

# Safety first

The Airbus Safety Magazine

Edition July 2013

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- ▶ Atlantic Airways: Introduction of RNP AR 0.1 Operations
- ▶ Flight Crews and De-Icing Personnel – Working together in Temporary Teamwork for safe Skies
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- ▶ Late Changes before Departure



# Safety First

## The Airbus Safety Magazine

For the enhancement of safe flight through increased knowledge and communications

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**A350 XWB**  
First flight of A350  
XWB at Toulouse-  
Blagnac Airport

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**Yannick MALINGE**

Chief Product Safety Officer

# Editorial

We have all recently shared the experience of the first flight of the A350, a new aircraft that will be operating successfully for its Customers through the coming decades. The preparation for that first flight is perhaps an interesting focus for us all, as it exhibited all the facets of safety and risk management that we know are so important.

When a new type of aircraft is about to fly its first flight, the behavior of the aircraft within the intended envelope is predicted through increasingly accurate simulation but there are still many potential threats. The work up process looks at these threats and prepares mitigation strategies to counter them. Through the development period more about the aircraft becomes known and confirmed and the operating envelope is developed into a secure defined environment in which the normal operation of the aircraft may safely take place.

The A350 has been designed with RNP approach and departure capabilities in mind. It is the first Airbus aircraft to be designed and built with full RNP redundancy in terms of system failures, whilst providing for a 0.1 nm RNP approach level of accuracy. This will not remove the need for excellence in pilot training for such approaches or departures but will fully support the pilots as these approaches become more widespread and also replace many circling to land and difficult non precision approaches in the future.

In this edition we have two articles on RNP. The first deals with some of the basics, whilst the second describes the very challenging RNP Approach at Vagar in the Faroe Islands. I hope you find these articles and all the others in this edition interesting and informative.

**Yannick MALINGE**  
Chief Product Safety Officer

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Director Product Safety Information

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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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# News **SAVE THE DATE**

## 20th Flight safety conference

Dubai, 24-27 March 2014

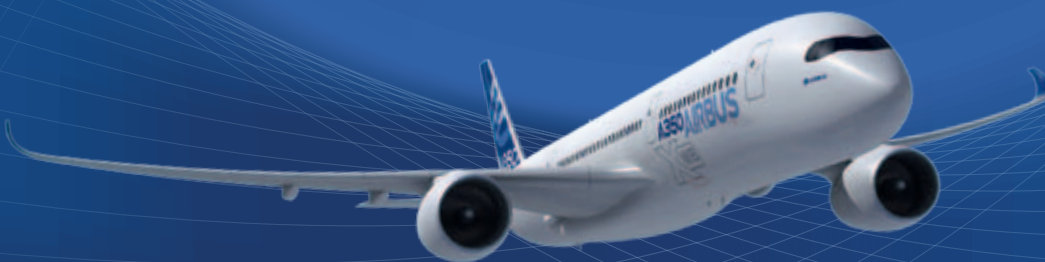
We are pleased to announce that the 20th Flight Safety Conference will take place in Dubai, United Arab Emirates, from the 24th to the 27th of March 2014. The formal invitations with information regarding registration and logistics, as well as the preliminary agenda will be sent to our customers in December 2013.

For any information regarding invitations, please contact Mrs. Nuria Soler, email [nuria.soler@airbus.com](mailto: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](mailto:nuria.soler@airbus.com)



**Matthias MAEDER**

Senior Director Flight Operations Support  
Airbus Training India Pvt. Ltd.

# Performance Based Navigation: RNP and RNP AR Approaches

## 1. Introduction

Performance Based Navigation (PBN) is becoming more established in worldwide operations. It includes approaches called RNP APCH and RNP AR APCH, where RNP stands for Required Navigation Performance, APCH is simply an abbreviation for Approach and AR for Authorization Required.

RNP and RNP AR procedures allow crews to fly approaches using internal and very accurate navigation tools, instead of traditionally using external guidance aids. They also allow the replacement of visual and circling approaches by instrument approaches, thereby enhancing the safety of airline operations. They are non-precision approaches although they provide the crews with cues and

procedures similar to those used on precision approaches.

This article first describes how the performance of non-precision approaches has evolved over time; from the step down procedures to the Constant Descent Final Approach (CDFA) concept and finally how this evolution has led to RNP solutions and associated benefits.

All Airbus Fly-By-Wire (FBW) aircraft equipped with GPS are currently certified for RNP approaches, which will constitute the majority of cases. RNP AR capability will usually be necessary in marginal cases, where extra flexibility in approach design is needed. This will be illustrated by the following article in this magazine, dedicated to RNP AR operation.

## 2. Evolution of Non-Precision Approaches

Advances in technology have modified the way non-precision approaches can be flown:

- The first technological step involved the move from the traditional step down approaches (also known as “dive-and-drive” approaches) to the CDFA concept, and the use of FMS systems to compute, then guide on the lateral and vertical approach paths.
- The second step implied the change over to RNAV/RNP approaches, primarily thanks to the introduction of GPS to civil aviation.

## 2.1 Step Down Non-Precision Approaches

The non-precision nature of the approach is characterized by the poor embodiment of the vertical path of the final approach. At the Final Approach Fix (FAF), the crew might be provided only with an assigned altitude and a distance to the Missed Approach Point (MAP). Thus, the crew awareness of the aircraft position versus the intended vertical flight path of the final approach is quite low (fig. 1).

This traditional step-down approach technique has the following drawbacks:

- ▶ The aircraft never stabilizes during the final approach. The pitch attitude needs to be changed even at low altitudes, thus the thrust and pitch have to be continuously adjusted.

- ▶ The aircraft reaches MDA(H) in quasi-level flight either before or after the Visual Descent Point (VDP). Consequently, the acquisition of visual references is affected by the pitch attitude of the aircraft. This pitch is significantly greater than the nominal pitch attitude observed when the aircraft is established on an e.g.  $-3^\circ$  approach descent angle. This affects the perspective view of the runway.

- ▶ When acquiring visual references beyond the VDP, the pilot might be tempted to continue the final approach visually, which will result in a high descent rate during the visual segment of the approach.

- ▶ The monitoring/advising task in these approaches is also very high but remains a critical element of a successful approach.

## 2.2 Constant Angle Non-Precision Approaches (CDFA) concept

The CDFA concept addresses the key drawbacks of the step down procedure, mainly because the descent angle is constant throughout the final approach (fig. 2), allowing:

- ▶ A stabilized final approach: pitch attitude, speed, thrust and pitch trim remain constant. The monitoring of the vertical flight path during the approach is simple and continuous.

- ▶ A smooth transition from instrument to visual flying, as the aircraft is established on a descent angle (e.g.  $3^\circ$ ) and the crew keeps a constant perspective view of the runway.

- ▶ A safe approach up to the landing as the go-around decision is taken at the VDP, which is on the flight plan.

and therefore minimizes the risk of:

- ▶ Controlled Flight Into Terrain (CFIT)

- ▶ Landing short

- ▶ Runway Excursion due to landing long

The move from the step down to the CDFA concept was made possible thanks to Flight Management System (FMS) features, which are currently available on all Airbus aircraft by the use of TRK/V/S, TRK/FPA, FINAL APP or FLS modes, when applicable.

## 3. RNP AND RNP AR APPROACHES

The CDFA concept was further adapted by RNAV (aRea NAVigation) approaches, which are described by a series of point-to-point trajectories where each point may be defined either by a bearing / distance to reference ground navigation aids (VOR – DME) or by a geographic position defined as a latitude / longitude. An altitude constraint is assigned to each waypoint. Therefore, RNAV approaches define both a lateral and a vertical trajectory.

The ICAO Document n° 9613 – PBN Manual - describes the navigation specifications for RNAV and RNP.

