

JULY 2009

FLIGHT

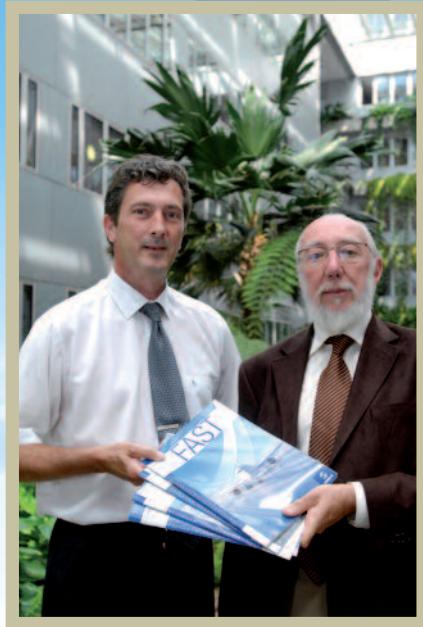
AIRWORTHINESS

SUPPORT

TECHNOLOGY

FAST 44





Dear Airbus friends,

"If you want to say nothing, write a book. If you want to say something, write an article".

I like this saying and I must say that over the past years our FAST magazine editors made use of it as a kind of golden rule.

For a technical magazine like FAST, the role of an editor is key. He/she must ensure that the quality of the articles meets our readers' expectations. It's not an easy task considering the high level of technical expertise of our readership as well as its diversity: Aircraft engineers, maintenance specialists, pilots, performance engineers, etc. The editor must also ensure the content of the magazine is well balanced; that the topics are of interest and make sure complex subjects are treated in a way that is attractive and understandable.

You may wonder why I am sharing my views with you on 'the editor's role'?

The reason is simple. FAST magazine is now celebrating its 26th year. Over this past quarter century - a nice longevity! - only two persons held the position of 'editor': Denis DEMPSTER, until 2004 when he retired, and since then Kenneth JOHNSON. Today, we turn a page in the history of this magazine. Kenneth is retiring and a new editor, the third one, is taking the relay.

I take this opportunity to pay tribute to the quality work done by Kenneth. Thanks to his long aviation experience and excellent editorial skills, he has been instrumental in keeping the level of quality of the magazine at high standards. This is confirmed by the customer satisfaction surveys regularly done by Airbus Customer Services where FAST magazine achieves high scores.

Kenneth will be sorely missed, but after a long career in Airbus, his retirement is well earned, so my colleagues and I would like to thank him for his exceptional work and wish him well in his retirement. I feel confident that you, the readers of his work, will feel the same and therefore we will wish him well on your behalf.

Our new FAST editor is Lucas BLUMENFELD. Lucas (47) is American and French. He has a good knowledge of Airbus aircraft having worked in the Flight Test department of our company, as well as in Engineering as a Continued Airworthiness Engineer. His background is in aircraft interiors' refurbishment and cabin upgrades. He holds a degree in Surfaces Chemical Physics and Flight Operations. My colleagues and I welcome Lucas to the Airbus Customer Services Communications team and wish him well in his new task.

Yours sincerely,

Bruno PIQUET,
FAST magazine publisher

J U L Y 2 0 0 9

FAST

F L I G H T
A I R W O R T H I N E S S
S U P P O R T
T E C H N O L O G Y

A I R B U S T E C H N I C A L M A G A Z I N E



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also called Flammability Reduction System (FRS)

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Every little helps!



A320 Family Maintenance planning escalation package

Structure improvements are provided by Airbus Upgrade Services to enable structures' maintenance tasks escalation from five to six years. This article presents the Service Bulletin (SB) package necessary to achieve such Maintenance

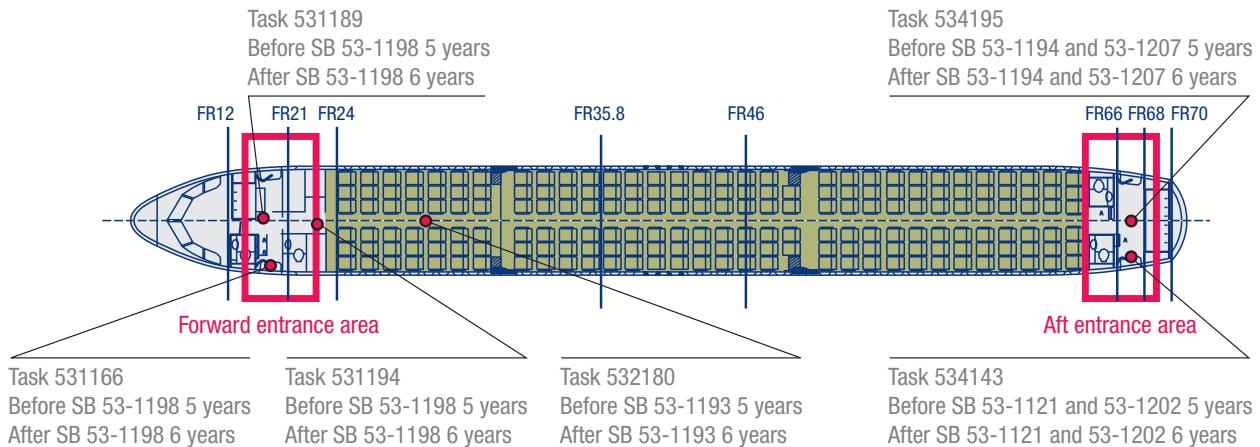
Planning Document (MPD) escalation. This escalation is a concrete benefit for airlines that can reduce their direct maintenance costs related to corrosion inspections by an estimated 20%.



Pierre-Jean GARROT
Design Manager
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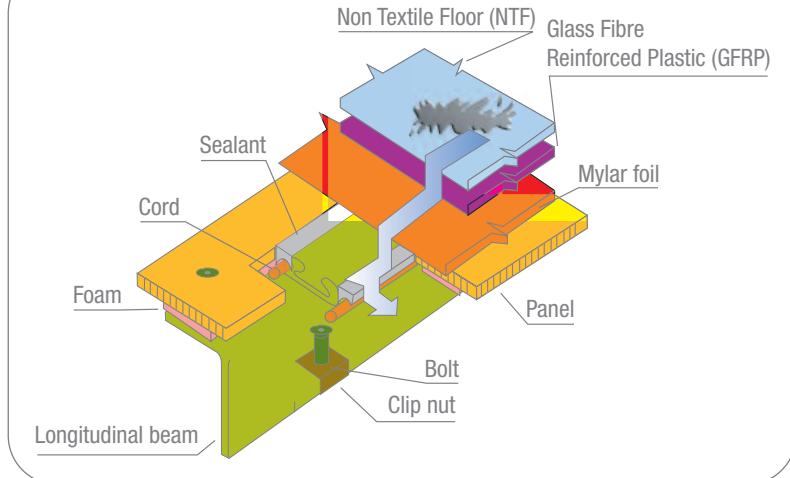
Structures' maintenance tasks mapping

