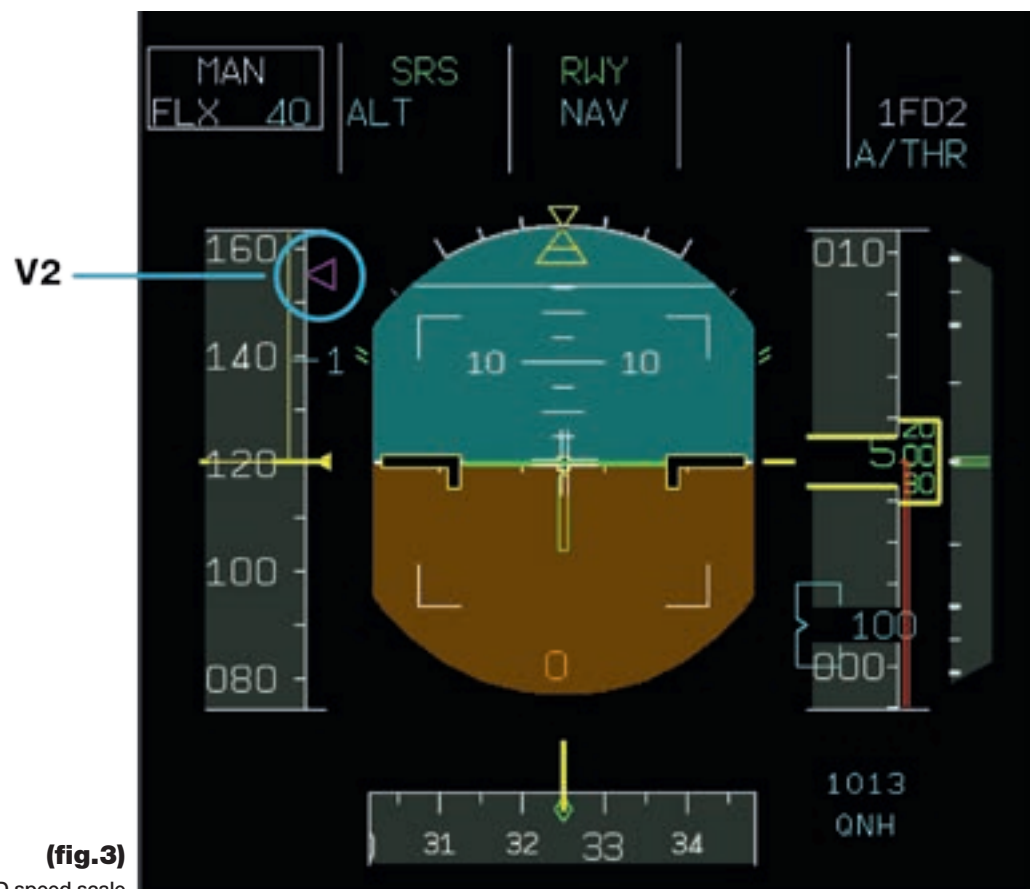


V2: Take-off safety speed

» Definition

V2 is the minimum take-off speed that the aircraft must attain by 35 feet above the runway surface with one engine failed at V_{EF} , and maintain during the second segment of the take-off.

This speed must be entered by the crew during flight preparation, and is represented by a magenta triangle on the PFD speed scale (**fig.3**).



(fig.3)

V2 on the PFD speed scale

» How is V2 determined?

V2 is always greater than V_{MCA} and facilitates control of the aircraft in flight.

On the upper end, Airworthiness Authorities have agreed that all oper-

ating speeds must be referenced to a stall speed that can be demonstrated by flight tests. This speed is designated V_{S1g} . V2 must obviously be greater than this stall speed.

$$1.13 V_{S1g} \leq V2$$

$$1.10 V_{MCA} \leq V2$$



NOTE

The multiplicative factors that were applied were specified by Airworthiness Authorities, in consideration of safety margins.

PROCEDURES

Control your speed... at take-off

» What are the operational implications of not respecting V2?

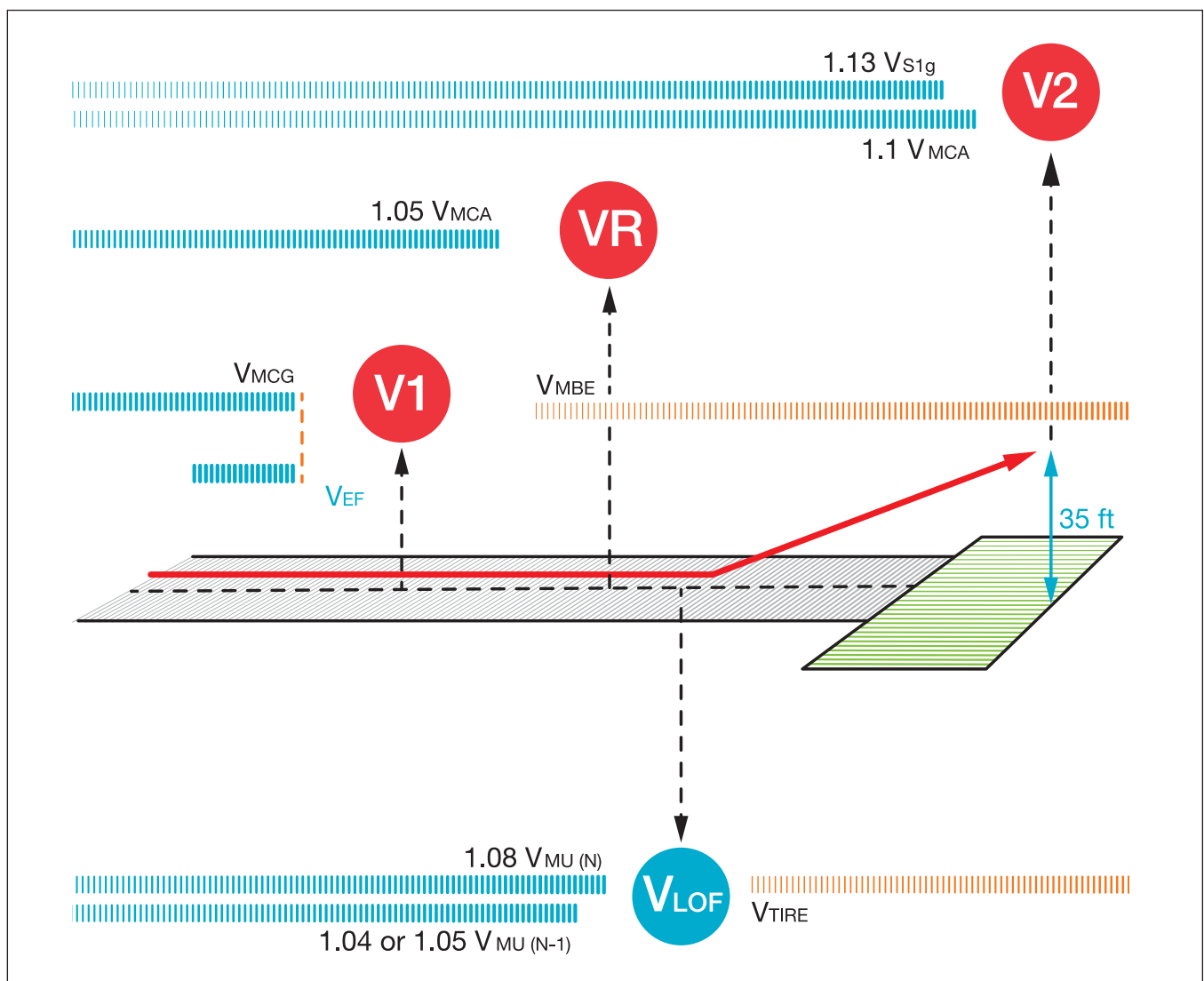
Supposedly, there are two different ways of “disrespecting” the V2 speed criteria:

1. Flying below V2 in case of an engine failure. 2. Flying above V2 in case of an engine failure.

The drag increase below V2 may lead to a situation where the only way to recover speed is to descend. If the speed further decreases and V2 is not recovered, then the high angle of attack protection may be reached, and the aircraft may ultimately enter into an unrecoverable descend trend. In particular, if the speed decreases below V_{MCA} , the aircraft might not be recoverable due to lack of lateral control.

In case of excessive speed, the required climb performance may not be reached, thus increasing the chance to trespass the obstacle clearance. ■

Take-off speeds in a nutshell



SECURING YOUR TAKE-OFF: THE ROLE OF THE PILOT MONITORING (PM)

The take-off phase is a very dynamic and demanding one, during which the PM plays a central role for a timely monitoring from cockpit preparation, all the way through take-off speeds computation and utilization.

Clearly flight crews are expected to be able to rapidly scan the essential and relevant parameters that support key decisions, such as continue or abort a take-off essentially. Doing so, the PM must be able to differentiate between situations that are detrimental to operational safety, and those that are not.

In this respect, he/she must be prepared to adapt his/her monitoring to the level of the threat and reach out in a communication sense to the PF to encourage action if necessary, by making callouts as per SOP. Callouts coupled to responses are a very effective means indeed to cope with demanding situations, and allow the crew to act as a well coordinated team.

Second, he/she must be aware of the primary threats to the safe completion of take-off in order to actively help to prevent take-off speed errors. Take-off speed calculation errors are often due to a combination of two factors:

- Error in parameter entry
- Poor crosschecks by other crewmember.

Prevention strategies should therefore be developed to ensure efficient crosschecks, particularly after last-minute changes (runway change, loadsheet modification, etc).