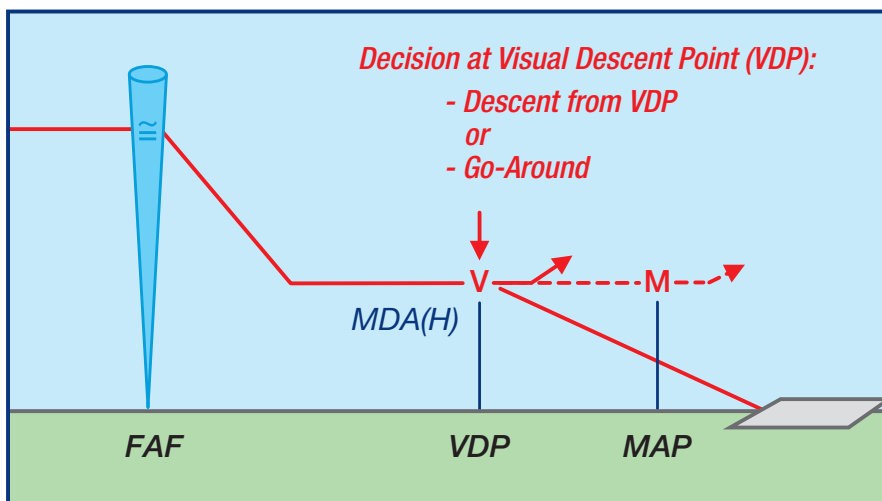


Figure 1  
Traditional step down NPA

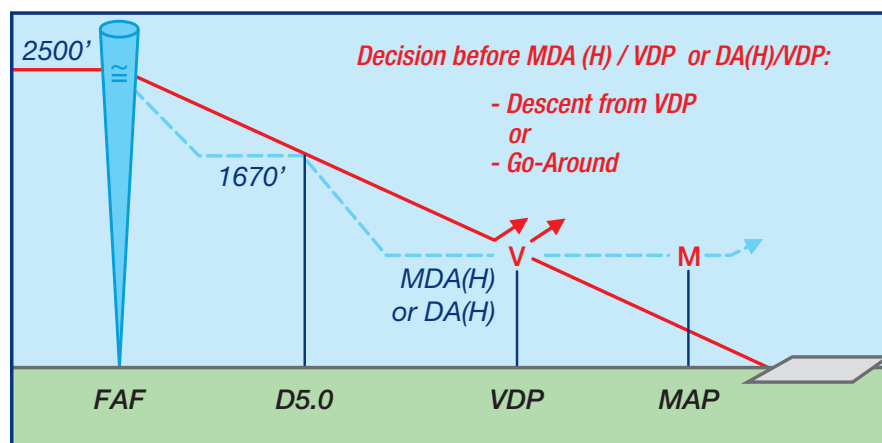


Figure 2  
NPA flown using the CDFA concept

RNP and RNP AR approaches are basically defined as RNAV approaches within a performance based navigation concept. The main difference is that they do not require ground facilities for navigation as they use the navigation performance of the aircraft. This means that the aircraft is able to fly the RNAV approach trajectory meeting a required navigation performance, where the RNP value, e.g. RNP 0.3, designates the lateral navigational performance required associated with a procedure (in nautical miles).

This is achieved by adding the following systems to the aircraft:

- ▶ A Global Navigation Satellite System (GNSS), of which the US Global Positioning System (GPS) is currently the world's most utilized type.

- ▶ An On Board Performance Monitoring and Alerting system (OBPMA). The OBPMA is required to monitor the navigation system and will alert the crew in case of malfunction, e.g. GPS PRIMARY LOST and, therefore, allows the flight crew to determine whether the RNP system satisfies the navigation performance required.

### 3.1 RNP approaches

The first approaches using RNAV equipment have been developed before the definition of RNP. For this historical reason RNP approaches are commonly charted as RNAV (GNSS) or RNAV (GPS).

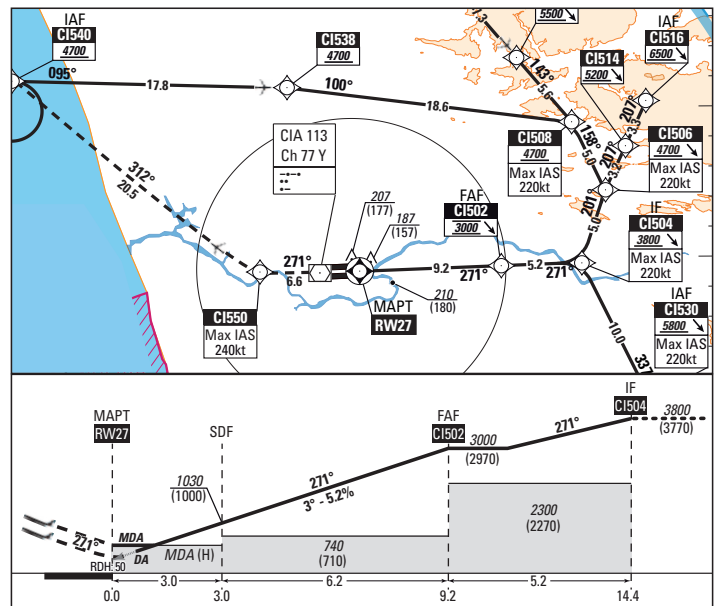
These RNP approaches are characterized by straight segments between the FAF and the runway (fig. 3).

### 3.2 RNP AR Approaches

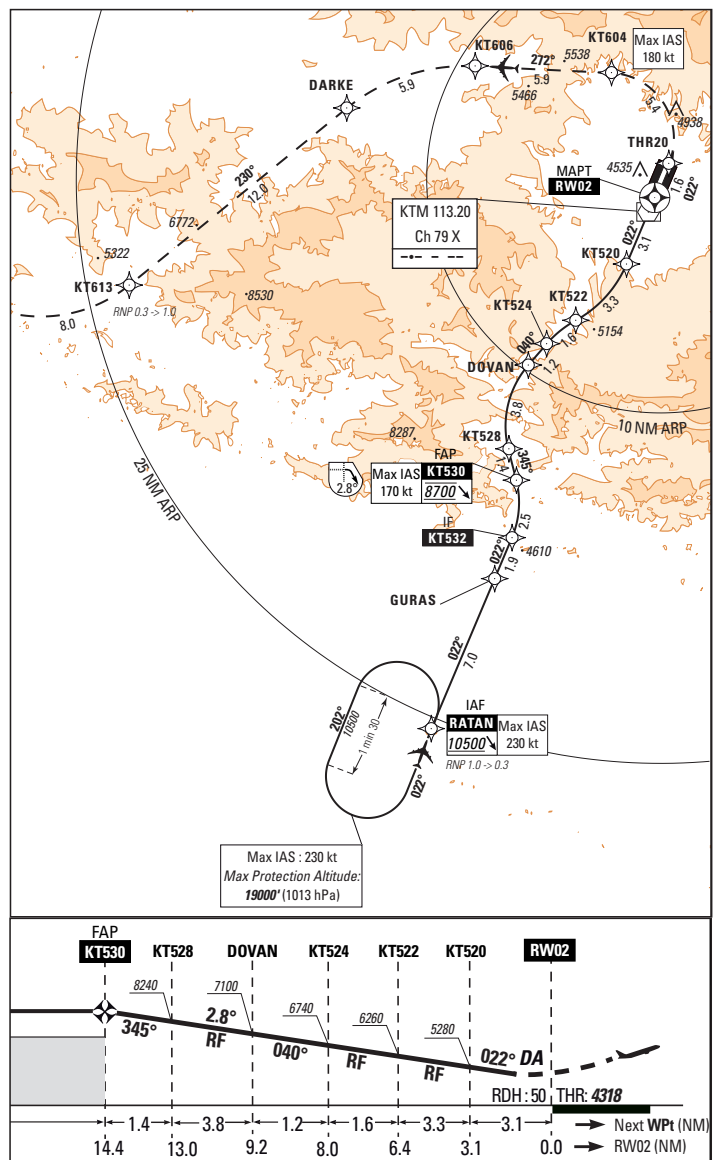
Compared to RNP approaches, where the segment between the FAF and the runway is straight, RNP with Authorization Required approaches might have “curved” final segments. These approaches are therefore colloquially called “curved approaches”. Furthermore, RNP AR approaches allow reduced obstacle clearance compared to RNP approaches (fig. 4) RNP AR\* approaches are charted as RNAV (RNP).

\* FAA terminology: RNP SAAAR (Special Aircrew and Aircraft Authorisation Required)

**Figure 3**  
Example of RNP approach chart



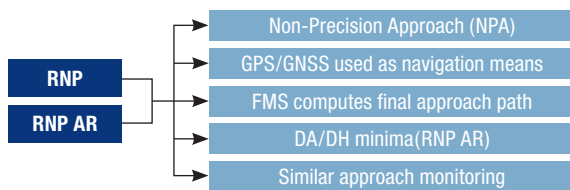
**Figure 4**  
Example of RNP AR approach chart



	RNP Operation	RNP AR Operation
RNP Value 0.3	✓	✓
RNP Value < 0.3 (down to 0.1)		✓
Straight segment between FAP and RWY	✓	✓
Curve between FAP and RWY		✓
Minima DA/DH could be as low as 250 ft	✓*	✓
Departure and/or missed approach RNP Value < 1		✓

\* MDA/MDH might be given as well (LNAV only Minima).

**Figure 5**  
Respective characteristics of RNP and RNP AR approaches



**Figure 6**  
Summary of some key elements for RNP and RNP AR approaches

### 3.2.1 RNP AR Implementation Requirements

The specific nature of RNP AR operations call for the following additional requirements compared to RNP operations:

#### ► Aircraft Certification

Some RNP AR operations will require specific aircraft configurations. RNP certification have been granted to most Airbus types (A320 Family, A330 and A345/6). The aircraft capability appears in the AFM. For in service aircraft, application of a dedicated Service Bulletin is required.

#### ► Flight Operational Safety Assessment (FOSA)

RNP AR operations generally require a FOSA. The assessment should give proper attention to the inter-dependence of the elements of procedure design, aircraft capability, crew procedures and operating environment.

RNP AR procedures must be designed and tested in accordance with the design specificities and performance of the concerned aircraft.

#### ► Training Programs

Airlines have to develop training programs dedicated to their RNP AR operations.

#### ► Operational Approval

RNP AR application packages include a full set of operational documentation, procedures and training programs, which need to be approved by the local Authority.

## 4. SAFETY BENEFITS

### 4.1 RNP Approaches

#### ► Replacement of visual and circling approaches

RNP allows IFR procedures to be designed in environments, where previously no instrument approach could be envisaged. RNP approaches are particularly suited for (but not limited to) approaches in challenging areas (e.g. mountainous areas) and as a replacement for most existing circling approaches.