Figure 1



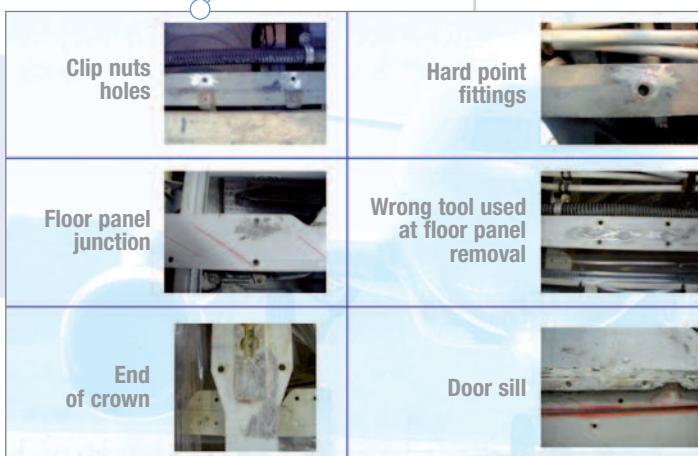
Fluid path in forward and aft entrance area

Figure 2



Floor structure corrosion typical damage impact

Figure 3



The interval for the vast majority of structure maintenance tasks, initially scheduled at five years, was extended to six years for the A320 Family, during the year 2004. In order to harmonize all structures' maintenance tasks formerly from five years to the new six years interval, some technical enhancements were deemed necessary in areas susceptible to corrosion (see figure 1). Whilst the original design fully meets maintenance objectives, it is clearly beneficial to operators to extend the check interval.

The corrosion discovered in a limited number of cases was caused by fluid ingress from galleys, lavatories and door entrances. The most significant impact was found in the wet areas of the forward and aft cabin (see figures 2 and 3).

As ‘gaining access’ to the impacted area and performing the job is costly in terms of embodiment time, installation during the heavy maintenance check is strongly advised to avoid unnecessary downtime.

The technical enhancements necessary to escalate the inspection interval years have gradually been introduced in production since 1996 and made available for retrofit in 2007 (refer to Service Information Letter (SIL) 53-093). They consist mainly of the following package of Service Bulletins: 53-1121, 53-1198, 53-1191, 53-1193, 53-1194, 53-1202 and 53-1207.

Maintenance Planning Document escalation SB package

The SB package necessary to enable Maintenance Planning Document (MPD) escalations is composed of one optional SB and six standard SBs; all of these are grouped in a package as it is appropriate to embody them simultaneously during the heavy maintenance check as currently scheduled at five or 10 years. These SBs are listed in table 1 with their technical contents and manufacturing embodiment point.

Another MPD task 575150, listed in SIL 53-093, has not been included in this package due to the fact that the linked SB 57-1118, which allows the escalation from five to six years, is mandatory.

Focus on SB 53-1198

Due to the diversity of cabin configurations amongst airline fleets, the forward area is the most customized part of the aircraft. SB 53-1198 was specifically developed for this area of restricted accessibility (being an optional SB providing a customized solution per aircraft – in contrast to the standard SBs that are available for glass fibre panel installation in other parts of the aircraft).

Table 1

A SB List	B Technical contents	C Manufacturing application rank	D Illustrations
1 53-1121 (standard SB)	This Service Bulletin introduces corrosion prevention to be applied in the door sill area, rear entrance floor panel between Frame 66 and 68 stinger 23, with sealant to be applied in even gap between the panels and the countersunk screw holes (see fig 5). Accomplishment of this Service Bulletin reduces the risk of moisture incursions in the vicinity of the door sill area and simultaneously reduces the risk of galvanic corrosion.	A318 : all MSN A319 : from MSN 616 A320 : from MSN 624 A321 : from MSN 620	
2 53-1191 (standard SB)	On the forward door frame (frame 16 and frame 20, left and right sides), corrosion develops at the junction between the blanking panel under the girt bar and the blanking panel with upper skins made of carbon by one made of glass and aluminium sheet (see fig 6). The modification is only available as retrofit, it is not a production modification.	By SB only	
3 53-1193 (standard SB)	Following the report of corrosion on rivets in the lower forward fuselage, Airbus has developed a modification, which uses a primer before applying the topcoat. This, thus, ensures the adhesion of the paint on the rivets. The corresponding Service Bulletin consists in recycling primer and topcoat on the fuselage internal structure between frame 24 and frame 35, stinger 32 left hand side to stinger 32 right hand side.	A318 : all MSN A319 : from MSN 0627 A320 : from MSN 0628 A321 : from MSN 0631	
4 53-1194 (standard SB)	In-service experience has shown that the structure below the entrance door (door 4) area is susceptible to corrosion due to the gap between two door sill cover panels with the cover sheet. This Service Bulletin details the procedure to remove the two panels and the cover sheet and install a new one-piece sill cover panel in the entrance area of door 4.	A318 : from MSN 3038 A319 : from MSN 3046 A320 : from MSN 3010 A321 : from MSN 3034	
5 53-1202 (standard SB)	This standard Service Bulletin has been issued to improve the corrosion prevention at the aft passenger door on frame 68. The screw and washer which connect the sealing angle to the aft passenger door frame 68, must be removed and wet installed with corrosion inhibiting low adhesion sealant.	A318 : from MSN 2750 A319 : from MSN 2729 A320 : from MSN 2792 A321 : from MSN 2730	
6 53-1207 (standard SB)	In service experience shows that the shear plates in the area between frame 69 and frame 70, left and right-hand side, are susceptible to corrosion initiated by the clip nuts. In order to prevent possible corrosion damage, composite clip nuts should be installed on the shear plate. For this purpose, the shear plates must be replaced by modified ones with increased assembly hole diameters. In addition, these modified shear plates have a new surface treatment.	A318 : from MSN 3038 A319 : from MSN 3046 A320 : from MSN 3010 A321 : from MSN 3034	
7 53-1198 (version SB, available RFC / RMO, P catalog)	Airbus has implemented an enhanced design glass fibre floor panel for the wet area between frame 12 and 24 replacing the formerly used carbon fibre panel. The SB 53-1198 enables the retrofit with these glass fibre panels.	A318 : all MSN A319 : from MSN 1123 A320 : from MSN 1128 A321 : from MSN 1133	
8			

It offers an 'on demand' retrofit solution for the vast majority of the first 1,000 A320 Family aircraft (those not fitted with glass fibre panels in production).