For this purpose, we want to highlight the main factors often observed when analysing take-offs in which speeds were not respected:

» Errors in take-off speed computation

- Data issued from a computerized system is rarely challenged. However, incorrect inputs may occur, thus resulting in inadequate take-off speed values computation.

- In take-off speed calculations, Zero Fuel Weight (ZFW) is sometimes mistaken for Gross Weight (GW). This is particularly true when a last minute change occurs in cargo loading, or when time pressure and workload are high. Therefore calculated speeds

will be much lower than expected, and will potentially lead to tailstrikes, “heavy aircraft” sensation, and high-speed rejected take-offs.

- Take-off speeds calculations are based on specific configurations. Any change in the parameters of these configurations will invalidate take-off speeds. Examples of such parameters include a runway change, a wet runway that becomes contaminated, or a take-off from an intersection.

PROCEDURES

Control your speed... at take-off

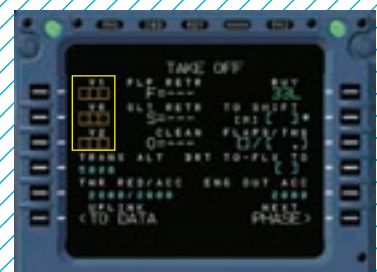


» Errors in take-off speed utilization

- When a last minute change occurs, take-off speeds are sometimes modified and crosschecked during push-back or taxi. During such phases of flight, the PF workload is high. As a result, the PF may not have sufficient time or resources to perform efficient crosschecks.
- If an incident occurs before V1, the PM's attention may be focused on trying to assess the situation and may forget the V1 announcement.
- In the event of an engine failure after take-off, and in an attempt to climb faster, there may be a tendency to set a pitch attitude too high if FD bars are not followed. The aircraft is then flown below V2, and climb performance cannot be maintained. ■

OPERATIONAL RECOMMENDATIONS FOR THE PM

- Compute/crosscheck V1, VR and V2.
- Enter V1, VR and V2 in the FMS, and ensure these data are re-inserted during taxi as per SOP in case of last minute changes. Attention should be paid to keystroke errors.
- Crosscheck information set or used by the PF.
- Ensure a take-off briefing is conducted that highlights take-off speeds (particularly if they were changed during taxi), slats/flaps configurations and weight.
- For aircraft that are not equipped with a V1 auto-callout: pay a close attention to the V1 standard callout.

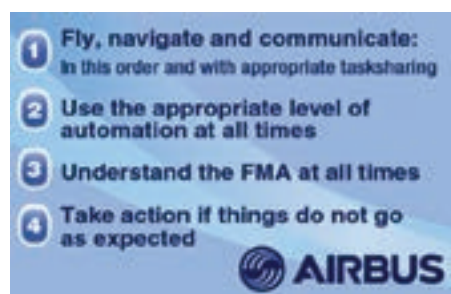




Understanding the implications of take-off speeds is paramount to enable pilots to sense instantly the available margin of maneuver they have left to preserve safety of flight, and make a wise GO/NO GO decision.

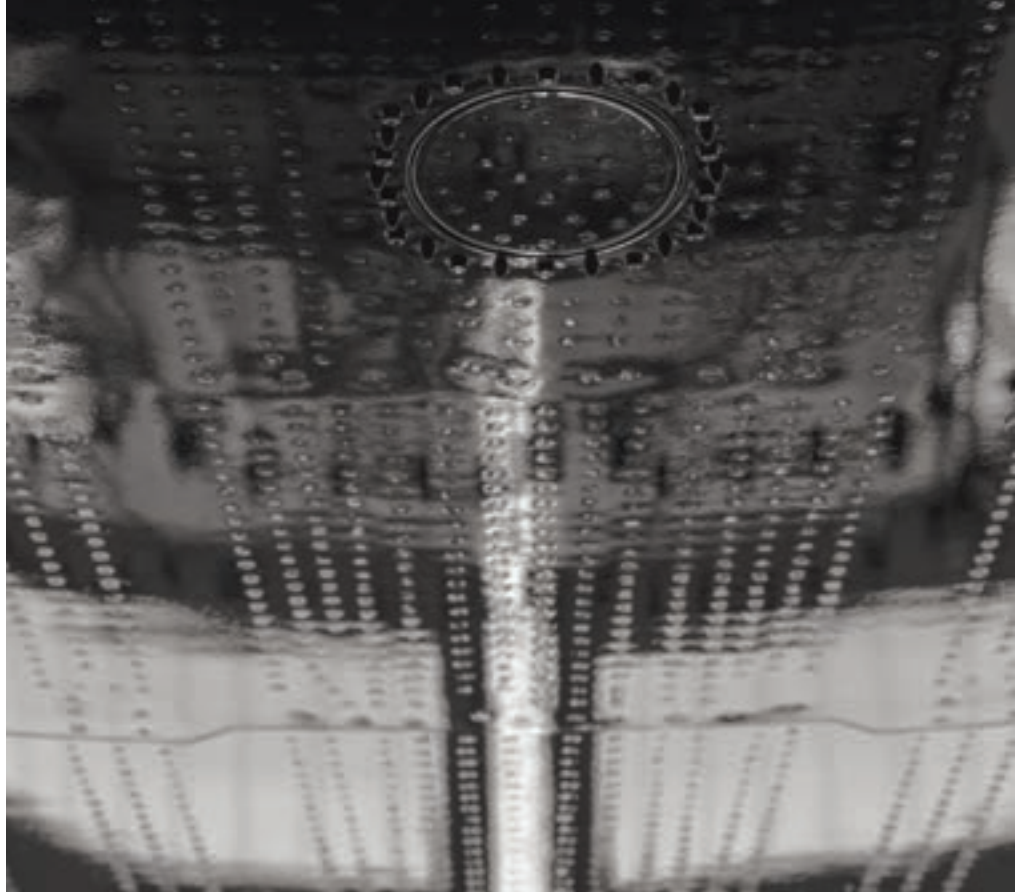
In practice, crew coordination and the PM's involvement in the take-off phase preparation and execution are essential parameters to satisfactorily manage the risks associated to this particular phase of flight, such as: a lateral or longitudinal runway excursion, maximum brake energy exceedance causing a brake fire, tail strike, lack of lateral control once the aircraft is airborne, or obstacle clearance trespassing.

Whatever the flying conditions, it is essential that flight crews number one objective remains to fly the aircraft according to the 4 Golden Rules for Pilots.



DID YOU KNOW

Read our brochure "Getting to grips with aircraft performance", available on AirbusWorld.



Safe operations with composite aircraft

Composite materials are increasingly used in aircraft design. The A350 XWB is the most recent illustration of this trend. Yet if the benefits of composite materials are not in doubt for airlines, some questions still remain as to their potential effects on safety.



**CHANTAL
FUALDES**

Executive Expert
Composite



**XAVIER
JOLIVET**

Director
Flight Safety



**CÉDRIC
CHAMFROY**

Product Leader NDT
Customer Services



Why composites in the first place?

The large increase of the fuel cost in the early 70s challenged aircraft manufacturers to improve considerably the fuel efficiency of commercial airplanes. This quest led designers to progressively replace aluminium by compos-

ites, as they typically weigh 20 per cent less than aluminium for an equivalent function. This aircraft weight reduction, in turn, led to a lower fuel consumption.

What are composites?

Composites are a particular kind of plastic. The majority of plastics in the world today are pure, and may be used to make things like toys or mineral bottles.

When additional strength is needed, plastics are reinforced with fibres and become comp, broadly known as reinforced plastics. The reinforcing fibres, or fabric, provide strength and stiffness to the composite, while the plastic resin, or matrix, gives cohesive properties, stability and environmental resistance.

In today's aerospace industry, most applications use carbon as reinforcing fibres. They are referred to as Carbon Fibre Reinforced Plastics (CFRP).

(fig.1)

Fibres reinforced plastics are usually made into laminates, i.e. layered sheets. A layer or ply is made to the specified size and orientation and then more layers are added, playing on the orientation until the piece has the properties it needs to support the loads it will carry.

Reinforced plastics may be in monolithic or sandwich form. Monolithic if they are solid and sandwich if the laminate sheets are separated by a core of different material type, usually honeycomb or foam. **(fig.2)**

Heavily loaded structural components are usually monolithic, while lightly loaded fairings, interior components are usually of the sandwich type.

Are there safety implications to the use of composites?

We are going to consider this question by looking at safety from three different perspectives:

- » **The certification process**
- » **The behaviour of composites in the face of operational threats**
- » **The assessment of impact damage**



(fig.1)

Carbon/Epoxy Impregnation (Prepreg)



(fig.2)

The two main concepts of composite: sandwich and monolithic

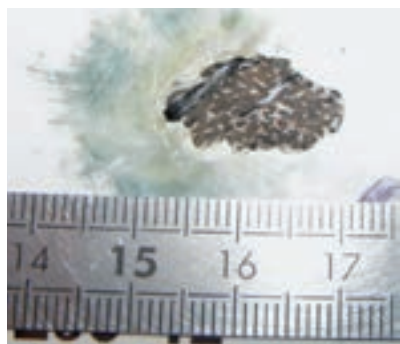
“ Composite aircraft are certified according to the same rules as their conventional counterparts. ”



(fig.3)
Metallic mesh, general view



(fig.4)
Metallic mesh, close-up view



(fig.5)
Impact of typical lightning strike
(scale in centimetres)

» The certification process

Composite aircraft are certified according to the same rules as their conventional counterparts.

Since composites show, in some respects, a different behaviour when compared to metallic materials, the Airworthiness Authorities have developed new Acceptable Means of Compliance (AMC), allowing manufacturers to demonstrate that these

new materials meet the existing safety requirements.