Compared to visual and circling approaches, the trajectory of the RNP approach is predictable. This enhances the preparation and briefing of the approach. Moreover, it facilitates the situational awareness and decision making. Flying these approaches fully managed in a lateral and vertical sense and in speed control makes energy management easy throughout the approach.

RNP approaches also ensure a simpler entry into a planned Go Around trajectory profile should one be required. This has always been a somewhat “difficult” aspect of circling approaches.

#### ► Lower weather minima

Lower minima allow a better transition to the visual segment when

aligned with the runway, thereby reducing the probability of having to go-around.

#### ► Less communication needs

The pilot workload is reduced as there is less need for communication.

#### ► Assessment of Terrain Avoidance Warning System (TAWS) warnings

The required procedure validation for RNP approaches will assess the absence of TAWS warnings.

### 4.2 RNP AR Approaches in addition to RNP Approaches

#### ► Improved flexibility

RNP AR approaches are expected to cover those cases where the procedure design limitations of RNP approaches do not allow to replace visual and circle to land procedures.

#### ► Implementation of safety criteria

The completion of a FOSA will ensure that for each specific set of operating conditions, aircraft and environment, all failure conditions are appraised and, where necessary, mitigations are implemented to meet the safety criteria.

## 5. CONCLUSION

The Constant Angle Non-Precision Approach (CDEFA) concept has replaced the non-stabilized final segments associated with the old step down Non-Precision Approaches (NPA).

RNP and RNP AR approaches are basically defined as RNAV approaches within a performance based navigation concept. The main difference is that they do not require ground facilities for navigation as they use the navigation performance of the aircraft.

For suitably equipped aircraft, RNP and RNP AR approaches provide an alternative “precision like” approach option for NPAs. All Airbus

FBW aircraft with GPS are currently certified to fly RNP approaches, which are suitable for the vast majority of airports.

In specific cases the added flexibility of RNP AR will be needed under certain terrain/approach and airfield situations.

Compared to visual and circling approaches the trajectory of the RNP/RNP AR approach is predictable, therefore facilitating situational awareness and decision making. The replacement of visual and circling approaches by RNP/RNP AR approaches is therefore a safety enhancement.



**Joen REMMER**Vice President Operations  
Atlantic Airways**Stan ABBOTT**

Consultant UK &amp; Ireland

# Atlantic Airways: Introduction of RNP AR 0.1 Operations

Atlantic Airways, the national carrier of the remote Faroe Islands, last year became the first airline in Europe to introduce RNP AR 0.1 (Required Navigation Performance – Authorisation Required) satellite-based approach and take-off operations. Joen Remmer and Stan Abbott look at the implementation of the system and its impact on safety, crew workload and regularity.

RNP AR operations arrived at Atlantic Airways with the delivery of the airline's first Airbus A319 in March 2012, following a period of close cooperation and intensive development in partnership with Airbus subsidiary, QuoVadis (fig. 1).



**Figure 1**  
Atlantic Airways took delivery of its first A319 on March 22<sup>nd</sup> 2012.  
CEO Magni Arge, centre, and (far left) Captain Jóhan í Niðristovu.

RNP AR 0.1 operations were permitted from Day One of Atlantic Airways' Airbus operation by the Danish Aviation authorities, which went on to grant full unrestricted approval, including significantly reduced operating minima, after a period of detailed monitoring.

RNP AR 0.1 has, since its introduction, achieved significant savings for the airline -- both in day-to-day operating costs (due to more fuel-efficient approach and take-off patterns) and through very significantly reducing the incidence of weather-related diversions to Vágar's nearest alternates, all which are an hour's flying time away in Norway, Iceland or Scotland.

Perhaps even more important (though harder to measure in cash terms) is the very real improvement in operational safety. This is not to say that the airline's operations prior to RNP AR 0.1 were "unsafe": simply that, in the highly safety-conscious environment of commercial aviation, the system makes Atlantic Airways' operations in an area of challenging weather and terrain even safer still.

By applying RNP AR 0.1 procedures, Atlantic Airways has been able to convert the implicit skills and knowledge of its pilots, built up over years of operation in their chal-

lenging environment, into explicit procedures programmed in the aircraft FMS. Automated flight is more often used where manual flight was required previously, leaving the pilots with more mental capacity to monitor the safe progress of the flight, and with more alertness to intervene, if unacceptable deviations develop.

To understand the very particular challenges that Atlantic Airways faces in its day-to-day operations demands first of all a short history lesson.

The Faroe Islands comprise an archipelago of 18 individual islands, 17 of them inhabited. Originally volcanic, the islands meet the full fury of the North Atlantic with precipitous cliffs, including one that rises more than 800 metres sheer and is claimed to be the highest in all of Europe.

In this mountainous landscape, the occupying British forces built a short airstrip during the last war, in the very west of the islands, on a saddle between areas of high land. The strip was in close proximity to both Sörvagur, which was a good harbour for vessels to operate to and from all year round, as well as to the lake on which Catalina flying boat operations were based (fig. 2).

After the war, the strip remained unused until the 1960s, when it reopened to commercial traffic. However, its location and runway alignment have posed significant challenges ever since.

Pilots have required above-average skills and handling capabilities, thanks to the combination of the

short runway (just 1,250 metres), only having non-precision approach aids, fairly high minima, surrounding topography allowing only narrow and offset approach paths, and the prevailing weather conditions that are typified by strong winds, violent wind shears, rotors, and much cloud and precipitation.

Indeed, the airport has, since its reopening seen two fatal accidents, both of which occurred during approaches in difficult meteorological conditions. Neither incident involved Atlantic Airways, which began its operations in 1988. As a consequence of findings that were published some time after the most recent incident (a turbulence-related fatal accident involving a Danish Air Force Gulfstream III in 1996), the Danish authorities imposed new safety rules that now include closure of the airport in certain wind strengths and directions.

As a consequence of the various challenges, Atlantic Airways' regularity has often been poor, especially in winter. In 2011 alone Atlantic Airways had more than 50 weather-related cancellations or diversions. Needless to say, this is a financial burden for the airline, and an inconvenience for Faroese industry and the public, who are so dependent on the life-line air service to and from mainland Europe.

When the Faroese Government launched a runway extension programme some years ago, Atlantic Airways immediately started to investigate what operational improvements could be achieved through

this. Not only would a longer runway (now 1,799 metres) cater for a larger and more modern aircraft type than the then fleet of BAe 146 and AVRO RJs, but any opportunity to improve the safety and regularity level had to be examined. The choice was for the Airbus A319 (fig. 3).

“We had investigated various conventional means of improving the accessibility of the airport in adverse weather conditions, but none proved successful,” explains A319 Captain Jóhan í Niðristovu. “But we had learned an interesting lesson when we introduced the AVRO RJ fleet on top of our existing BAe 146 fleet: that new technology, such as improvements to the autopilot, could also reduce workload, raise safety levels and have a positive effect on regularity. So when we first learned about RNP, we realised that new technology, rather than conventional, would be the right focus.”

Atlantic Airways soon learned that, even though RNP AR had been successfully implemented around the world, there was no previous application of RNP AR with low RNP value (below 0.3nm) in Europe. The first challenge was therefore to bring together the various stakeholders, that is Vágur Airport, the Danish aviation authorities and Airbus. There are very few RNP AR design providers and Atlantic Airways decided to team up with QuoVadis for obvious reasons: its close relationship with the manufacturer of the A319 that the airline had procured, and its record of very successful RNP design projects around the world.



**Figure 2**  
A view of the Sörvágsfjord,  
which leads to runway 12 at Vágur.



**Figure 3**  
Airbus on take-off from Vágur.

Early studies revealed that RNP 0.3 (which is the “basic” precision used in public procedures) would not offer any advantage over the localiser approaches in terms of minima. Atlantic Airways therefore decided to construct and get authorisation for RNP AR procedures at the highest possible precision, 0.1, so as to take the best possible advantage of this technology. The 0.1 value means that the aircraft’s position is accurate to a variation of no more than 0.1 nautical miles.

The roadmap was agreed with the Danish authorities in the spring of 2011, the kick-off meeting for the implementation project followed in June, and the authorisation to start the RNP AR operation was obtained the day before the first commercial flight with the new A319 on March 28 last year.