Following implementation of this SB, the materials and geometry of the cabin floor panel, as well as the clip nuts and sealing are significantly improved. As a result, the corrosion resistance of the floor structure is increased while the floor panel's thickness and weight are slightly reduced (by around 1kg for the forward entrance area).

The change introduces glass cloth on both the upper and the lower sides of the carbon floor panel skins to reduce the galvanic couple between the carbon fibre and the aluminium seat rail (see figures 5 and 6).

Furthermore, the gaps between floor panels and metallic beams, and the gap between adjacent floor panels are increased by 1.5mm whereas the distance from the fitting hole axis to the edge panel is reduced using the new glass type ASNA 5110 7508 at the perimeter.



Figure 5

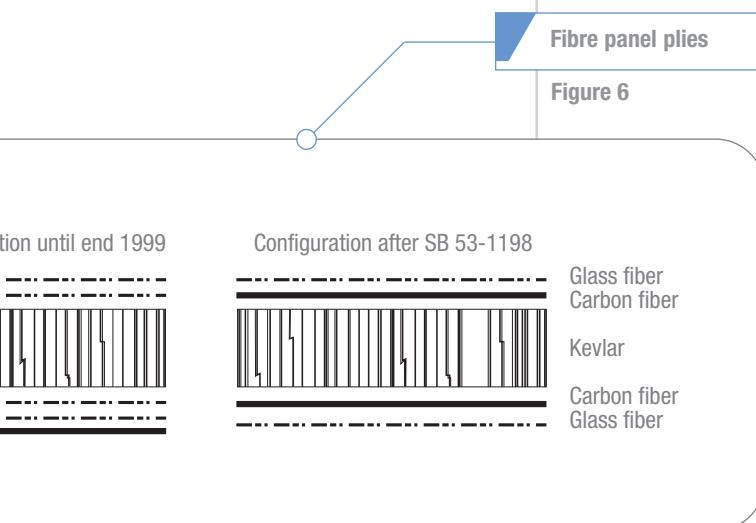


Figure 6

n

notes

1. For airlines which have heated floor panels at door 1 LH/RH but with former floor panels installed, the new generation allows the escalation without changing the heated floor panels in the entrance area.
2. SB 53-1198 enables corrosion inspection task 531190 escalation from 10 to 12 years.

In addition to that, the use of a more fluid sealant (PR1436GANA /PQ10010-022-04) improves the seal between floor panels and metallic beams (see figure 7).

Clip nuts (see figure 8) are also modified with a stronger protection, so as to reduce friction on the beam corrosion protection during installation (ABS0365-3-1B/2B and ABS0365S3-1B).

Further details about the glass fibre floor panels are available on the Airbus Upgrade Services e-Catalogue.

(<https://w3.airbus.com/upgrade-eCatalogue/index.html>)

Due to the customized definition of floor panels for each airline, an average lead-time of six months between SB kits' ordering has to be anticipated before the fourth C-check scheduling. Price information is given on request.

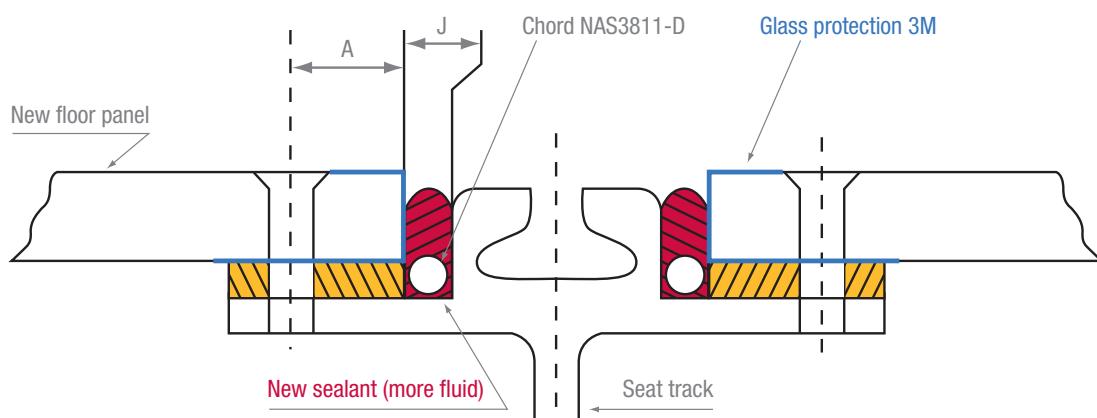
Airlines' benefits

Thanks to these structures' improvements, an escalation of the maintenance tasks can be achieved. In real terms, this means that airlines can reduce their direct maintenance costs related to corrosion inspections by an estimated 20%.

Embodiment of these SBs during heavy maintenance checks has the dual advantage of grouping complex removal and reinstallation operations that are similar to those necessary for the corrosion inspection. Consequently, time-consuming preparatory work does not have to be performed twice, thus reducing aircraft on ground time.

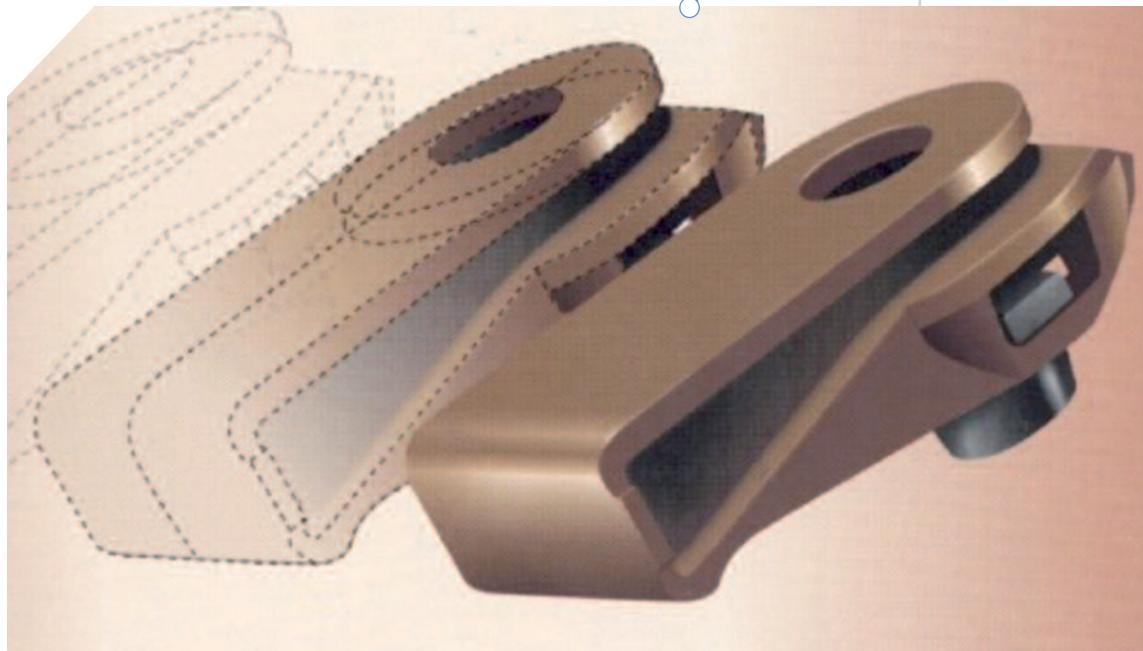
New sealant and more space for sealant application