In line with a conservative Airbus policy on the introduction of new technology, the manufacturer has carried out numerous tests, taking into consideration even the most exceptional scenarios, thereby exceeding the requirements defined in the above AMCs by a large margin.

» The behaviour of composites in the face of operational threats

In the course of its lifetime, an aircraft structure is exposed to a certain number of threats. Let us consider the main ones and the means put in place on the A350 XWB to mitigate these threats:

• Lightning strikes

Full scale tests have demonstrated that the A350 XWB fuselage is protected against lightning strikes. This is achieved by a proper dimensioning of the structure and by compensating the lower conductivity of carbon fibre composites by integrating a metallic mesh. (fig.3 and 4)

The typical lightning strikes led to no more than clearly visible burn marks and paint scrapes, as illustrated in figures 5 and 6. For very severe lightning strikes, despite more extensive damage, no detrimental effect was witnessed on the fuselage integrity.

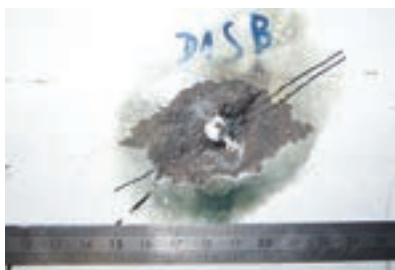
• Bird strikes

Safe flight continuation was proven through residual strength analysis carried out after dedicated tests. The objective was to verify the resistance of specific parts of the structure to damage caused by bird strikes. The most exposed composite areas are the radome and the leading edges of the wing and horizontal/vertical tail planes.

During these tests, damage from bird strikes was acceptable on secondary structure like aerodynamic fairings or leading edges but without detrimental effect on any load carrying primary structure.

One of these tests consisted of projecting an 8 pounds bird against the leading edge of the horizontal tail plane at a speed of 330 kt. The test demonstrated that the damage was limited to the leading edge, while the spar was unaffected by the collision.

(fig.7)



(fig.6)
Impact of very severe lightning strike
(scale in centimetres)



(fig.7)
Damage to horizontal tail plane after bird strike test

• In-flight hail

The risk of in-flight hail was mitigated through design precautions, mainly by increasing the thickness of the structure on the most exposed areas, like the nose cone of the aircraft.

• Uncontained engine failure

A range of high velocity impact tests were performed on fuselage barrels to simulate the effects of an uncontained engine failure. The tests demonstrated no detrimental damage and no dynamic effect on the fuselage.

• Fire

Fire, Smoke and Toxicity requirements (FST) are applied for all aircraft interior elements. Composite materials are common to both structure and cabin, they therefore also have to fulfil the same smoke and toxicity requirements. Concerning the resistance to fire, it is interesting to note that CFRP is auto-extinguishable and that the thinner composite fuselage skin is more “burn through” resistant than a metallic equivalent.

• Corrosion

On their own, composite parts do not corrode and do not require specific protection against corrosion, while aluminium structures require continuous inspection and re-protection.

The risk of galvanic corrosion, which exists when composites are in contact with metal, has been mitigated on all Airbus programs by paying attention to the choice of metallic elements and by taking associated design precautions. Aluminium rivets for example, were replaced by titanium on the fuselage.

• Fatigue

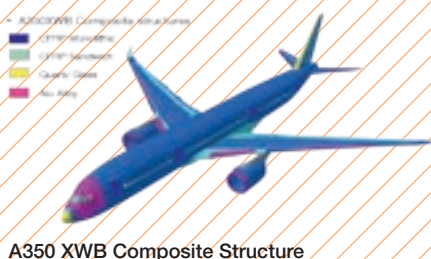
Whereas aluminium structures require very specific attention, the composite structures do not require inspection for fatigue.

Composite structures are designed using static ultimate conditions, where the Materials and Design principle demonstrate no sensitivity to fatigue cycling.

Carbon-Fibre Components: Lighter, Stronger, Tougher

The use of carbon-fibre components in the aviation industry is becoming more and more common. But for Airbus, Carbon Fibre Reinforced Plastic (CFRP) components are nothing new.

Airbus has used carbon-fibre materials for years, starting with the A310-200 in 1983 when the spoilers, airbrakes and rudder were made of sandwich CFRP. Three years later, the A310-300 pioneered the introduction of composite on a primary structure with the vertical tail plane designed in monolithic CFRP. On the A320, carbon-fibre materials were used on flaps, ailerons, spoilers and on the vertical and horizontal tail planes. On the A340-600 the rear pressure bulkhead and keel beams were made of CFRP. On the A380, Airbus introduced them in the fuselage rear section and centre wing box connecting the two wings together, while the wing ribs moved to carbon-fibre. This evolution continued on the A350 XWB where the entire fuselage and wing skins – more than half of the structure - is made from carbon-fibre composites.



A350 XWB Composite Structure



(fig.8)
External view of the damage



(fig.9)
Resulting internal delamination

The “line tool”

The “line tool” is an easy to use device developed by Airbus, which allows basic ultrasonic inspections to be performed by non NDT qualified personnel.

This tool will allow the release of an aircraft if no delamination is found. But if delamination is observed, a more detailed inspection must be performed by means of additional Non-Destructive Testing (NDT), which uses ultrasonic methods to determine the exact extent of that damage.



» The assessment of impact damage

In case of impact damage, a composite structure may behave in a different way when compared to a metallic structure. As a consequence, in case of an impact with a foreign object, the internal damage on a composite structure might be larger than the visible external damage. This point was illustrated in a previous Safety first article **(ref.A)** as well as in an Airbus Operator Information Transmission **(ref.B)**. Thorough visual inspection of the

aircraft exterior is therefore even more important on a composite aircraft than on its metallic counterpart. **(fig.8 and 9)**

Whereas a mechanic inspecting a metallic structure will typically look for dents or cracks and will determine whether action is needed based on the size of the damage, the same mechanic on a composite structure will rather look for any visual clue, more particularly for dents.

» If damage is smaller than barely visible....

According to the Barely Visible Inspection Damage (BVID) concept, any dent whose depth is less than a certain threshold, defined in the Structural Repair Manual, is acceptable and does not require any action. The dimensioning of the aircraft panels takes into account the BVID cri-

teria. In other words the panels have been sized with a margin corresponding to the loss of strength that the panel would incur when the damage is barely visible.

» If damage is larger than barely visible...

If a damage is visible and lies beyond the BVID threshold, a more detailed inspection, typically ultrasonic testing, may be required by the Structural

Repair Manual (SRM) and carried out in accordance with the Non-destructive Testing Manual (NTM).

» The special case of high energy blunt impacts

Two types of events may be classified as high energy blunt impacts:

- Tire bursts
- Impacts from ground servicing vehicles

Above a certain energy threshold, a metallic structure sustains a permanent deformation and displays a dented area, whereas a composite panel deforms and then returns to its original shape with minor or no damage on its surface,

but potentially important damage to its internal core.

On the A350 XWB, additional inspection tasks have been added to sections 05-51 of the AMM to deal with these types of impacts.

Whereas tire bursts are self-evident occurrences, impacts from ground vehicles require a high level of awareness among all ramp actors on the necessity to report these types of events. ■



NOTE

For abnormal events, such as lightning strikes or bird/hail impacts, reference should be made to the applicable Aircraft Maintenance Manual (AMM) 05-51 section.

These sections include relevant instructions for composite components inspections and checks.



INFORMATION

Focus on training

Information on structure courses proposed by Airbus Training is available on: **AirbusWorld and airbus.com**

Extract from FAA Advisory Circular 65-33:

As more composite aircraft enter into operation, detailed and documented composite training should be developed to ensure that personnel performing composite maintenance on aircraft structures and components properly repair damage to meet the highest level of safety.

Extract from FAA Advisory Circular 20-107B and EASA Alternative Means of Compliance 20-29:

d. Damage Detection, Inspection and Repair Competency.

(2) Pilots, ramp maintenance, and other operations personnel that service aircraft should be trained to immediately report anomalous ramp incidents and flight events that may potentially cause serious damage to composite aircraft structures. In particular, immediate reporting is needed for those service events that are outside the scope of the damage tolerance substantiation and standard maintenance practices for a given structure...

The use of composites provides significant benefits to aircraft operators in the form of fuel savings, weight reduction, fatigue and corrosion resistance and extended in-service life. Composite aircraft are certified according to the same rules as their conventional counterparts. Due to the specificities of composites, Airworthiness Authorities have developed new Acceptable Means of Compliance (AMC) to adapt to this new technology and ensure an equivalent level of safety. In accordance with its policy on the introduction of new technology, Airbus has gone a long way beyond these AMCs. Composite aircraft are designed to respond as well and in some cases, like fatigue and corrosion, better than traditional metallic airplanes to operational threats. Composites provide also some additional benefits in terms of behaviour to fire: Carbon Fibre Reinforced Plastic (CFRP) is auto extinguishable and more burn through resistant than aluminium. Composites, however, have a specificity that needs to be taken into account when assessing damage: the non-visible side deterioration might be larger than the visible external damage. After visual inspections, the maintenance programs call for:

- No further action if the damage is barely visible
- A specific inspection if the dent lies beyond the Barely Visual Inspection Damage (BVID) threshold

This rule has two exceptions: tire bursts and impacts by ground servicing vehicles. Both types of events must always be reported and require appropriate inspection prior to returning the aircraft into service.

References

A. Safety first "Trimable Horizontal Stabilizer Damage" issue n°3 December 2006

B. Operator Information Transmission (OIT) 999.0115/04 "Assessment of external damage on composite structure"



A350: the flagship of a new training concept

Learning from the evidence

In September 2014, Airbus will inaugurate its new A350 pilots Type-Rating course. The drivers for this development were both the EBT (Evidence-Based Training) principles and an analysis of natural learning mechanisms.