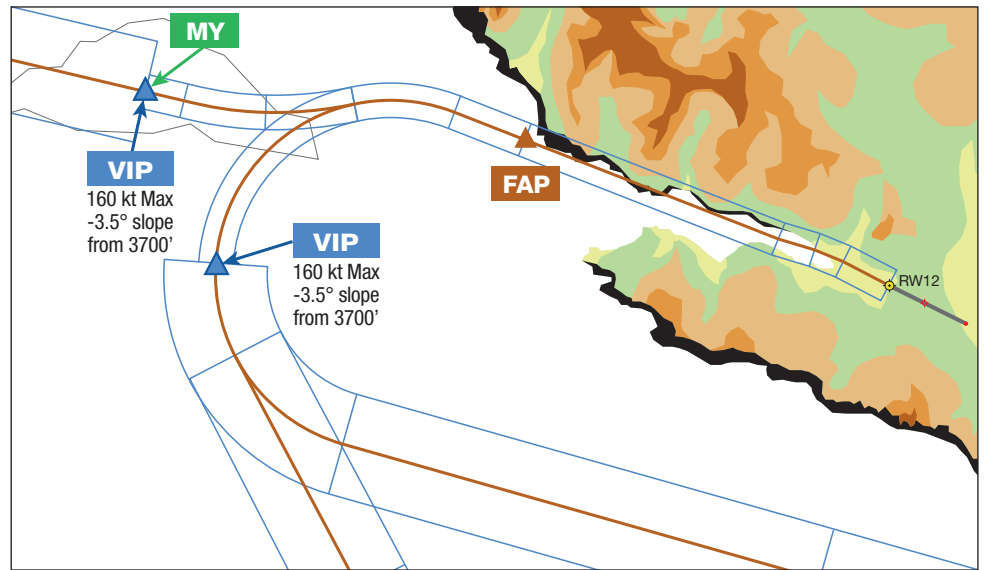
The development period of about eight months was a challenging time of intense collaboration between all parties. On the one hand, Atlantic Airways had to ensure that what was designed would truly be beneficial for the airline, in terms of increasing safety levels and regularity, and on the other that the project would be in perfect compliance with relevant ICAO guidelines and EASA regulations.

As for the design work, Captain í Niðristovu, continues: “To meet our primary objectives – enhanced safety and improved regularity and a secondary objective of reduced fuel burn – it was crucial for the airline that its implicit knowledge of operating on Vágar was carefully combined with the explicit knowledge of QuoVadis on the A319 and RNP AR capability, so as to achieve the best result.”

Several design meetings took place, at which experienced Atlantic Airways captains worked closely with procedure designers from QuoVadis to define the most desirable trajectories for various weather conditions. Exploiting a technology that offers so much flexibility (like turns after the Final Approach Fix) required careful attention to the key value-makers: avoiding known areas of

strong turbulence and shears (generally associated with strong winds in certain directions that give rise to significant turbulence in the lee of sea cliffs and mountains), getting a better alignment with the runway on a short final and obtaining the lowest possible Obstacle Clearance Height (fig. 4).

correct track-keeping capability of the autopilot in dimensioning wind conditions. The design and testing activities were ongoing from August 2011 right up to January 2012. The formal validation was demonstrated in front of the Danish CAA. All procedures were validated in



**Figure 4**  
RNP AR trajectories for rwy12. Three intermediate approach tracks leading to the same final approach. The blue lines indicated the trajectory boundary, which is 0.1NM from the Vertical Intercept Point and inwards.

When the principal trajectories were sketched, QuoVadis started to detail and fine-tune the design, and conduct thorough simulator testing of each procedure. One aim was to ensure that no false Ground Proximity Warning System (GPWS) alerts would occur when flying the procedures, another to verify the

both an A319 engineering simulator (that uses real aircraft systems) and a full flight training simulator with realistic Vágar scenery. And finally, a demonstration flight without passengers was performed at Vágar, flying all the RNP procedures in good weather conditions (fig. 5).



**Figure 5**  
Vágar simulator scenery. The RNP AR training was given in a full flight simulator with very detailed scenery of Vágar.

Already, after a month of operation, Atlantic Airways was seeing its vision realised, with crews confident that RNP AR was giving them precision approach-like capabilities and advantages in a place where precision approach by conventional means was impossible to implement for both runways. And, in that short time, it was already clear that diversions had been avoided. "The increase in safety level is tangible, because the peak workload is over when the final approach starts and so, much more attention is given to monitoring the approach parameters," said Captain í Niðristovu at the time. "And the avoidance of conventional procedure turns is saving us precious litres of fuel on almost every flight."

One other key element in the successful introduction of RNP AR was crew training. In November 2011, three captains from Atlantic Airways joined an intensive three-month line training programme with Air New Zealand, which operates the A320 family and has RNP AR procedures at several destinations. All four crews in the first round of Atlantic Airways Airbus training, as well as additional line training instructors, received tailored Vágar RNP AR training at the Airbus training academy in Toulouse shortly before entry into service.

Atlantic Airways' unusual choice of the 27,000lb thrust-rated CFM56-5B7/P engines for the A319, was also linked to the RNP AR capability. The very powerful engines ensure the best possible one-engine-inoperative missed approach climb gradient, an important factor in obtaining the lowest possible Obstacle Clearance Height of 250 feet AGL. And the airline installed a Head-Up Display on its first A319, in anticipation of its upgrade for use during RNP AR operations, to further reduce the workload of the pilot in poor visibility.

One year on, Atlantic Airways can instance more than a dozen diversions avoided and is confident that the investment in RNP AR capability will provide a long-lasting im-

provement in its operation to and from the Faroe Islands, securing the return on investment, thanks to the high impact on safety levels and regularity.

The airline's work in pioneering RNP-AR 0.1 in Europe was recognised by industry peers when the airline received the European Regions Airline Association's Airline of the Year (Bronze) Award in September 2012.

Full and unrestricted approval for the RNP AR system followed soon afterwards from the Danish CAA and Sámal P Danielsen, Director Flight Operations, said: "We are delighted to receive full and unrestricted approval for our proprietary RNP operating system after a successful trial period of operating at higher minima, during which every procedure flown was post-analysed for accuracy and integrity." (fig. 6)



**Figure 6**  
The RNP trajectory on the A319 Navigation Display leading to runway 12 at Vágar. Notice the lateral and vertical deviation indicators (L/DEV and V/DEV) on the Primary Flight Display.

The approval is proprietary to Atlantic Airways and therefore the operating minima are not published or publicised, although they are significantly below those achievable by using Vágar Airport's own recently commissioned ILS system.

Magni Arge, Chief Executive, added: "Atlantic Airways may not be the largest airline in Europe but we are very proud to be the first airline in Europe to introduce this Performance-Based Navigation System. I am delighted too that the Danish aviation authorities have been ready to work with Atlantic Airways and QuoVadis. Their final approval of our proprietary system has been great news for our customers and for everyone who has worked hard to achieve this."

**Alun WILLIAMS**

Manager, General Mechanical Systems  
Engineering

# Flight Crews and De-Icing Personnel Working together in Temporary Teamwork for safe Skies

## 1. Introduction

Flying aircraft in winter conditions is not an abnormal condition - but it does require more attention to detail and some specific knowledge. It is normal to be relieved at the end of winter and to relax a little as the threat subsides, but the memory of winter needs to be preserved for the next seasonal repeat. This “winter threat” also requires a high level of additional team-work between flight crew and ground staff. For a fairly short periods of time flight crew and ground staff are focused on one objective: the safe take-off of the aircraft, and must therefore work together towards a common aim.

In this article we will be speaking about this important interaction between flight crews and ground crews and how their complementary action can enhance safety. Pilots ultimately have responsibility for their aircraft and, in winter, they need more input from ground crews, in order that their decision making is fully informed

## 2. Importance of proper Training

It is of prime importance that all ground de-icing personnel of whatever grade or function are fully trained to recognize icing of all types and in all forms – even to recognize the conditions prevailing when ice or frost can form (active icing conditions).

A good pair of eyes is crucial in many ways to the safety of the aircraft. Ground staff can sometimes be the only way that flight crews (in the cockpit) can be informed of icing safety issues on their aircraft in unseen areas.

All crews (flight and ground) need regular training for winter operations and this needs to be constantly in the memory – not something which is put to the back of the mind in summer and therefore comes as a shock - next winter.

Another aspect of the flight/ground crew interaction, is that flight crews are not always ‘informed’ on AMM Procedures (de-icing etc) and ground crews are not generally ‘informed’ on FCOM content. Some general cross training for both crews serves to improve the flow of information between both.

The worst statistics for dispatch reliability, loss of aircraft slots and even cancellations tend to occur in the October/November period every year, when this transitional period into winter operations has not been properly prepared for.

The best time to prepare for this is in August/September, using simulators if possible but certainly practicing procedures and scenarios and refreshing the memories of what happened last winter.

### 3. Typical De-icing Procedure

There is no 'typical' operation – all airports are different, the buildup of activity is 'organic' and activities occur differently in different locations. A de-icing procedure, which is inherently good for Bolivia may not be the best for Siberia or Paris. This is why all authorities require each airline to write their own individual procedures for their own locations and to work with de-icing service providers to ensure the procedures they create are correct for their aircraft.

### 4. Importance of proper Teamwork

To illustrate the importance of good flight crew / de-icing personnel teamwork, we have split a winter ground operation workflow into the following representative phases:

- ▶ Pre-Boarding
- ▶ Start of Engines and Taxi to De-icing Pad
- ▶ Ground De-icing
- ▶ Taxi to Runway
- ▶ Pre Take-Off

And for each phase, we look at how their complementary action can enhance safety.

#### 4.1 Pre-Boarding

After receiving the weather briefing aircrew will inspect the exterior of the aircraft during their pre-flight inspection. At this time the flight crew may request de-icing or further anti-icing depending on the aircraft condition and the weather. (The aircraft may or may not have been treated prior to their arrival. It is more likely now that the aircraft is boarded first and then de-iced on the way to take-off via the de-icing pan.)

Flight crew should also remember that the ground crew are outside 'in' the weather and may have advice on the immediate conditions prevailing.