Figure 7



Considering the time required to perform the six inspection tasks and the immobilisation cost against the benefit of the package

embodiment, the implementation of the SB package induces an average payback period of 16 months.



Clip nuts

Figure 8



Conclusion

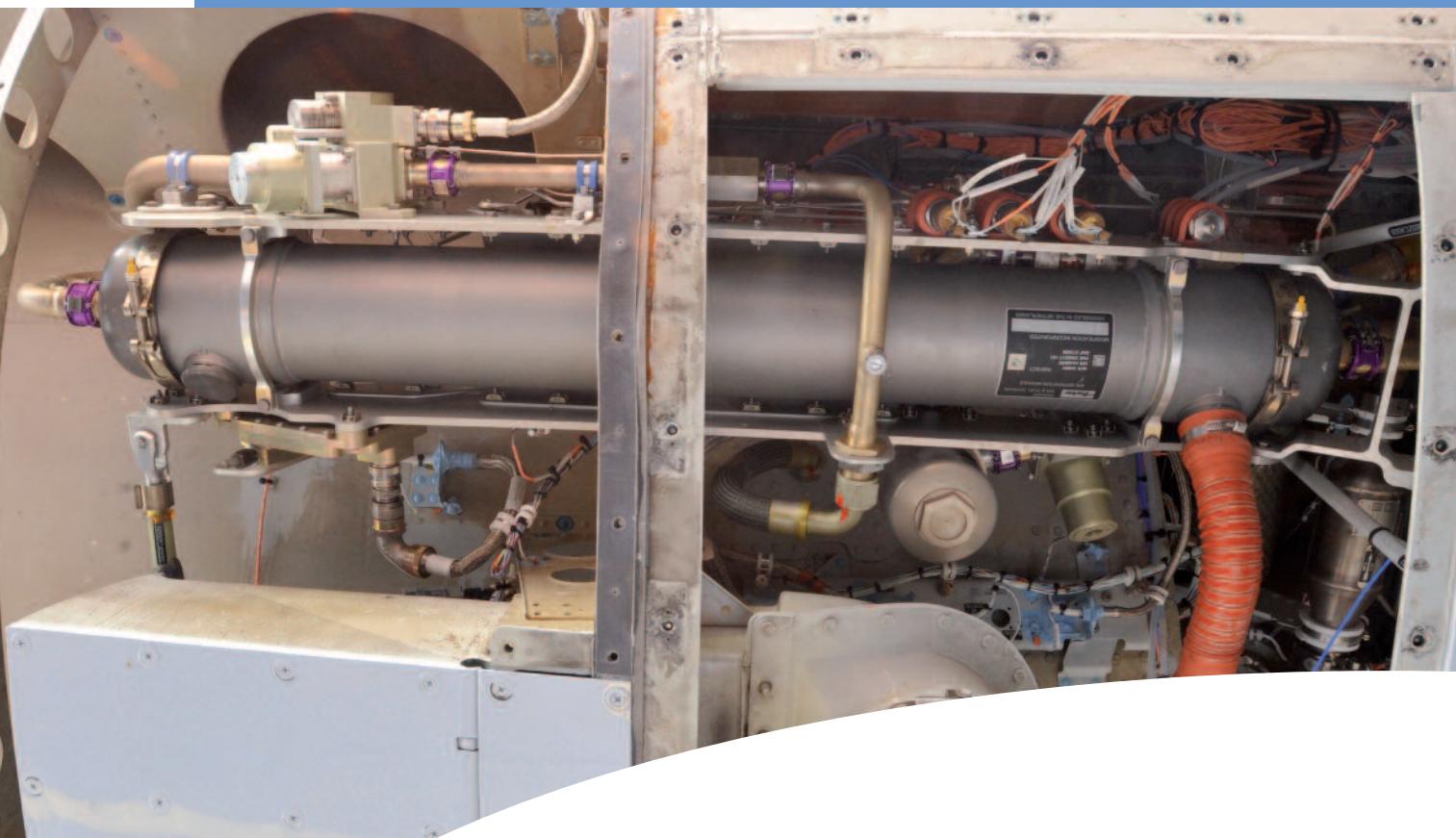
In today's extremely competitive market conditions including high fuel prices, continuous improvement is necessary to reduce direct maintenance costs as it forms an important factor in airlines' operational planning. By enabling an escalation of the maintenance interval from five to six years, the SB package described above offers a solution to a challenge faced by the vast majority of Airbus customers. Within this retrofit package, SB 53-1198 plays a specific role. Due to the diversity

of galley configurations and the restricted accessibility, the concerned area requires a customized solution for each aircraft. In contrast to the glass fibre panel installation in other areas (for which standard SBs are available), the forward parts between frames 12 and 24 need a customized SB for retrofit.

Implementation of this SB contributes to a 20% extension to the maintenance interval of the A320 Family early generation.

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Fuel Tank Inerting System also called Flammability Reduction System (FRS)

A retrofit industrial challenge for the next decade

This article seeks to describe the flammability reduction subject in more details, whilst

clarifying the technical, industrial and retrofit standpoints.



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Background

As a result of a major accident resulting from a fuel tank explosion, in 1996 the Federal Aviation Authority (FAA) Technical Centre undertook researches into fuel tank flammability and ignition risks.

Since 2000, Airbus has actively been involved in flammability reduction, conducting studies for the FAA and flight tests on the A320 prototype in 2003.