CHRISTIAN NORDEN

Director A350 Flight
Operations & Training
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DAVID OWENS

Senior Director
Training Policy

How humans learn to perform complicated and safety critical tasks is a complex science. Our new approach to training has moved the emphasis from focusing on the outcome of events or exercises, towards understanding and assessing the underlying behaviours required for successful execution. The advent of the A350 programme was just the right signal to put theory into practice and establish a brand new pilots training system for the new aircraft.

INJECTING REALITY INTO TRAINING

Lessons learned

For decades, the content of flight crew training programmes remained unchanged, according to regulation. Training curricula included repetitive exposures to a set of prescribed events, which, as technology evolved, became highly improbable with modern aeroplanes. In addition, these events were mainly examples of negative performance and we just expected crews to learn effectively from them. In some cases, we learned what NOT to do but rarely what could or should have been done to change the outcome of the event. This gives little help to the crew if faced with a similar or any other challenge.

Training programmes were consequently saturated with items that may not necessarily mitigate the real risks or enhance safety in modern air transport operations.

Furthermore, training approaches traditionally regarded non-technical skills (through Crew Resource Management courses) and technical flying skills (during simulator sessions) separately. Learning from past events, we have come to realize that air incidents and accidents rarely result from the improper use of a given skill alone, but rather involve a combination of both technical and non-technical aspects.



“Pilots need to be trained to mitigate the risks of the unpredictable”

Building a new competency-based training philosophy

These observations clearly established the need for our industry to revisit some training principles.

In today's rapidly changing flying environment, it is impossible to predict every single plausible situation that might arise in operations.

“When people and complex systems interact, there will always be an infinite number of possible outcomes”, explains Michael VARNEY, Senior Director Training Policy.

In other words, pilots need to be trained to mitigate the risks of the unpredictable. And means to reach this very objective do not seem obvious at first glance.

The ICAO Evidence-Based Training (EBT) concept is a safety-improvement initiative part of the ITQI project (IATA Training and Qualification Initiative) that precisely addresses this challenge by prioritizing the development and assessment of a finite number of key competencies. The EBT basically recommends to train competencies (not events) and choose training scenarios based on evidence collected from in service data to make sure pilots are able to demonstrate a good performance in front of realistic threats and errors.

Although this concept was primarily designed for recurrent training, the regulatory prescriptions of a Type-Rating skill test can also be achieved using this modern competency-based approach. ■



INFORMATION

The EBT and ITQI initiatives

In 2007, Airbus started work on a concept eventually titled Evidence-Based Training (EBT). The initiative was supported by other OEMs and stakeholders, and was taken to IATA to form part of the IATA Training and Qualification Initiative (ITQI).

The ITQI is an industry-wide project steered by a committee comprising the IATA, the ICAO, the International Federation of Air Line Pilots (IFALPA) and the Royal Aeronautical Society (RAeS). This initiative focuses on 2 different areas: Flight operations and Engineering & maintenance. Their objective is to improve operational safety, quality and efficiency of commercial aviation by developing international agreement on a common set of pilot training, instruction and evaluation standards and processes that will result in ICAO provisions.

Based on the success of the EBT approach, ICAO published new guidance material in ICAO Doc 9868 PANS-TRG and ICAO Doc 9995 Manual of Evidence-Based Training in 2013. EBT was born as a new option for safety improvement and is now making rapid progress, defining a new paradigm for training worldwide.

FROM DEVELOPING THE SKILLS NEEDED TO MANAGE AN INVENTORY OF PRE-DEFINED SITUATIONS, TO TRAINING WHAT IT TAKES TO MANAGE ANY OPERATIONAL SITUATION...

Competencies as training tools

Competencies are the backbone of the new training concept; therefore the ones we wanted to use for our training courses needed to be defined with great care and accuracy. It was also important to base our approach on work previously and diligently undertaken during the development of the EBT concept.

In principle, such competencies needed to be defined against the real threats and risks airline pilots will face in everyday operations. This implied understanding those threats through a comprehensive review of safety-related evidence, i.e. data collected from both training results and operations, including the facts of pilot involvement in accident scenarios. Experts in the practice of flight crew training analysed the available wealth of data and agreed definitions of:

- core competencies and
- associated performance indicators aiming to enable training instructors to evaluate those competencies

Both were eventually introduced in ICAO Doc 9995.

Whilst keeping the current regulatory framework, Airbus adapted this sys-

tem and introduced its own set of core competencies in the Autumn of 2013. These competencies are the key driver for all training and assessment in Airbus, including the A350 curriculum development.

The Airbus 9 core competencies are listed alphabetically as follows:

- Application of procedures
- Communication
- Flight path management – Automation
- Flight path management – Manual
- Knowledge
- Leadership and teamwork
- Problem solving and decision making
- Situation awareness
- Workload management

To create an effective training programme, we had to understand the relationship between this finite number of competencies, and the capability to manage an infinite number of operational situations. Doing so, our efforts were directed towards understanding the underlying conditions for effective performance, rather than on the outcome of events and maneuvers as was traditionally the case. Instructional technique needed to evolve to the person and not to the event.



“ The role of the instructor becomes essential in this approach ”

Facilitating and communicating: our new instructional technique

Psychologists have developed a theory that our learning retention rate gets higher if we learn step-by-step by improving our performance, rather than just getting things right or wrong after a demonstration or lecture. Effective learning demands retention, which can be enhanced by enquiry, practice and feedback from performance.

Better than realizing a scenario went right or wrong, we want to understand why the outcome was negative or positive, and learn from this analysis. This includes viewing an incident not only in terms of its causes, but also with respect to what prevented a more serious outcome.

The role of the instructor becomes essential in this approach: (s)he no longer is just a speaker, but a facilitator and an advisor, continuously interacting with the trainee. He/she gives the trainee the necessary freedom to learn by discovering functionalities and guides him/her when necessary following his/her observations.

In this respect, our approach to training now includes “Facilitated de-brief” during which the instructor adopts a non-judgmental attitude and raises simple questions as a prelude to an open and unfiltered discussion with the trainee:

- “How did it feel?”
- “What did you do well? Why was it effective?”
- “What could have been done better?”

This new approach is meant to ease the discussion between the instructor and the trainee, and build a relationship of trust and honesty between them. With this mindset, it becomes possible for trainee pilots to develop from both their achievements as well as their mistakes.

“When an ILS approach is not completed successfully, rather than considering that the exercise is failed because it was “out of limits”, we want to ask ourselves why it was not completed satisfactorily.” mentions Michael VARNEY.

The upstream cause may be poor descent planning, FMS handling, communication or energy management leading to a rushed approach. A simple repeat of the ILS approach would probably ultimately result in a successful approach, but this method would not necessarily address any of the descent planning, FMS programming or energy management root causes.

To make learning effective, the relationship between the trainer and the trainee is crucial, both of them now being considered as partners in the process of developing confidence and capability in the operation of a modern jet transport aircraft.



Assessing and grading competence

Modernizing our training programmes involved reviewing our approach to trainees' performance assessment. Traditionally, the successful completion of training courses was marked by the trainee's ability to pass tests. However, those tests did not focus on a demonstration of performance to measure the trainee's actual ability to fly an airplane and manage the threats a crew may face in today's operational environment.

Since October 2013, Airbus Training instructors assess trainee pilots' performance according to a new competency-based grading system. This new grading system requires a demonstration of each of the 9 core competencies, as opposed to the traditional assessment that was made up of right or wrong proposals.

"Training is more than ticking boxes", says Jean-Michel BIGARRE, Director of Airbus Flight Training. "It is a matter of bringing the pilot and the aircraft work safely and efficiently together" he adds.

In line with this philosophy, the new grading concept uses Pass or Fail criteria, based on a list of observable performance indicators and a grading scale.

The performance indicators detail clearly observable criteria that were designed to enable the trainer to grade all skills in an objective manner - including the non-technical ones. At all times during the training or checking session, the instructor observes the trainee's performance in relation to these pre-defined performance indicators. Then, by determining the consistency and frequency of these indicators, he/she is able to make a holistic appraisal of the trainee's understanding of each competence, and his/her ability to exercise it using the grading scale. At the end of the training session, this grading scale offers a global picture of the trainee's performance during the session by showing a mark between 1 and 5 against each of the 9 core competencies. ■

“ Training is more than ticking boxes, says Jean-Michel BIGARRE, Director of Airbus Flight Training. ”

THE A350 TRAINING CONCEPT: COMBINING EBT AND NATURAL LEARNING PRINCIPLES...

The new A350 Type-Rating course is fundamentally modelled on the EBT approach and it is built in accordance with the principles described earlier. But it also proposes beyond a new approach to delivering training to trainee pilots. Fundamentally, it focuses on engendering trainee pilots' confidence in their own competencies as well as in the aircraft they interact with.

The A350, a new approach to developing the “Flight Path Management – Manual” competence

Among the 9 core competencies, the “Flight Path Management – Manual” appeared to us as one of the most challenging to maintain in line operations. Maintaining proficiency and adequate flying skills can be a challenge indeed, particularly for commercial aviation pilots who manual fly relatively infrequently, thus creating the potential for manual flying skills degradation from non-use. In effect, the loss of control in flight remains one of the main causes for accidents ; therefore efforts seeking to advocate for a return to the basics of manual flying clearly have a beneficial potential to invert this tendency.

For this reason, whilst developing the A350 Type-Rating curriculum, Airbus put a particular emphasis on this manual flying competence.

Traditionally, trainee pilots started practical training on a new aircraft with a maximum of flight guidance systems and automation engaged, making them reluctant to switch it off if needed operationally.