### The three different contamination checks required to be accomplished

#### 1. Pre-Flight Contamination Check

- ▶ Normally accomplished by the flight crew. However in the absence of the flight crew the Controller (De-Ice Coordinator) can accomplish the check.

#### 2. Post De-Ice Contamination Check

- ▶ Accomplished by the De-Ice Inspector.

#### 3. Pre Take-Off Check

- ▶ Accomplished periodically during taxi out and prior to take-off by the flight crew.

#### note

Various different terms can be used to describe the activities of people on the team:

- One person should be designated as the manager or responsibility holder for all de-icing activities. He or she would normally be called the Controller, De-Ice Coordinator, sometimes also 'Ice-Man'.
- One person must be designated as the inspector – normally called 'De-Ice Inspector'. This person is responsible for making sure and confirming that the aircraft 'critical surfaces' – wings, stabilizers and fin are free from frozen contamination (contamination = ice, frost, snow etc). The final required method is by touching the aircraft wing skin (Tactile Test). This person can be anyone from the teams. Different airports have different personnel configurations; what is important is that one person is designated for this responsibility.

#### 4.2 Start of Engines and Taxi to De-icing Pad

Understanding the significance of Holdover Times (HoT) is important as these will directly affect the pre-flight phase planning. Prepare the aircraft for de-icing – close intakes, and outflow valves. Set aircraft in Ditch mode.

Anti-icing is a less aggressive stage which ensures the aircraft remains clear of contamination for the required time.

Aircrew need to remind themselves that they are following procedures (FCOM) and are highly occupied with cockpit work and preparation. Any extra information and assistance they can get from ground crew should not be forgotten or dismissed.

#### 4.3 Ground De-icing

De-icing procedures are basically written and designed to remove 'contamination' from the aircraft critical surfaces. Fuselage cleaning and front fuselage cleaning needs to be performed carefully to ensure airdials are not damaged and windscreens and wipers are not clogged with fluid.

Ground crews are local, often pilots are not. That means that although

pilots will be given a weather briefing, often the ground crew can give details for short local changes, which can be valuable to pilots.

Here the aircrew and the ground de-icing crew come together. The flight crew taxi the aircraft into position on the de-icing pan and the de-icing vehicles drive up to the aircraft. If necessary, the aircraft is de-iced and anti-iced, in accordance with the pilot's request and the prevailing weather conditions.

The ground de-icing crew should consist of a Controller (De-Ice Coordinator), the relevant number of vehicle drivers and de-icing lance operators and a De-Ice Inspector. There must always be a ground De-Ice Inspector, qualified locally and to national and international standards to confirm to the pilot that the de-icing has been effective and that the aircraft carries no contamination before moving off to the flight area.

In most cases the preferred method of confirmation is by 'Tactile Test' – or basically, De-Ice Inspector will touch the aircraft wing surface with bare fingers (fig. 1). This is probably still the only trusted method of confirming the wing is clear of contamination – particularly clear-ice (fig. 2).

**4.4 Taxi to Runway**

When the aircraft is ready and declared free of ice, the flight crew will taxi on towards the runway. Flight crew still need to be vigilant to watch the time and ensure HoT is not over-run, weather conditions do not change and the aircraft starts to collect contamination. If in doubt turn back.

Use as much of the ground resource as possible and keep checking that no contamination has formed or stuck.

Aircrew must also be vitally aware that contamination can grow in areas they cannot see. For example, in extreme low temperatures and in precipitation, particularly snow, it is possible for the precipitation to hit the windscreen and melt. The windscreen (externally) is not necessarily at a very high temperature but hot enough not to freeze. Thus any clear melt water will run down the side of the aircraft underneath the windscreen and out of the pilot's vision. If the aircraft is required to return for re-treatment and the time builds, this can build a fairly thick ice-bridge which may cause a problem with unreliable airspeed at a later time, because it will deflect the airflow away from the pitot tube (fig. 4, 5 and 6).

If an aircraft is slow to take-off for any reason and needs to be de-iced again or retreated for anti-icing (sometimes more than once) aircrew must bear in mind the potential growth of these ice-bridges and their potential to cause 'unreliable airspeed' indications during take-off. This is not to be confused with unreliable airspeed caused by ice crystals in cruise.

**4.5 Pre Take-Off**

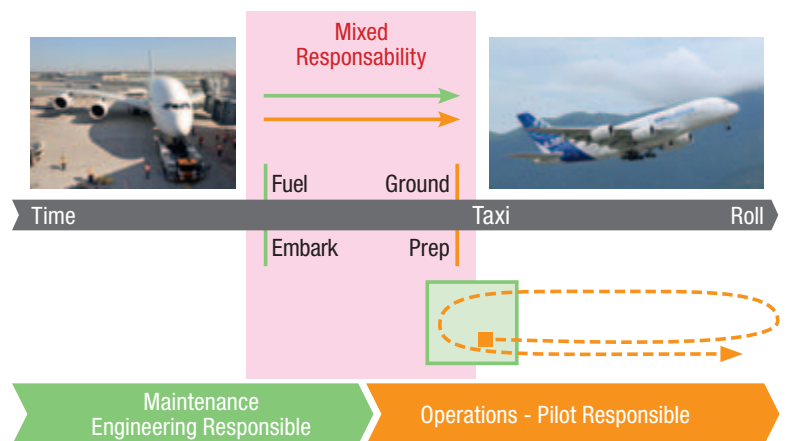
For the previously described situations it would be necessary for ground crew to approach the aircraft, for example to confirm icing on the front fuselage. If that is the case, it is the responsibility of the flight crew to call them forward and ensure their safety.



**Figure 1**  
Tactile Test



**Figure 2**  
Clear-ice contamination on the wing



**Figure 3**  
Under all the above conditions, it is necessary for ground crew and resources to be available to pilots until roll to take-off

## 5. Conclusion

### 1. Know your de-ice and anti-ice procedures

### 2. Be ready to adapt:

There are good rules and procedures, but we cannot be rigid as the weather situation can alter quickly. All situations need to be treated with intelligent adaptation.

### 3. Maximise Teamwork:

Good team work between flight-crews and ground crews is an essential ingredient of safe winter operations.

Ground crew local knowledge may be invaluable – it should be sought and used by flight crews.

Flight crew have the ultimate responsibility but they need to make use of ground crew capability until the latest possible moment.

### 4. Always maintain vigilance:

It leads to improved safety levels.

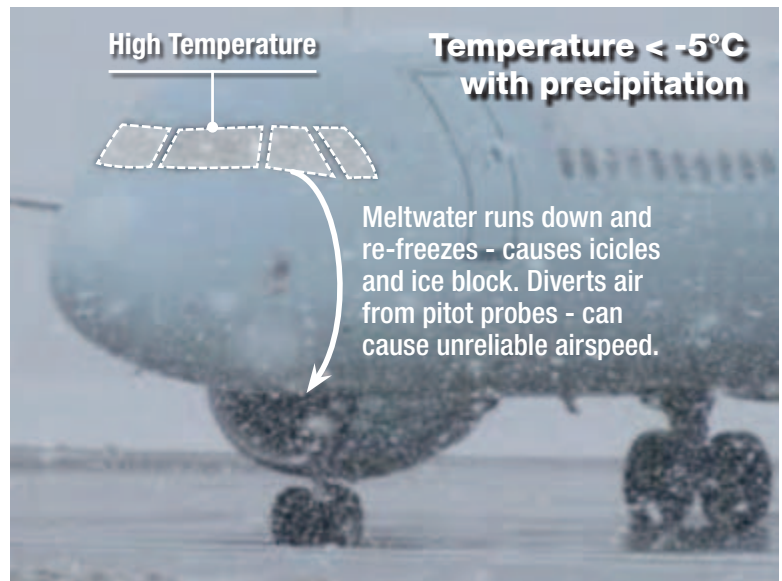
## References

### A320 Family, A330/A340, A380:

- ▶ Flight Crew Operating Manual (FCOM): PRO SUP - ADVERSE WEATHER - COLD WEATHER
- ▶ Flight Crew Training Manual (FCTM): NORMAL OPERATIONS - SUPPLEMENTARY INFORMATION - COLD WEATHER
- ▶ Aircraft Maintenance Manual (AMM): Chapters 12-30-00 and 12-31-00 Complete

### A300/A310:

- ▶ FCOM 2.02.13 - PROCEDURES AND TECHNIQUES - INCLEMENT WEATHER OPERATION; OPERATION IN ICING CONDITIONS
- ▶ FCTM 2.34.10 - SUPPLEMENTARY INFORMATION - INCLEMENT WEATHER COLD WEATHER OPERATIONS AND ICING CONDITIONS
- ▶ AMM: Chapters 12-30-00 and 12-31-00 Complete



**Figure 4**  
In poor visibility during extreme weather conditions, the ground crews need to be as close as possible to see clear ice on the front fuselage



**Figure 5**  
Clear pitot tube



**Figure 6**  
Ice bridge causing deflection of airflow away from pitot tube





**Albert URDIROZ**

Director, Flight Safety

# Low Speed Rejected Take-Off upon Engine Failure

## 1. Introduction

Rejected Take-Off's (RTO) are often considered in the context of  $V_1$ , the Decision Speed, otherwise called the Critical Engine Failure Speed. However, there are situations, at speeds much lower than  $V_1$ , when RTO's can be quite challenging. These are sudden engine failures at speeds when the rudder has not yet become effective for maintaining directional control. Consequently, establishing safe lateral control relies on the following: immediate cancellation of the forward thrust asymmetry, selecting both thrust reversers so as to take advantage of the "live" engine reverse thrust, steering with rudder pedals and asymmetric braking as appropriate.