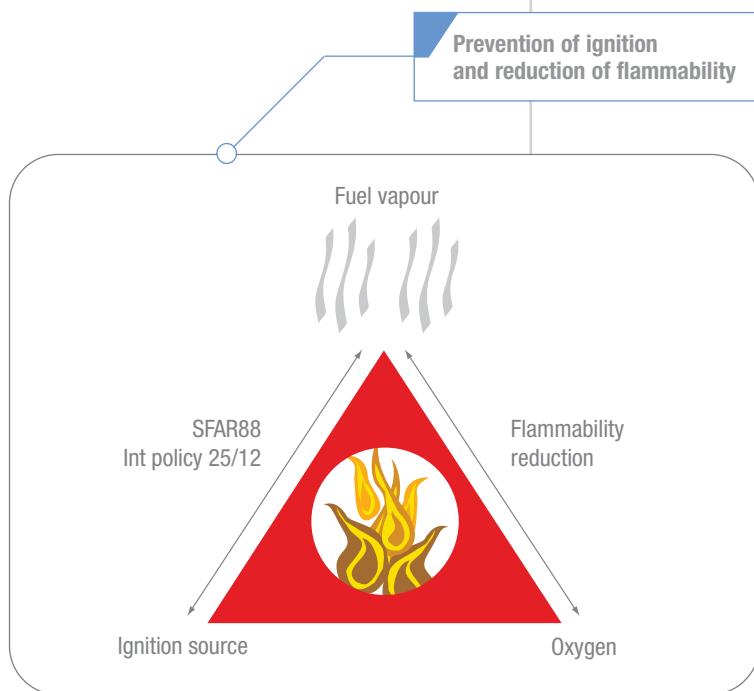
As a result of these researches, the FAA has developed a rule that requires operators and manufacturers of air transportation categories to take actions that will reduce the exposure to catastrophic fuel tank explosion.

This can be achieved by mitigating the two main conditions that must be present in a fuel tank to support combustion that can lead to a fuel tank explosion:

- An ignition source,
- A flammable fuel-air gaseous mixture.

The prevention of ignition is covered by the FAA (SFAR 88) and EASA (INT-Policy 25/12) requirements for which Airbus demonstrated the full means of compliance in May 2006.

As well as aircraft and equipment modifications, these requirements have also been introduced in the new Critical Design Configuration Control Limitations (CDCCLs). The process has been set up to reduce the potential ignition sources within the fuel tanks (i.e. pumps, wirings...) whereas the Fuel Tank Inerting System (FTIS) is a means to reduce the flammability of the fuel tanks. So both are complementary and cannot supersede each other.



Fuel Tank Inerting System

STATUS ON THE REGULATIONS

The FAA and EASA have developed requirements for design precautions to mitigate the risks associated to fuel tank flammability.

FAA

On 21 July 2008, FAA required operators and manufacturers to incorporate a Flammability Reduction Means (FRM) or Ignition Mitigation Means (IMM) on fuel tanks having a flammability exposure exceeding certain thresholds, following the official published FAR 25, 26, 121, 125 and 129 amendments.

These amendments affect new aircraft type certification, new aircraft in production and in-service aircraft produced after 1 January 1992 (see information box on the following page).



notes

- Existing freighter aircraft or passenger to freighter converted aircraft are not involved.
- For the A300-600 aircraft, no more N-registered passenger aircraft will be operated at the time of the FAA deadlines for the retrofit completion. If the Flammability Reduction Means (FRM) is required by any local Airworthiness Authorities as the fleet average flammability exposure near 7%, a modification based on a cooling concept of the centre tank will be proposed.



information

FAA ruling requirements (summary)

- **FAR Part 25: Amendment 125**
It will be the certification basis for new aircraft types. It updates § 25.981 by including the flammability criteria and means to be met by the tanks, the IMM requirements, the instruction for Continued Airworthiness. It defines the methodology to be used to perform the fuel tank flammability analysis,
- **FAR Part 26: Amendment 3**
This amendment is applicable to existing Type Certificates (TC) including Supplemental Type Certificates (STC). It requires for passenger aircraft of 30 or more seats manufactured on/or after January 1st, 1992:
 - to submit to FAA by Feb 16th, 2009. A flammability analysis for each tank as per FAR Part 25 appendix N,
 - to provide a FRM or IMM for tanks having a fleet average flammability exposure exceeding 7%,
 - to submit the required FRM/IMM changes and associated Service Instructions for approval by Dec 26th 2010,

EASA

For new aircraft, EASA (European Aviation Safety Agency) have issued for consultation a draft amendment to CS-25 (NPA 2008-19) which is harmonized with the corresponding American standard (FAR 25). A final decision is expected by the 2nd quarter of 2009.

For in-production and in-service aircraft, EASA have stated they will publish in 2009 a NPA to CS-26 and a Safety Directive to be adopted by the 4th quarter of 2010 after taking into account the received comments.

AIRBUS COMPLIANCE TO THE RULES

Airbus demonstrated that 'only the centre tank' of some of its existing aircraft has fleet average flammability exposure exceeding 7% and is affected by the requirements of the FAR Part 26. There is no necessity to do any modification on other tanks.

It concerns the following aircraft:

- A320 Family,
- A330-200, A340-200, A340-300, A340-500, A340-600,
- A300-600.

At the date of publishing, the rules apply only for passenger aircraft produced and delivered after 1 January 1992 flying with US operators or N-registered passenger aircraft.

SYSTEM DESCRIPTION

The Airbus solution for the A320 Family and A330/A340 Family is based on a system developed with the supplier, Parker, which reduces the oxygen levels of the centre tank ullage space.

The installation of this new device is designed to avoid the modification of existing systems and structures. The Fuel Tank Inerting System (FTIS) interfaces with the following systems:

- Fuel systems,
- Environmental Control Systems,
- Engine bleed air supply systems.

Several other alternate means have been studied (e.g. reduction of heat sources, tank pressurisation and foam). But they lead either to important structure modifications or operational constraints.

One solution studied was to use bottled nitrogen, but it was dismissed due to the significant required additional airport infrastructure and the impact on aircraft Turn Around Time (TAT).

SYSTEM INSTALLATION ON AIRCRAFT

The system is installed in the left hand side of the aircraft belly fairing as shown in figure 1.

PRINCIPLE

The system (see figure 2) provides protection against fuel tank fire and explosion by creating an inert condition within the ullage space of the fuel tanks. This is achieved by using oxygen depleted air known as Nitrogen Enriched Air (NEA) to displace the oxygen in the tank ullage spaces.

The system is based on a continuous flow principle and produces NEA from conditioned engine bleed air by gas separation, then injects it into the tank.