“The Airbus Golden Rules require to take over if the need arises, and our training regime needs to prepare them exactly to do this.”, says Dominique DESCHAMPS, Vice President Flight Operations and Training Support.



INFORMATION

Airbus Cockpit Experience (ACE)



ACE is a brand new training tool developed by Airbus for the A350 Type-Rating course. It is a 3D laptop-based cockpit simulator that is used from day 1 of the course to allow trainee pilots practicing systems knowledge and Standard Operating Procedures as often and early in the scheme as possible.

The device has the functionality of the real aircraft, the pilot being led by computer guided instruction, defined exercises and even free-play modules to connect to the new “office”. ACE enables to offload a lot of training content from the APT (Airbus Pilot Transition) and even Full Flight Simulator (FFS), thus giving more time for realistic and dynamic maneuvering training in the FFS.



For its A350 Type-Rating course, Airbus has developed a hands-on “learning by discovery” process for trainee pilots to familiarize themselves with the aircraft and its manual handling characteristics through early and frequent practicing. This concept follows the principle described earlier of humans learning step-by-step with progressive skill improvement by cleverly sequencing theory in classroom, and practice in the Flight Training devices.

The goal of a Type-Rating program is to make a pilot proficient in interacting with a new complex technical system (the aircraft), using a new Human Machine Interface (the cockpit). Traditional Type-Rating programs introduce in priority the technical systems first (in the last decades by CBT style training). The cockpit is only introduced during the latter stages of the program using Flight Simulation Training Devices (FSTDs).

The Airbus A350 training concept has reversed this paradigm, introducing the cockpit interface and the Full Flight Simulator (FFS) as early as possible in the curriculum. According to this approach, practice on ACE is introduced from day 1 of the course.

Then, systems description modules are integrated in ACE as “quick user guides” to enable the pilot to start learning in the most realistic environment rapidly.

For FFS sessions, instructors are given guidance as to when they should let the trainee discover on his/her own, finding out how the aircraft works by experimenting, and when they should demonstrate. This principle echoes the way in which people frequently ignore the instructions guide when

they try a new device, and simply turn it on and try to find out how it works by experimenting. They would consult the instructions guide after they had tried various actions, and eventually could not manage by themselves.

We have considered that the same happens with a new aircraft: we want to let trainee pilots get to grips with the aircraft by experimenting in the FFS early in the scheme, thus enabling them to develop their manual flying instinct.

“ We want to let trainee pilots get to grips with the aircraft by experimenting ”

“Our ambition is to re-ignite this very feeling they had when they first flew a real aircraft, by not overloading them with theory before they had a chance to try and experiment.”, says Franck VESSIOT, designer of the FFS training sessions.

Only after manual flying consolidation, automated systems are introduced gradually, one after the other, both in theory, and in practice in the FFS. The “Bird” (Flight Path Vector) comes first, then the Flight Director, Auto Thrust and eventually the Auto Pilot.

In the end, the approach to training is reversed: pilots are encouraged to appreciate flying the aircraft manually and consider automated systems a full benefit, rather than considering manual flying a degraded and potentially challenging configuration.

“ This element of surprise brings training closer to real situations ”

Surprise...

Incidents and accidents analyses show that abnormal situations rarely present themselves in a standardized or predictable sequence. Although the potential element of surprise is more suited in the recurrent training domain, we decided to include some elements of surprise while programming the A350 Type-Rating courseware.

Prior to the training session, trainees will be informed of the subjects that will be covered, but they will have no information about the exact nature or sequence of events the instructor will use. In the final sessions, the instructor will have a choice between several malfunctions and events intended to develop the same competencies, thus limiting, if not avoiding pre-planned or routinized actions by the crew.

This element of surprise brings training closer to real situations, and raises opportunities for the trainee and the instructor to discuss the available options and solutions on a case by case basis.

In addition, keeping it a surprise allows enough flexibility for the instructor to play scenarios the closest possible to the airline's specific operations.

The training programme really is customized according to the airline's operational constraints in order to ensure the pilots are confident in managing real threats and hazards as they commence supervised and ultimately unsupervised line flying. ■

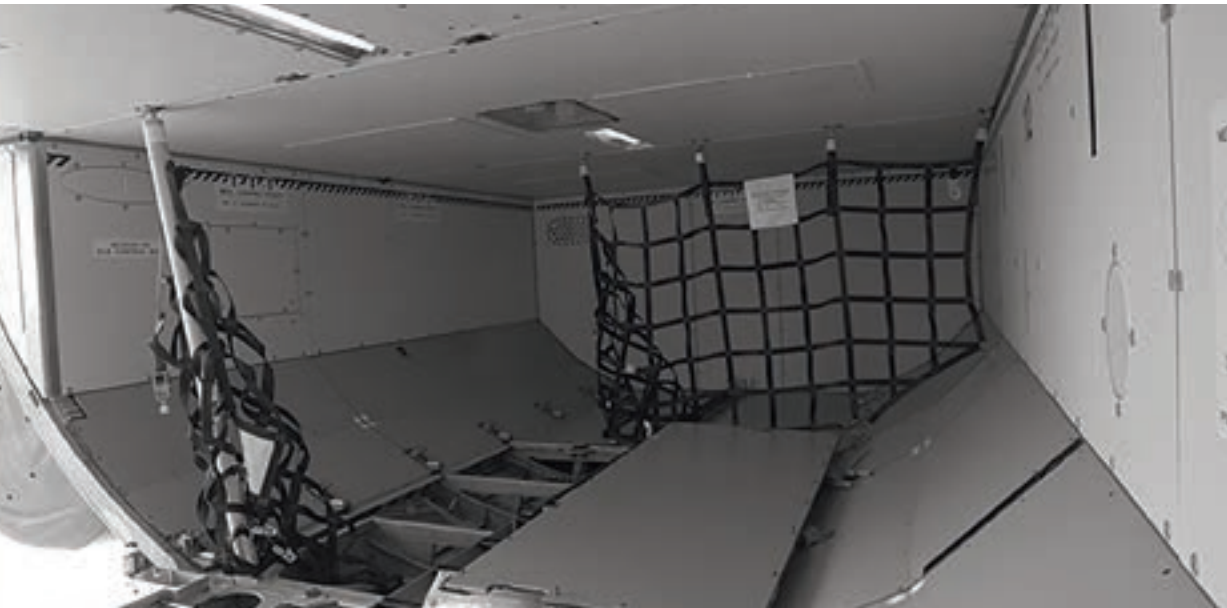
Developing the new A350 Type-Rating training programme, Airbus has endorsed a new philosophy for pilots training using new training principles, new training devices and a new training scheme.

We, as an industry, can learn from studying accidents and incidents, but we also need to study events with positive outcomes to learn from the success of others as well as our own achievements. We should study “what went right?” every day for every flight, then analyze “why did it go right?”.

Understanding the path to an outcome of a particular area of performance, whether positive or negative, rather than just the outcome itself, can raise avenues of reflection to progress. This concept underlies the new A350 Type-Rating course, which will enter into service in September 2014. Our objectives were mainly: facilitate trainee pilots' appreciation of new technology features and focus on their ability to handle the aircraft, not just the automated systems.

With the ICAO having published the Evidence-Based Training principles as a regulation for recurrent training in May 2013, Airbus is fully committed to applying elements of the evidence-based and competency-based training in all Type-Rating programmes. Today on the A350, in a near future on all of its legacy aircraft platforms.





A320 Family cargo Containers/pallets movement

No crew likes the idea of Unit Load Devices (ULD – containers and pallets) moving around in the cargo holds of their aircraft during flight. This type of occurrences may have multiple causes.

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IN-SERVICE EVENT

Mid of last year, an A321 cockpit crew reported hearing loud noises during the approach and landing phases.

Theses sounds were coming from the aft part of the forward cargo hold.

Once on the ground, inspection of the forward cargo hold revealed that all container restraining XZ latches were lowered. The hold was loaded with a single container, the noises

were therefore attributed to the free movement of that container in the cargo hold.

The inspection, which revealed no damage to the cargo linings, concluded that the XZ latches were not correctly locked before take-off. ■

CARGO LOADING SYSTEM DESCRIPTION

General

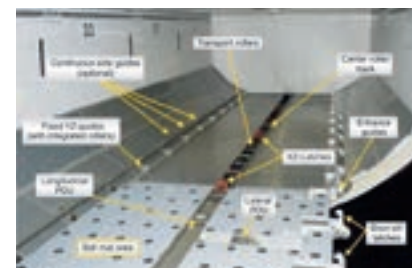
The standard A320 Family cargo hold is configured for bulk loading.

Around one third of the fleet is equipped with the optional semi-automatic Cargo Loading System (CLS), which is proposed for all members of the Family except the A318.

The CLS is an electrically powered system that allows ULDs to be carried in the aircraft. The main goal is to reduce manpower and loading/unloading time.

The CLS is composed of several components, which can be grouped according to their intended functions **(fig. 1)**:

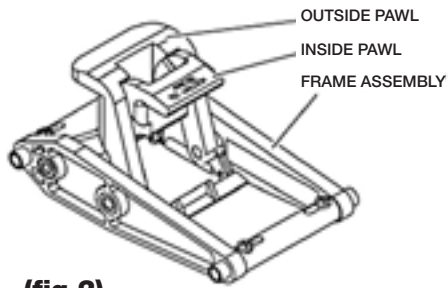
- Guidance, thanks to entrance guides and YZ guides along each side of the holds.
- Transport and Conveyance, performed by power drive units on ball mats and roller tracks.
- Restraint of ULDs, ensured by XZ latches, installed on the centre roller track.