In order to review the operational challenges, this article describes an in-service event when an engine failure at about 60 kt resulted in a lateral runway excursion.

This article reviews the pertinent Flight Crew Operating Manual (FCOM) Standard Operating procedures (SOPs) and Flight Crew Training Manual (FCTM) recommendations, and also reflects on the documentation relevant to other Airbus models.

## 2. In-Service Event

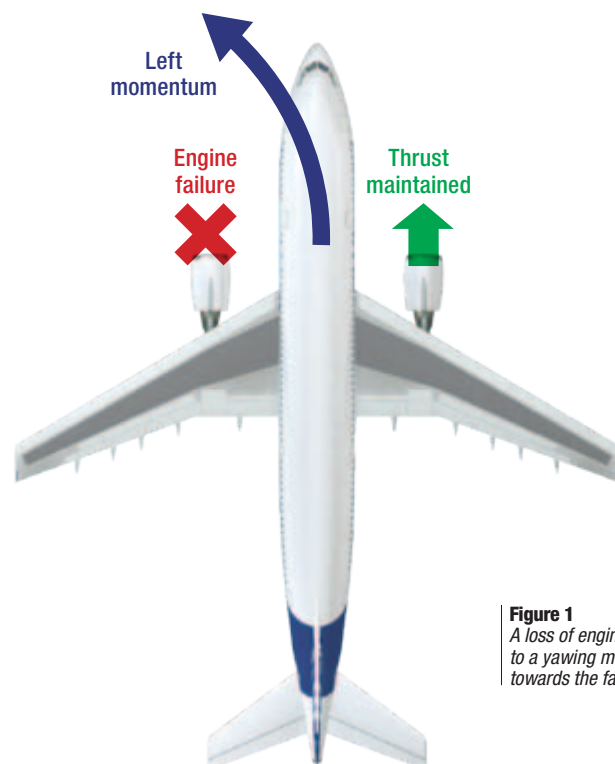
### 2.1 Engine Failure at low Speed

The daylight incident involved an A300-600 taking off from a uniformly wet runway, with patches of ice.

As the aircraft was being aligned, the go-levers were triggered and the Auto-Throttle was engaged in Take-

Off mode. Both engines spooled up symmetrically.

Within 12 seconds, engine one stalled. The thrust asymmetry caused the aircraft to deviate to the left of the runway. Ground speed was less than 60 kt (fig. 1).



**Figure 1**  
A loss of engine leads to a yawing moment towards the failed engine

## 2.2 Runway Excursion Sequence

The crew aborted the take-off within one second by simultaneously:

- ▶ Setting both thrust levers to IDLE, without applying reverse thrust.
- ▶ Applying right rudder pedals, thus counteracting the thrust asymmetry.
  - The rudder pedal inputs acted both on the nose wheel steering and the rudder deflection. On the A300-600, the maximum achievable nose wheel steering angle, when using rudder pedals, is 6°. This does not depend on the air speed. The rudder deflected fully, but had limited aerodynamic effect at that speed.
- ▶ Applying manual brake inputs as follows: nearly full left and limited right pedal braking.
  - This resulted in a significant asymmetric braking in the wrong direction.

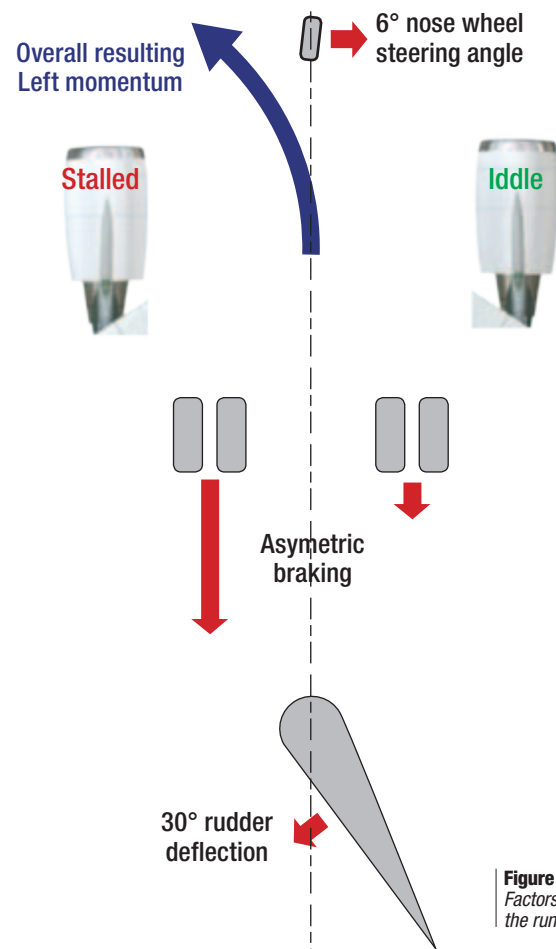
(fig. 2) illustrates the individual effects and the overall resulting momentum. The directional balance was still to the left, so the aircraft continued deviating towards the edge of the runway.

In an ultimate attempt to remain on the runway, an additional nose wheel steering demand was applied with the tiller. The aircraft went off the runway and stopped on uneven ground. Seven seconds elapsed between the engine failure and the runway excursion. There were no injuries and the aircraft sustained only limited damage.

## 3. Review of relevant Procedures

### 3.1 Seating/Pedal Position Adjustments

The final report documents that the likely key to the asymmetric braking in the wrong direction was the pilot's seating and pedal position adjustments.



**Figure 2**  
Factors leading to the runway excursion

The pilot was probably in a position where he could apply full rudder, but not full braking.

The A300-600 FCTM, Normal Operations, Pre-Start recommends to first adjust the seat by means of the

eye-indicator, then the arm-rest, and finally the rudder pedals such as to be in a position to simultaneously apply full rudder and full brakes on the same side (fig. 4). Similar recommendation is reflected in other Airbus FCTM.



**Figure 3**  
A300-600 cockpit

### 3.2 Directional Control during Take-Off

Use rudder pedals for directional control during take-off. As written earlier, the tiller was ultimately used to try and counteract the lateral deviation by increasing the nose wheel deflection. This was not effective. As ground speed builds up, the nose wheel skids if too much deflection is applied. When using the tiller, the nose wheel was deflected beyond its operational limit and skidded without directional effectiveness.

All Airbus FCOM SOP's applicable to take-off read:

DIRECTIONAL CONTROL \_\_\_\_\_  
 \_\_\_\_\_ USE RUDDER

Additional information is available in the A300-600 FCTM (fig. 5). The same information is also reflected in the documentation relevant to other Airbus models.

### 3.3 Use Manual Braking at low Speeds

The Auto-Brake activation is associated to the automatic deployment of the ground spoilers, which occurs when the ground speed is above 85 kt on the A300/A310 (fig. 6) and 72 kt on other Airbus models.

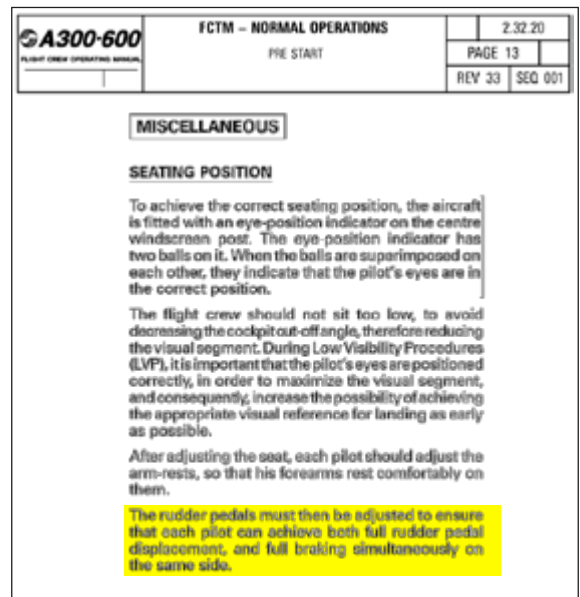
As a result, the Auto-Brake may not activate in case of low speed RTO and braking must be performed manually.

### 3.4 Lessons learnt from Simulator Sessions

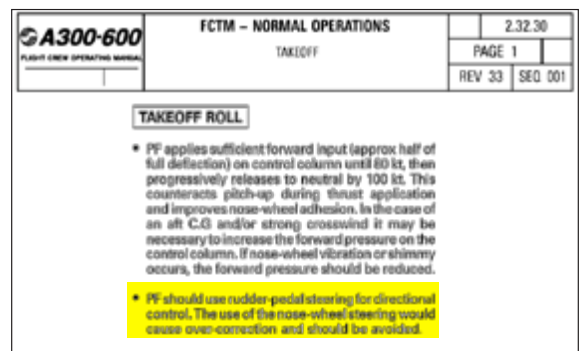
An A300-600 simulator session was run in order to experiment with different scenarios of engine failure at low speed during the take-off roll and determine the most appropriate course of actions. These involved different runway status (dry, wet and patchy icy).