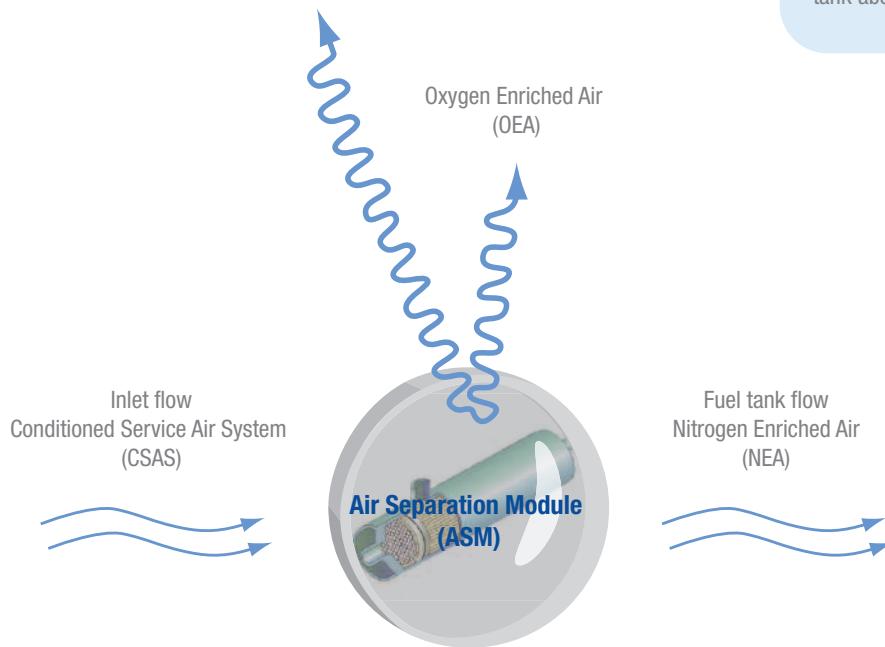
Figure 1

Installation of the FTIS (Fuel Tank Inerting System) in the left hand side of the belly fairing



Air Separation Module flow

Figure 2



notes

Ullage is the space within a fuel tank above the liquid propellant.

TECHNICAL DESCRIPTION

The architecture (see figure 3) is broken down in two major subsystems:

- 1) The Conditioned Service Air System (CSAS)
- 2) The Inert Gas Generation System (IGGS)

THE CSAS

Some bleed air is taken from the pneumatic air distribution system and then cooled down to a level compatible with the IGGS subsystem using the air from the exiting ECS (Environmental Control System) ram air channel. It is organized into two functional elements: a temperature control subsystem and the CSAS Isolation Valve with an ozone converter subsystem. Driven by the CSAS controller, the solenoid Controlled Isolation Valve ensures the shutdown of the system if the engine bleed air pressure is abnormally low or if over-pressure or over-temperature is detected

from the sensors. The ozone converter reduces the amount of ozone in the bleed air to protect the IGGS components.

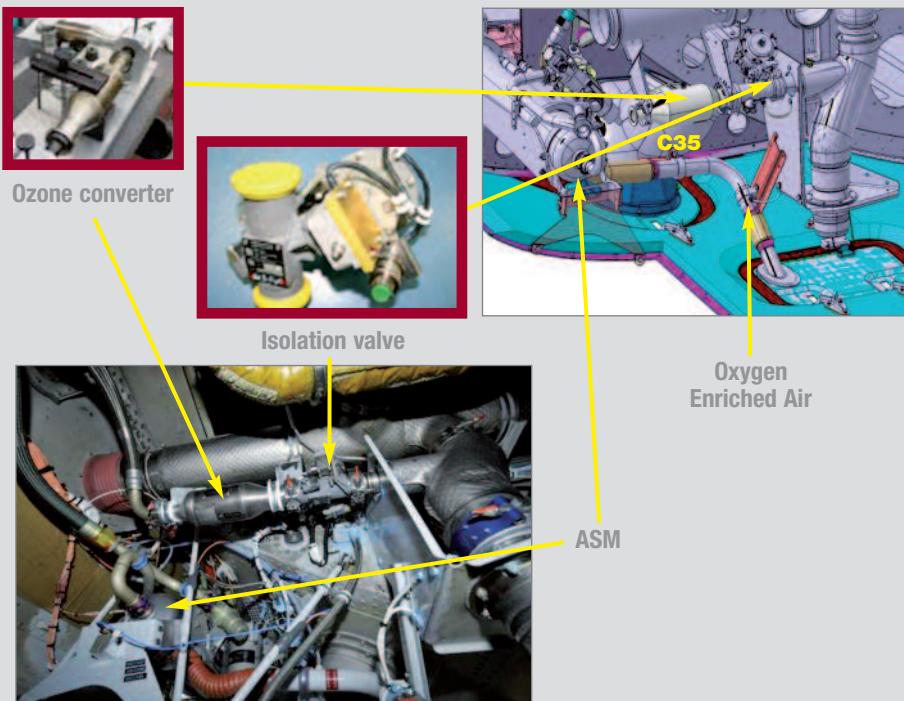
The CSAS controller, located in the avionics' bay, performs the system control and health monitoring BITE (Built In Test Equipment) and is interfaced with the Flight Warning System (FWS) and maintenance computer.

THE IGGS

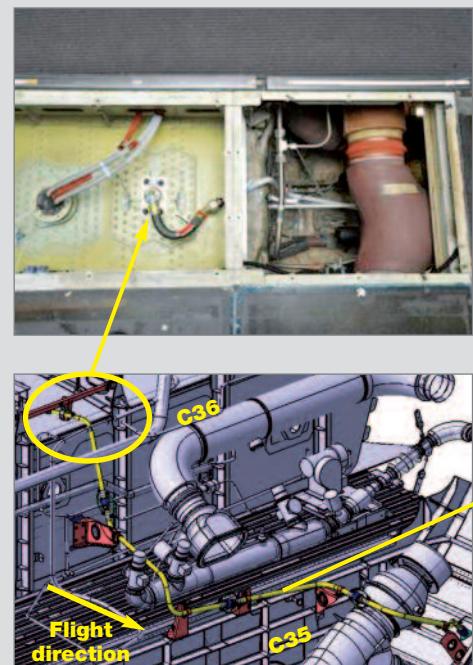
It uses Air Separation Modules (ASM) to filter the conditioned air stream, creating Nitrogen Enriched Air (NEA) and Oxygen Enriched Air (OEA) (see figure 4); the OEA is sent overboard.

The air at the ASM inlet remains clean, free of hydrocarbons, dust and other contaminants thanks to the HEPA (High Efficiency Particle Air) filter. Being connected to the fuel tank, the system must meet very stringent safety requirements:

A320: Installation of the Isolation valve and Ozone converter



A320: Nitrogen Enriched Air going into the centre tank



- Air greater than 200° C must not come into contact with fuel or fuel vapour,
- Fuel tanks must not be over-pressurized,
- Prevention means for fuel ingress upstream to the ASM.