(fig.1)
A320 Family CLS components

OPERATIONS

A320 Family cargo Containers/pallets movement



(fig.2)

XZ latch 2842T100 series

Restraint of ULDs

The ULDs are maintained in position by XZ latches, which consist of an aluminium frame and a pair of spring-loaded interlocking pawls.

If the outside pawl is lifted up, the inside pawl extends and locks automatically. Conversely, if the inside pawl is depressed into the retracted position, the outside pawl automatically folds down (fig.2).

Once each ULD is in position, the loading procedures call for these XZ latches to be raised and locked manually (fig.3).

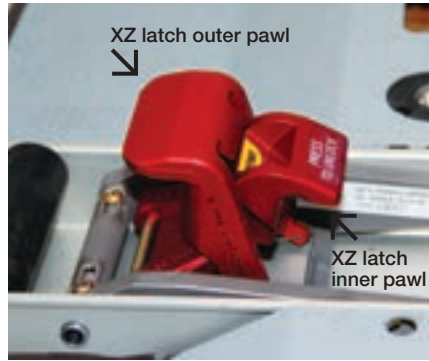
Each ULD is then restrained by one XZ latch on each side of their baseplate or by one latch and one end-stop for those located at the borders of each holds (fig.4). ■

(fig.3)

XZ latch manual operation



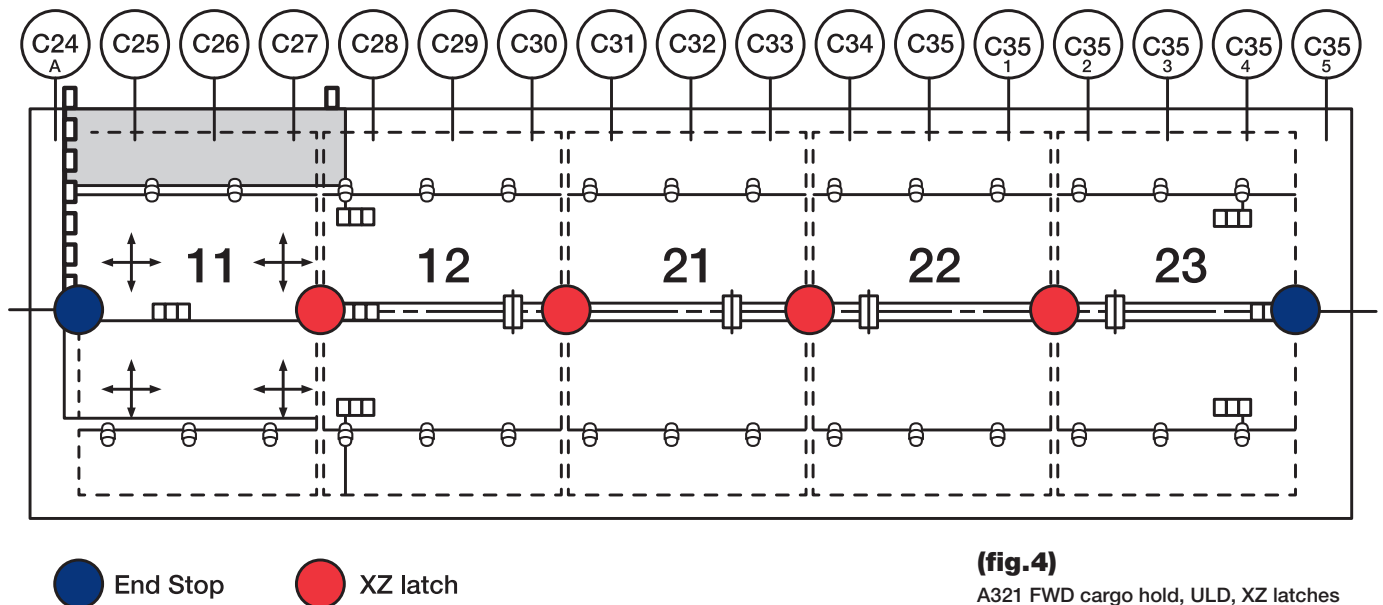
XZ latch in down position



XZ latch in intermediate position (not yet locked)



XZ latch raised and locked Interface with ULD/ pallet baseplate



(fig.4)

A321 FWD cargo hold, ULD, XZ latches and End stops positions



NOTE

On the other Airbus types ULD movements are rare occurrences, because most loading configurations call for 2 latches on each side of the ULD baseplates. Moreover, the wide body aircraft often fly with fully loaded cargo holds.

CAUSES OF ULD MOVEMENTS AND HOW TO AVOID THEM

Several possible root causes have been identified, based on the ULD movement events reported by operators.

Latch not raised or not correctly locked

If the loader does not raise up the latch or does not properly lock it into position, the container/ pallet will not be restrained in the X (flight) direction and will therefore move freely.

» Alleviation means

Awareness

Loaders should be made aware that instructions call for **all latches to be raised and properly locked**, independently of whether the positions are empty or not, as specified in the Weight and Balance Manual (WBM, chapters 1.10.05 and 1.10.06), and Aircraft Maintenance Manual (AMM, chapter 25-52).

Design improvement

If the outside pawl is lifted up, the inside pawl extends and locks automatically.

A weak spring may not extend the inner pawl enough when the outside pawl is lifted up, leaving the latch in an intermediate (unlocked) position. The new design calls for an increased spring force.

This design equally calls for the addition of an easily visible yellow indicator when the latch is in intermediate position, i.e. not raised enough to be in the locked position **(fig.5 and 6)**.

This latch (Part Number 2842T100-3) has been introduced in production from MSN 0573 onwards (Feb 1996) and is proposed through the Illustrated Parts Catalogue (IPC) as alternate.

Damaged latch

An inoperative or damaged latch may as well lead to ULD movements.

» Alleviation means

The following A320 Family Maintenance Planning Document (MPD) tasks call for visual and operational checks of the XZ Latches:

- Task 255000-11: "Visual check of the xz latches and door sill latches" Interval: 750 FH
- Task 255000-02: "Operational check and detailed inspection of XZ latches" Interval: 8000 FH

A third task has recently been added (in the July 2013 revision) for a detailed inspection of the latch after removal. The removal of the part allows for an easier inspection, especially regarding the spring condition.

- Task 255000-25: "Remove XZ latches for detailed inspection" Interval 24000 FH

(fig.5)

Latch correctly locked: the yellow indicator is not visible



(fig.6)

Latch in intermediate position, not correctly locked: the yellow indicator is visible



Interference between the ULD baseplate and the XZ latch

A non-standard or damaged ULD baseplate may also impair the proper functioning of the latch.

» Alleviation means

- ULDs should comply with National Aerospace Standards (NAS) 3610 and IATA specifications during their entire lifetime.

- ULDs should be loaded in accordance with the WBM.

- Airbus encourages airlines to clean their cargo hold to avoid debris that could interfere between the ULD baseplate and the XZ latch, as recommended in Task 12-21-12-100-007-A.

Object falling from ULD

An object falling from an improperly closed container/pallet on the inner pawl could lead to a latch disengagement.



NOTE

This scenario is excluded when the cargo is fully loaded. In such case, both pawls of every XZ latch are blocked by the adjacent ULD baseplate.

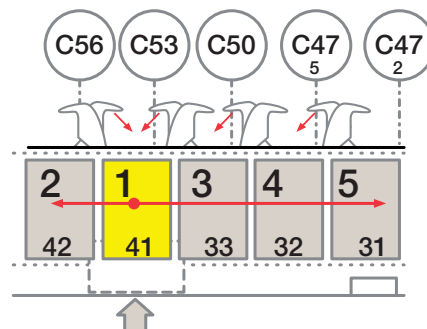
procedure, proposed in SIL 25-162, remains identical for all holds and aircraft types. Its application will ensure that the inner pawl of the latch, i.e. the movable pawl, will always be blocked by the adjacent ULD/ pallet baseplate **(fig.7)**.

» Alleviation means

To mitigate this risk, a specific loading procedure is recommended when cargo holds are not fully loaded. This

fig.8 below illustrates, when two containers are loaded in positions 41 and 42, how the inner pawls of the latches are blocked by adjacent containers, making any disengagement impossible. ■

(fig.7)
Recommended A321 AFT cargo hold loading sequence

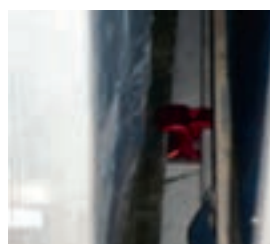


Possible movement of the inner pawl of the Latch

- 1,2,3...: loading sequence priority with regard to the total number of ULDs to be loaded

(fig.8)

Latches in locked position after loading



Latch at frame C56 between ULDs at position 42 and 41



Latch at frame C53 behind ULD at position 41

FEEDBACK TO AIRBUS

As illustrated above, feedback from airlines led Airbus to propose a design modification of the latches to reduce the number of ULD movements.

Airbus encourages operators to communicate any suspected or confirmed

case of ULD movement by means of a specifically designed reporting sheet.

This sheet is available in SIL 25-162 and has been specifically produced to facilitate the search for the root cause of the movement **(fig.9)**. ■

(fig.9)

Airbus ULD Movement Report-Sheet

A320 Family operators regularly report cargo hold ULD movements during flights. Most of these highly undesirable occurrences...

can be attributed to one of these four causes:

- A latch not raised or not correctly locked
- A damaged latch
- Interference between a ULD baseplate and a latch
- An object falling from an ULD, which unlocks a latch

and could be avoided by:

- Following the recommended loading procedures
- Using only standardized containers and pallets
- Filling them according to specifications
- Applying the documented inspection tasks
- Regularly cleaning the cargo holds.