Upon an engine failure at 60 kt ground speed, the crew would immediately select IDLE thrust on both engines. The session showed that:

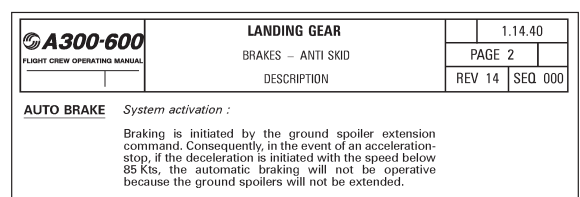
**Figure 4**  
 A300-600 FCTM rudder pedals adjustment recommendation



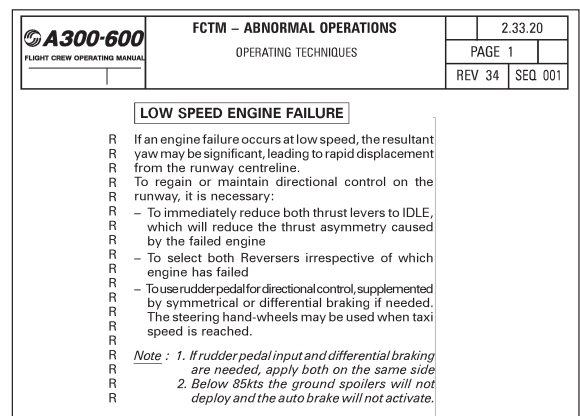
**Figure 5**  
 A300-600 FCTM on rudder pedal steering during take-off



**Figure 6**  
 Auto-Brake is associated to the ground spoilers



**Figure 7**  
 A300-600 FCTM on Low speed engine failure at take-off



► Keeping directional control with rudder pedals upon the initial trajectory deviation, as instructed by SOP's, was effective in all cases.

► When full symmetric braking was applied, both brake pedals on stops, no runway excursion was experienced. However, given the runway length available in such early RTO scenarios, it appeared that braking performance was much less an issue than directional control. Smoother recoveries were achieved with less pronounced braking inputs.

► Asymmetric braking may contribute to maintaining directional control, provided that it is applied towards the operative engine. When applied towards the failed engine during the simulator session, the aircraft unavoidably deviated towards the edges of the runway.

► When maximum reverse thrust is applied on the operative engine, the trajectory deviation is reduced by a small amount given the limited efficiency of reverse thrust at low speed but still in a helpful recovery sense.

**3.5 Operational Advice**

The observations made during this simulator session support the operational advice included in the FCTM, Operating Techniques, Low Speed Engine Failure on low speed RTO. (fig. 7).

These recommendations are reflected in the FCTM for the whole Airbus fleet.

**4. Training Recommendations**

**4.1 Safety Recommendation by the final Investigation Report**

The final report documents that the likelihood in the operational summary, the final report highlights:

“...deficiencies in pilot training with regard to training for sudden losses of engine thrust in the speed range below VMCG.”

The following safety recommendation is associated to this finding:

“EASA is recommended to ensure

**VMCG Minimum Control Speed on the Ground**

**EASA CS 25.149 (e) definition of VMCG:**

“VMCG, the minimum control speed on the ground, is the calibrated airspeed during the take-off run at which, when the critical engine is suddenly made inoperative, it is possible to maintain control of the aeroplane using the rudder control alone (without the use of nose-wheel steering), as limited by 667 N of force (150 lbf), and the lateral control to the extent of keeping the wings level to enable the take-off to be safely continued using normal piloting skill. In the determination of VMCG, assuming that the path of the aeroplane accelerating with all engines operating is along the centreline of the runway, its path from the point at which the critical engine is made inoperative to the point at which recovery to a direction parallel to the centreline is completed, may not deviate more than 9.1 m (30 ft) laterally from the centreline at any point.

**VMCG must be established, with –**

- (1) The aeroplane in each take-off configuration or, at the option of the applicant, in the most critical take-off configuration;
- (2) Maximum available take-off power or thrust on the operating engines;
- (3) The most unfavourable centre of gravity;
- (4) The aeroplane trimmed for take-off; and
- (5) The most unfavourable weight in the range of take-off weights.”

For the A300-600, VMCG is documented in the Airbus FCOM within section Aircraft General - Operational Limitations, FCOM 2.01.20.

**2 - SPEEDS  
A - VMCA - VMCG**

	kt CAS	kt IAS
<b>VMCG</b>	109.5	114 in 15/0 and 15/15 113 in 15/20

that initial and recurrent pilot training includes mandatory rejected take-off exercises that cover events of a sudden loss of engine thrust below VMCG.”

**4.2 Airbus Position**

Training plays a vital role in emphasising the importance of applying correct SOP and techniques.

Airbus encourages operators to include low speed RTO's in their recurrent training program if not already implemented. This should include unexpected RTO's well below V<sub>1</sub> to ensure both pilots are seated in a position where full rudder with full manual symmetric braking can be achieved.

Additionally, yearly line checks (or the equivalent of) should include an observation of the correct seating position for all relevant phases of flight by the Line-Check Captain.

**5. Conclusion**

This in-service incident illustrates the challenges associated with containing the sudden asymmetry resulting from engine failure during the first seconds of a take-off acceleration. However it is possible to maintain directional control by reacting immediately and in a coordinated manner:

- Thrust levers are closed
- All reversers are selected (even if designated as an MMEL item)
- Apply up to full opposite rudder pedals until directional control is regained
- Braking may be symmetrical or differential as needed to complement steering
- Steering hand-wheels may be used when taxi speed is reached.

Being in a position to effectively respond implies that both pilots have adjusted their seat such as to be in a position to simultaneously apply full rudder and full brakes on the same side if required.

Effective response also relies on crew training. Therefore Airbus supports Operators including RTO's scenarios in the recurrent training. The engine failure should be unexpected and introduced at speed well below V<sub>1</sub>. Such scenarios would address simultaneously the seat adjustment and the coordinated response to the sudden asymmetry.



**Captain  
Peter KRUPA**

Training Captain A320 and  
Chief Accident Investigator  
Lufthansa



**Nicolas BARDOU**

Director, Flight Safety

# Late Changes before Departure

## 1. Introduction

Following the presentation that was made at the 18th Airbus Flight Safety Conference in Berlin, we decided to come back on this topic that affects pilots on nearly all flights.

Additional information will be provided on how a small mistake affects the calculation of aircraft performance and also on design improvements that are now available (update of Safety first n°8 dealing with the Take-Off Securing Function, TOS).

Finally, to balance the “manufacturer’s view”, an open forum is offered to an experienced airline pilot that will share his views and tips on handling these challenging situations.

## 2. Examples of Late Changes

Many things can affect departure preparation. Some cause distractions, which can then lead to the introduction of small unnoticed but incorrect changes that affect the safety of the take-off.

A few examples that may occur either individually or often together:

- External disturbance during check lists
- Noisy cockpit ambiance
- Weather change
- Runway change
- Runway state change
- New taxi routing
- Updated take-off data
- ATC pressure
- High workload
- Multitasking
- Technical conditions of aircraft (e.g. MEL)
- New fuel figures
- Updated cargo
- Late pax
- Late luggage
- De-icing
- Ground staff
- NOTAMS
- Passengers pressure
- ...

Those are typical examples of changes but they often occur when time pressure and workload are high just before departure and they can have big consequences, as illustrated by the following two case studies.



**Figure 1**  
*Time pressure and workload  
are high just before departure*

## 3. Event Analysis

### 3.1 Case Study 1

#### 3.1.1 Description

While preparing the flight in the cockpit, the flight crew was constantly interrupted by conversations in the cockpit, cabin crew, ground staff, discussion on SID, etc...

This resulted in crosschecks on take-off data not being properly done and the gross weight entered was lower than the actual aircraft weight by 100 tons. Only one digit difference in the pilot selection, but it resulted in a tailsrape, a liftoff after the end of the runway and a broken runway light. Selection of TOGA provided enough power, in this case, to allow the aircraft to climb away (fig. 2 and 3).

#### 3.1.2 Understanding the Impact

Entering a lower gross weight than the actual leads to:

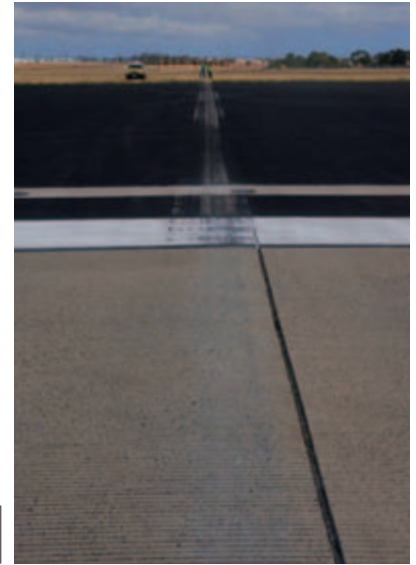
##### ► Lower speeds

Calculated stall speed will be lower, giving a lower  $V_2$  and lower  $V$  speeds. As a consequence there will be poor

or no rotation at  $V_R$ , leading potentially to a tailsrape.

##### ► Higher Flex temp

Taking off with a higher Flex temperature reduces the available thrust and take-off performance might not be reached. This is illustrated by fig. 4.