Sensors, valves and controllers ensure these safety requirements. Downstream of the ASM is an oxygen sensor ensuring that the oxygen concentration is below 12%.

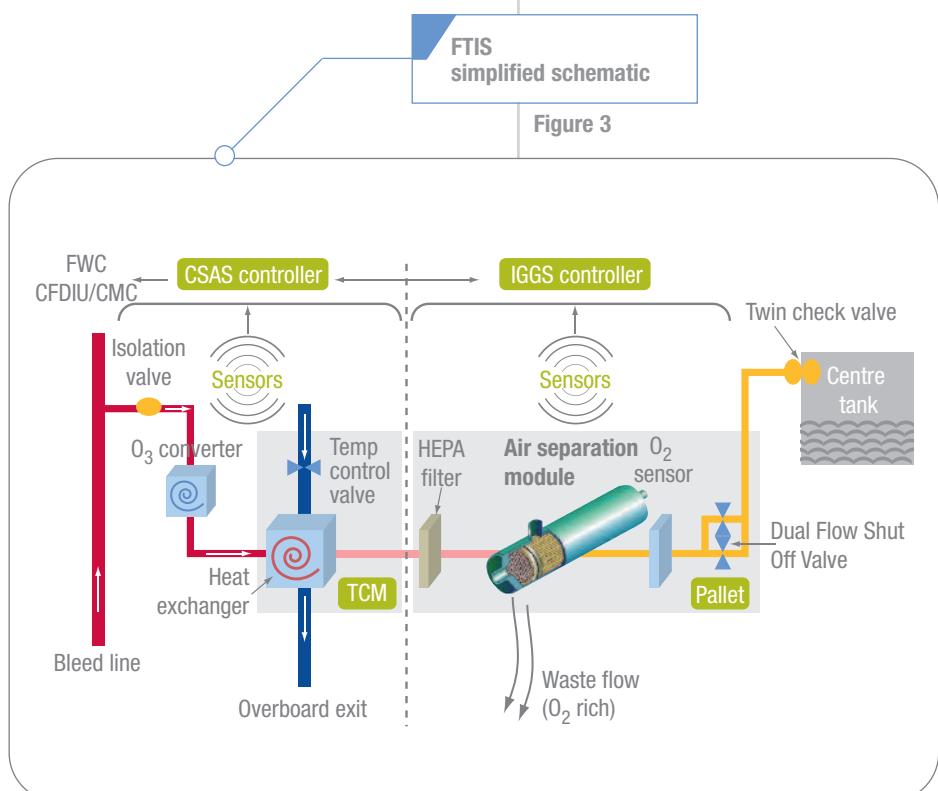
A Dual Flow Shut Off Valve is then used to control the NEA flow to the fuel tank and enables the system to switch between low/mid/high NEA flows, and to isolate the IGGS from the fuel tank.

NEA is distributed from the IGGS to the fuel tank through a twin check valve which provides a double barrier to the potential back-flow of fuel.

The IGGS controller provides system control and health monitoring/BITE.

FTIS simplified schematic

Figure 3

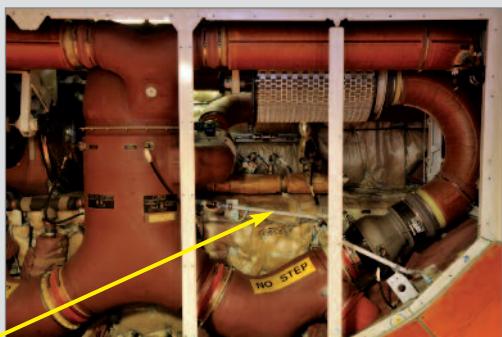
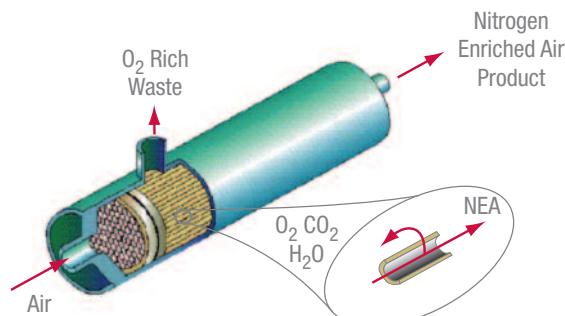


Air Separation Module (ASM) description

Figure 4

It is the core of the Inert Gas Generation System. The objective is to reduce the centre wing tank ullage O₂ concentration to below 12% during most conditions. Each ASM is a semi-permeable hollow fibre

membrane bundle contained in a pressure containment canister. This canister is a cylinder with three ports. There is only one ASM on the A320 Family aircraft, two on the A330-200 and A340-200/300, and three on the A340-500/600.





information

Alarm and maintenance computers

In order to provide alarm and maintenance messages, the prerequisites are:

- The Flight Warning Computer (FWC) standard must be:
 - H2F5 for the A320 Family
 - T3 for the A340-500/600
 - L11 for the A340-200/300 and A330-200
- The maintenance computer must be at:
 - Standard 10 for the CFDIU (A320 Family)
 - Standard L8-A for the CMCS (A330/A340 Family)



Temperature Control Module

Figure 5

FTIS operation

The Fuel Tank Inerting System (FTIS) operates during flight when the bleed air is supplied. The system does not operate when the aircraft is on the ground, except during maintenance operations.

It has three flow modes designed to achieve the flammability reduction objective during the different flight phases:

- Low is used in climb and cruise,
- Medium is used in approach and slow descent,
- High is used in descent.

The FTIS will not be operational when either the electrical power or the bleed air are unavailable, nor when the anti-icing is ON with a non-operating engine (i.e. A330).

OPERATIONAL IMPACTS

The FTIS has automatic control with no requirement for crew intervention.

Any system fault leading to the loss of inerting capability generates a cockpit and maintenance message at the end of the flight (flight phase 10) for maintenance purposes:

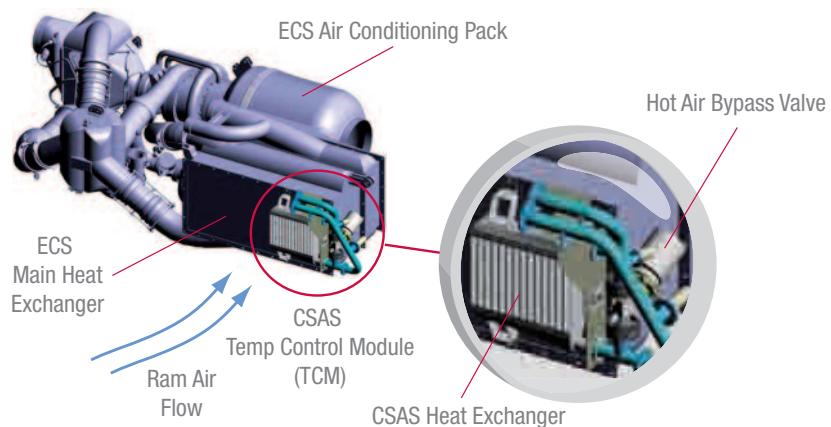
- For A320 Family a maintenance STATUS: 'INSERT FAULT',
- For A330/A340 Family an ECAM message: 'FUEL INERTING SYS FAULT'.