To minimize the number of improperly locked XZ latches, a new design has been developed with a stronger spring and a clear visual indication to confirm whether the latch is properly locked. To help Airbus develop new prevention means, operators are encouraged to communicate all cases of ULD movements during flight by means of a specifically designed reporting sheet available in SIL 25-162.



Parts Departing from Aircraft (PDA)

PDA's may be considered by some people as noncritical, especially when the part is small. Yet whatever the size, they may represent a potential safety risk. Preventing them must be the single objective of the combined and coordinated effort of a number of actors.

**JEROME REAL**

Engineer,
Propulsion Systems
Customer Services



PARTS DEPARTING FROM AIRCRAFT (PDA) REPRESENT A REAL SAFETY RISK

What is a PDA?

A PDA, also called TFOA, which means “Things Falling-Off Aircraft” is any piece of equipment falling from an

aircraft, ranging in size from a simple rivet up to a fan cowl.

Why may a PDA represent a potential safety risk?

A PDA may lead to damage vital parts of the aircraft and/or cause serious or fatal injuries to passengers or people on ground. A part detached during take-off may also represent a danger

to following aircraft, if the part falls on the runway and is ingested by an engine or projected against a control surface for example.

Example of PDA

Potable water service doors 164AR/154BR were reported to have detached from A330 and A340 aircraft.

In one occurrence the panel hit the horizontal tailplane, damaging its leading edge **(fig.1 and 2)**.

How can this risk be reduced?

Securing all the parts before aircraft departure is certainly an answer, but it is a bit simplistic. Preventing PDAs starts with aircraft design and goes all

the way to the maintenance and crew pre taxi walk-around involving, along the way, a variety of players.



(fig.1 and 2)

A potable water service panel was lost in flight and damaged the horizontal tail plane

AIRBUS		PDA Reporting Sheet	
1. A/L:	2. Date:	3. Page 1 of 2	
4. A/C Type/Model:	5. MSN:		
6. PDA PIN:	7. Flight Phase:		
8. ATA:	9. FC:	10. FH:	
11. Weight (kg):	12. Size (mm): Length: Width: Height:		
13. Subject:			
14. Location where the part was recovered:		15. Modifications or Repairs to the NHA:	
16. Consequential Damage to A/C:		17. Injury to any third party:	
18. Recent Maintenance Activity (before event):			
19. Additional Data / comment:			
20. Pictures:			
21. Possible Root Cause:			

AIRBUS		PDA Reporting Sheet	
1. A/L:	2. Date:	3. Page 2 of 2	
22. Corrective actions:			
23. Author: Name: Signature: Date:			

(fig.3)

Standardized PMA reporting sheet

» The role of the operators

• Maintenance personnel

Mechanics may reduce the number of occurrences by complying with the procedures, by identifying all elements during the visual inspections, which could lead to a PDA and by making sure they properly close all access panels and cowls after maintenance operations.

• Flight crews

Pilots may do their part by performing a thorough walk-around before each flight.

But there is another, less obvious actor, which has a more remote and transverse, yet important role to play:

• The engineering department

Indeed the recurrence of similar PDAs across the fleet may highlight the need to modify the design, amend a maintenance procedure or training. By reporting all PDA events to Airbus, the engineering department contributes to the identification of areas where a design/procedure/training modification would reduce the risk.

When such a modification is made available, the engineering department then plays a role in its implementation on the aircraft, in the maintenance documentation or in the training course material.

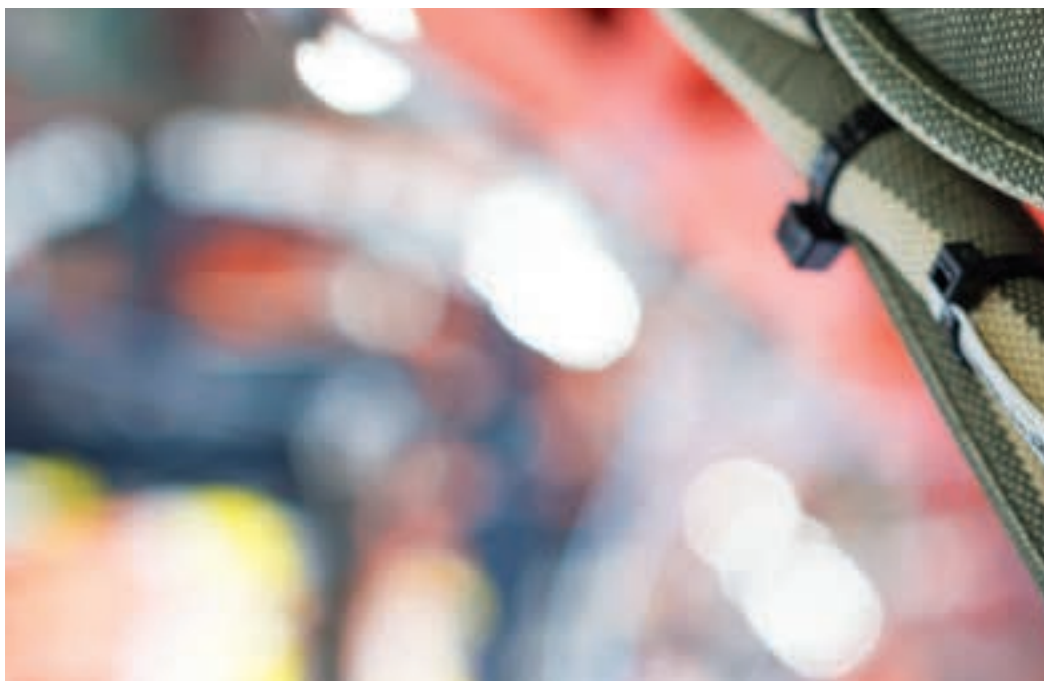
Airbus has raised awareness about the need to report PDAs through a dedicated Operator Information Transmission (OIT ref 999.0094/12) and a WISE article (ref.EngOps-14921).

The reporting itself has been facilitated by the introduction in the Trouble Shooting Manual (TSM 05-50) of a standardized PDA Reporting Sheet **(fig.3)** and the creation of a generic reporting e-mail address: pda.reporting@airbus.com

» The role of the manufacturer

As mentioned above, the modification of the aircraft design, the maintenance procedures or training may play a significant part in the reduction of PDAs. In fact, the role of the manufacturer is to:

- Investigate all PDA occurrences
- Develop mitigating solutions, which may range from a simple information or training recommendation to operators up to a maintenance procedure change or design enhancement
- Communicate these solutions to the operators
- Monitor the in-service effectiveness of these solutions
- Report all PDA events to EASA



But... To fulfil this role, Airbus is entirely dependent on the information provided by the operators. It is therefore very important that airlines report all

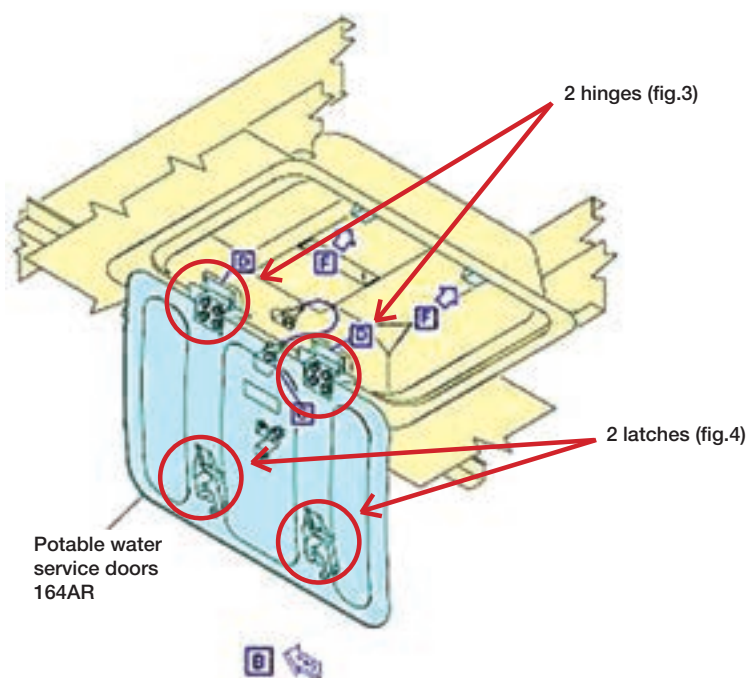
PDA occurrences to their manufacturer so that they can benefit from the PDA prevention measures that Airbus may develop.

Illustration of a solution developed following a report to Airbus

Using the example of potable water service doors 164AR/154BR detachment, the PDA events were reported to Airbus, which then launched an investigation. Analysis of

the occurrences concluded that the loss of the panels were attributable to both worn hinges **(fig.4)** and deficient locking mechanisms **(fig.5)**.