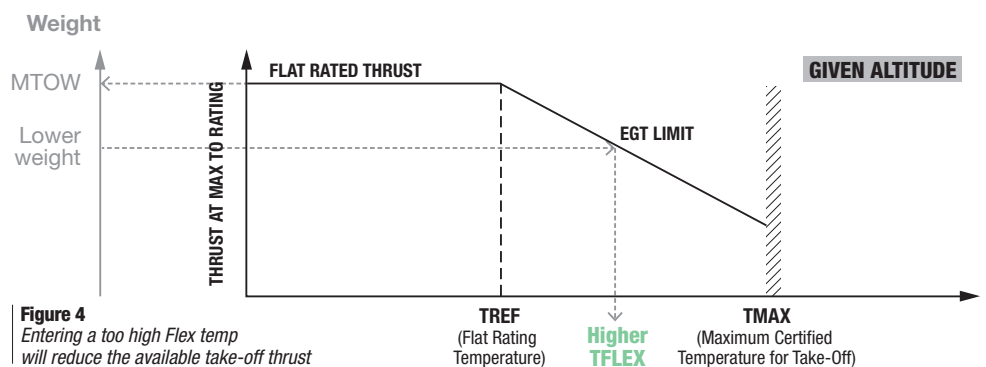
**Figure 2**  
Entry of a gross weight lower than the actual aircraft weight led to a tailsrape...



**Figure 3**  
...and to a collision with a runway light.

## The take-off reference speeds

- $V_1$ : Maximum speed at which the crew can decide to reject the take-off, and is ensured to stop the aircraft within the limits of the runway.
- $V_R$ : Speed at which the pilot initiates the rotation, at the appropriate rate ( $\sim 3^\circ/s$ ).
- $V_2$ : Minimum climb speed that must be reached at a height of 35 ft above the runway surface, in case of engine failure.



### 3.2 Case Study 2

#### 3.2.1 Description

Another example is shown below where many pre-flight interruptions led to some mistakes that “normally” would never happen.

Take-off data was computed using the given weather, runway access

(thus available runway length) and the obstacles mentioned on the airport charts.

Changes to all those factors led the aircraft to fly through the top of the trees at the end of the runway.



**Figure 5**  
The departure end of the runway before the incident



**Figure 6**  
The same view after the aircraft clipped the trees

**3.2.2 Understanding the Impact**

► Upon departure, there was a reported 3.5 kt tailwind whilst pre-departure computation was done for zero wind. This alone would have given a lower  $V_R$  (-4 kt) and  $V_2$  (-3 kt) and reduced the vertical flight path by 54 ft.

► The initial departure computations were made using the full length of the runway whereas it was entered for take-off via an intersection (350 m shift). This alone would have given a lower  $V_R$  (-4 kt) and  $V_2$  (-3 kt) and reduced the vertical flight path by 34 ft.

► The chart was indicating 40 ft high trees at 655 m from the end of the runway, whereas the actual trees were 54 ft high at 393 m from the end of the runway. This alone would have given a lower  $V_1$  (-5 kt),  $V_R$  (-7 kt) and  $V_2$  (-5 kt) and reduced the flight path even further.

The combination of these factors ensured that the immediate post take-off climb profile was so reduced as to hit the obstacles whilst the crew thought that the flight path would be clear.

**4. Design Improvements**

Despite flight crew cross checks, mistakes can be made and some errors might remain undetected. In order to help flight crews, some design improvements have been developed. As a follow up to the Safety First n°8 (July 2009) article, the Take-Off

Securing (TOS) pack 1 includes a series of checks of take-off data:

- Weight check: to avoid an erroneous ZFW input in the FMS.
- ZFW entry must be within defined range per aircraft type.
- Speed check:
  - Take-off speeds order
  - Speeds between their limits
  - Speeds consistent with weight, thrust & slat/flap configuration
- Trim setting check: to avoid error of TRIM, erroneous ZFWCG input, auto-rotation or “heavy nose”.
- Slat/Flaps configuration check: to avoid error of S/F conf settings that will impact speeds and distance.
- Temperature check: to avoid take-off with MCT (Maxi Continuous Thrust) instead of FLEX thrust.

Those improvements are developed for all fly-by-wire airbus aircraft

types, will be available via FMS and/or FWC upgrade (Upgrade depends on actual A/C configuration: approach your field service representatives or customer support directors for detailed information and operational impact).

**5. A Pilot's View**

Last minute changes, disturbances and all imaginable versions of disruptions during flight preparation are normal issues to airline pilots, they set the stage for the daily “business as usual” activities.

All the information regarding a flight and all decisions merge in the cockpit where a good part of the flight crew’s duty consists of managing the right things at the right time.

The challenge is that not all things are right things and even less occur at the right time.

To simply promote the idea of not allowing any disturbance during critical phases of flight preparation would be an impracticable solution. By the time somebody “knocks on the door”, he or she has already disturbed the flight crew, and if you close the cockpit door, they will certainly return, be it on the interphone, via cell phone or any other creative means. Finally, in contrast to many other professions, problems usually cannot be deferred for long times in airline operations. If not managed they usually return like a boomerang.

Summing up, there is a general experience based acceptance in the

Reminder

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$V_1 \leq V_R \leq V_2$

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$V_1 \geq VMCG$

---

$V_R \geq 1.05 \times VMCA$   
 $V_R \geq kV_R \times Vs1g$

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$V_2 \geq 1.10 \times VMCA$   
 $V_2 \geq kV_2 \times Vs1g$

---

pilot community for disruptions. To ensure safe operations anyhow, it is important to have an easy and reliable concept to manage them instead of tilting at the windmills of disruption.

A proven way is to divide all tasks into small packages of measures. These packages should be stringent and complete in themselves, but small enough to allow for short time deferment by disruptions. An easy formula might be: allow for disruptions during overall tasks but do not allow any disruption to break up a defined package. This eases the safe return into the workflow after the disruption is managed.

As an example, during cockpit preparation, the F/O has done all the necessary FMS inputs and now it is your turn to check the entries. While you review the flight plan on the MCDU F-PLN page the ramp agent steps into the cockpit with an important question regarding loading. It would be rather impractical to let him wait until you have completed the entire FMS check. On the other hand, shifting your attention directly to the loading problem could result in an FMS entry error remaining undetected. Starting the complete FMS check anew after the distraction could result in an endless activity because there will certainly be another disruption during your next try. Dividing the task of checking the FMS entries into separate working packages for each MCDU page gives you the chance to finish one of these packages in a reasonable time short enough for any disruption to be deferred and well enough defined to allow for a safe continuation after the interruption.

A second very important point is time management. Captain Murphy has a reliable companion: F/O Has-temakeswaste. A human reaction on time pressure is the intention to speed things up with the motivation being not to bust schedules. Humans have a maximum design speed like every machine and it is hardly possible to exceed it. Ironically, if we exceed our design speed, things get even slower simply because the number of faults increases

exponentially. One is lucky if this results only in a slower pace. The history of accident investigation is full of dramatic examples where some well meant shortcuts and quick actions resulted in fatal faults. If a slot expires, there will be a new one. If there is a major bug in take-off data calculation there might not be a second chance.

Always remember: the pacemakers are sitting in the pilot's seats, not in a Central Flow Management Unit, not in a Collaborative Decision Making Computer, not in an Operational Control Center or whatever well intentioned institutions there may be in our worldwide working environment. Take your time and slow down when you are in a hurry!

Finally, there is a very important caesura in your flight: Going Off-Blocks. In the majority of flights, the circumstances for flight prepara-

tion do not obey the rule books. This means you can count on disruptions, time pressure, surprises and pretty well any kind of trouble. Often, there is no practicable way to circumnavigate these challenges. However you should never allow them to get airborne. Off-Blocks is the last time to leave all these disturbances behind and revert to an unrushed flight SOP's.

As a conclusion, there is no practicable way to avoid disruptions, they simply exist. To guarantee safe operations, we should not try to avoid, but manage them. Regarding time, we need to know the limitations of human pace and the crews ability to accept them. And whatever the conditions were during flight preparation, make a clear distinction after Off-Blocks and continue thereafter with a regular flight.

## 6. Lessons learnt

**"Anything that can go wrong, will go wrong".** *Capt Ed. Murphy*

Interruptions, disturbances, last minute changes will always happen at the worst moment. Normally at that precise moment many issues have to be solved at the same time. It is when pressure is increasing a lot, that a small but critical mistake may sneak into the pilot's computations. That small mistake (maybe only one digit) can have big consequences.

To help the crews, the following hints can be highlighted:

► **At the briefing, explain to the flight crew** what you will be doing in the cockpit to prepare the flight and that there are phases when you can be interrupted and others when you need "sterile environment" for a few minutes.

► **Know the rough order of magnitude** of values before computing them, e.g: for a very long flight (more than 12 hours), an A340-500 will weight over 300 tons. A high Flex temp of 75°C is generally associated with a light weight take-off.

► **Recognize when you are being distracted and double check** at a quieter time using all available means (paper doc, LPC, ...).

► **Split your task into small packages** that you can reasonably do and secure before being interrupted.

► Finally, in case of a doubt or a last minute change, take a break, **re-do the computation.**



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