Pre-Mod



(fig.4)

Pre mod worn service panel hinges



(fig.5)

Pre mod service panel latch



OPERATIONS

Parts Departing from Aircraft (PDA)



(fig.6)

Post mod hinges



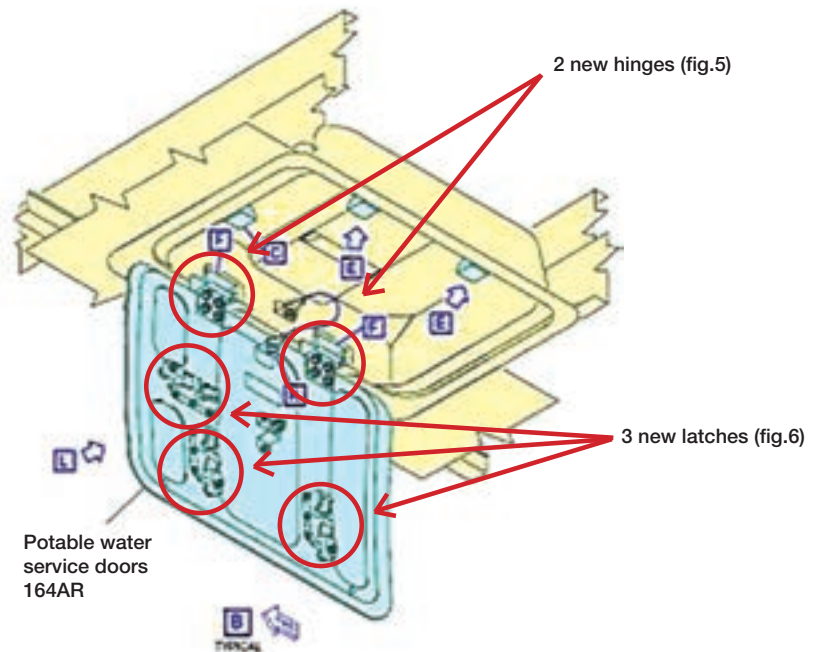
(fig.7)

Post mod latch

This led to the development of Modification n°53666 (Service Bulletin n°52-3076/4087/5010), which increases the hinge pin bearing area **(fig.6)** and Modification n°201715 (Mandated SB

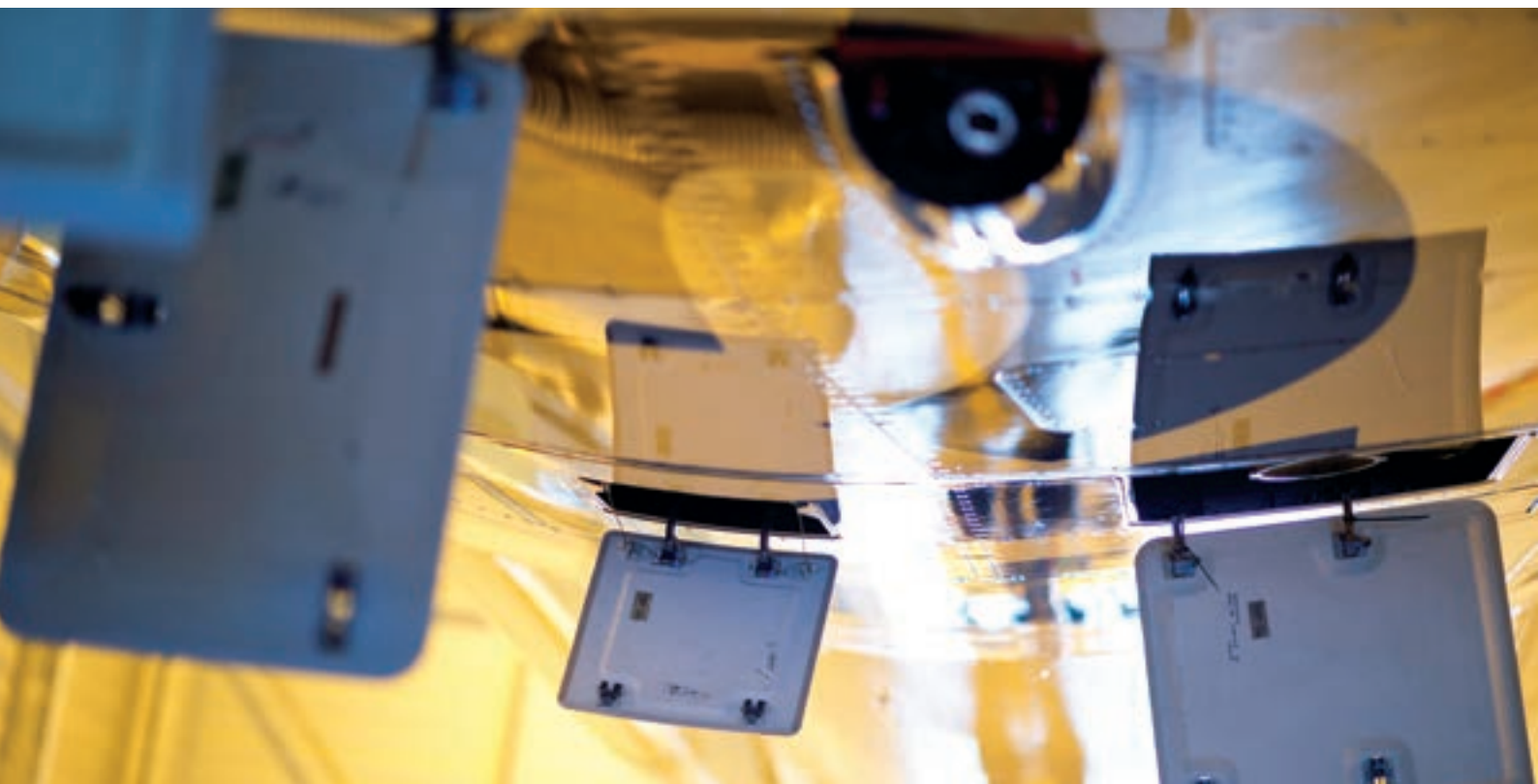
n°52-3086/4094/5019), which consists in replacing the existing latches by more robust models **(fig.7)** and by introducing an additional latch on the leading edge of the door.

Post-Mod



No new occurrences were reported on aircraft which had these modifications embodied. The lessons learnt from

these occurrences were transferred to the A350 design and will also be transposed to all future programs. ■





Parts Departing from Aircraft range in size from fan cowls - which were the subject of a specific Safety first article on July 2012 (issue 14) - down to a simple nut. However they share a common point: they may all represent a safety risk to the aircraft and its occupants, to people on ground or to following airplanes if they land on a runway.

Manufacturer and operators both have the responsibility to minimize the number of PDA occurrences, but the former definitely needs the cooperation of the latter in order to be able to fully play its role. Airbus therefore needs to be informed by the operators of all PDA occurrences, no matter the shape, material, size or weight of the detached part.

The reporting itself has been facilitated by the introduction of a standardized PDA Reporting Sheet, in chapter 05-50 of the Trouble Shooting Manual, which may be sent to the following generic e-mail address: pda.reporting@airbus.com

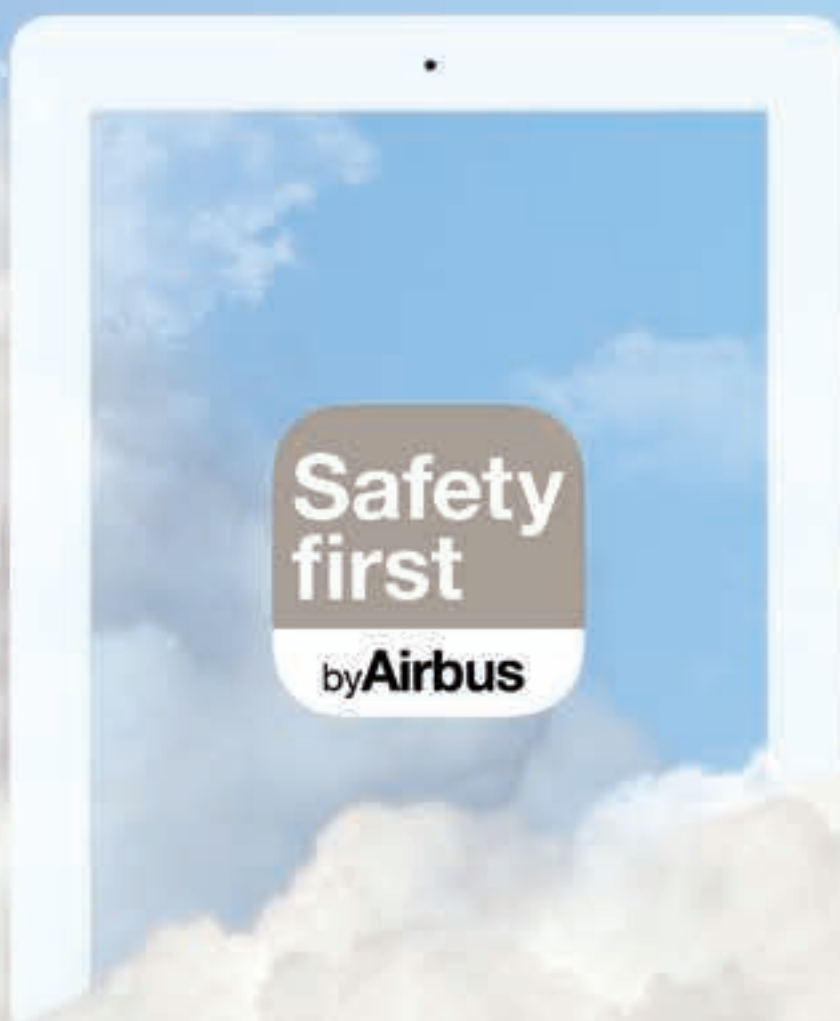
This will allow Airbus to:

- monitor PDA events and launch appropriate prevention actions, through communication, training, maintenance tasks or redesign
- check the efficiency of these preventive actions

References

- Safety first issue 14, July 2012, "Preventing Fan Cowl Door Loss"
- Operator Information Transmission (OIT) 999.0094/12 "ATA 00 Reporting of Part Departing Aircraft (PDA)"
- WISE article EngOps-14921, "How to report to Airbus a part found missing after a flight"
- PDA Reporting Sheet, Trouble Shooting Manual (TSM) chapter 05-50-00-810 "Part found missing during walk around inspection / maintenance action / servicing"
- Maintenance Briefing Note " Parts Departing from Aircraft (PDA) – Update"

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