The aircraft can be dispatched under Minimum Equipment List (MEL) with the system inoperative during 10 days with no specific maintenance action.

The implementation of these new cockpit and fault messages requires upgraded standards of the Flight Warning Computers (FWC) and maintenance computers (CFDIU for the A320 Family, CMC for the A330/A340 Family) (see information note).

MAINTENANCE IMPACTS

In order to ease the maintenance, the heat exchanger with the Hot Air Bypass Valve, the Temperature and pressure sensors of the CSAS subsystem are installed in the Temperature Control Module (TCM) (see figure 5).



Airbus has taken the same approach for the design of the IGGS.

A pallet is used to group the major IGGS components.

They are as seen in figure 6:

- The Gate Valve,
- The HEPA filter,
- The Pressure sensor,
- The Temperature sensor,
- The ASM (s),
- The Oxygen sensor,
- The Dual Flow Shut Off Valve and ducting.

In order to maintain the system performance and to minimize the exposure to unscheduled maintenance, some scheduled maintenance actions are required as described in table 1.

The industrial challenge of the retrofit campaign

The FAA rules impacts around 900 Airbus aircraft in-service to be retrofitted within seven years.

If EASA follows the FAA decision on retrofit, around 4500 Airbus aircraft will have to be retrofitted during the next decade.

PLANNING

Under such a hypothesis, a strong coordination with every operator is a must. A well-prepared retrofit and embodiment planning has to be set up between the operators and Airbus to avoid any industrial bottlenecks.

IGGS Pallet

Figure 6

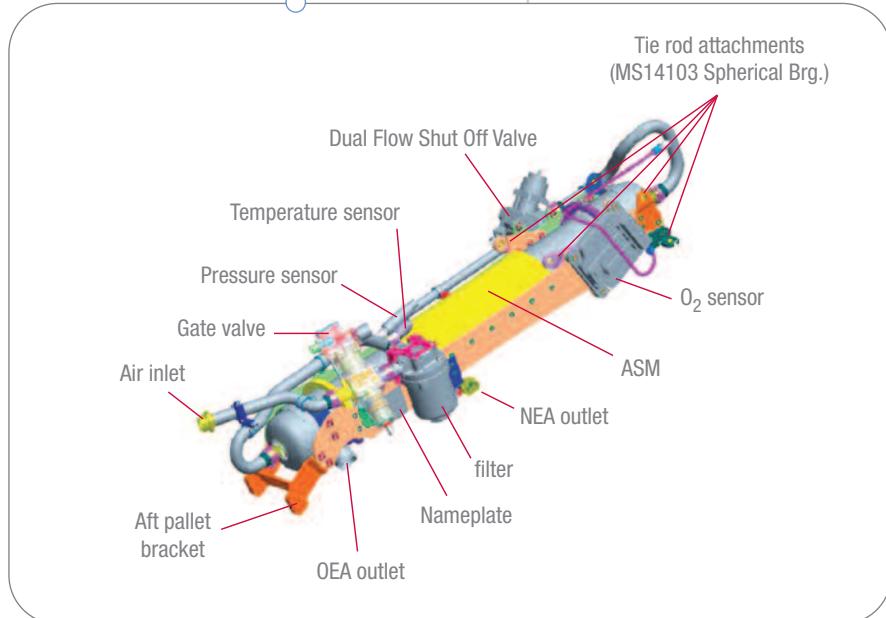


Table 1

Task	Task time (hours)	Check labor time (hours)	Interval	Procedure ^{1,2}
Replace ASM	0.75	1.2	27,000 hours	Remove and replace, leak test
Replace filter element	0.28	0.45	7000 hours	Remove and replace, leak test
Ozone Converter cleaning	0.58	0.75	6000 hours	Remove and replace
Heat Exchanger cleaning				Consistent with ECS heat exchanger cleaning interval
Check valve and DFSOV Leak test ³	1.0	1.5	12,000 hours	Test and replace as needed

¹ No special tools or test equipment required for scheduled maintenance tasks

² Drain cap is opened to check for liquid fuel ingress following no operation MMEL periods or after a fuel tank overfill

³ Valve Leak test is performed at the liquid drain plug location and the test port location between the check valves



glossary

- ASM:** Air Separation Module
- BITE:** Built In Test Equipment
- CFDIU:** Centralised Fault Display Interface Unit
- CMC:** Centralised Maintenance Computer
- CSAS:** Conditioned Service Air System
- DFSOV:** Dual Flow Shut Off Valve
- EASA:** European Aviation Safety Agency
- ECS:** Environmental Control System
- FAA:** Federal Aviation Administration
- FAR:** Federal Aviation Regulations
- FRM:** Flammability reduction Mean
- FTIS:** Fuel Tank Inerting System
- FWC:** Flight Warning Computer
- HEPA:** High Efficiency Particle Air
- IGGS:** Inert Gas Generation System
- IMM:** Ignition Mitigation Mean
- MEL:** Minimum Equipment List
- NEA:** Nitrogen Enriched Air
- NPA:** Notice for Proposed Amendment
- OEA:** Oxygen Enriched Air
- RFC/RMO:** Request For Change/ Retrofit Modification Offer
- STC:** Supplemental type Certificate
- TC:** Type Certificate



Conclusion

To comply with the FAA flammability reduction rules, Airbus have developed the most cost effective technical compromise in terms of maintenance and operations. Airbus is fully committed in supporting the operators with these new requirements taking into account

the deadlines set up by the authorities. This can only be achieved with the cooperation of the concerned operators that will overcome this challenging embodiment of the Fuel Tank Inerting System technology by scheduling the installation in due time.

AIRBUS RETROFIT OFFER

Airbus Upgrade Services through the RFC/RMO process will provide customized commercial and technical services consisting of a retrofit package with:

- Two Service Bulletins:
 - One SB for the structural and electrical provisions,
 - One SB for the equipment installation allowing the customer to complete the retrofit in packages during C-checks,
- Airbus kits (brackets, pipes, rods, wiring, etc.),
- Specific FTIS equipment from Parker and Liebherr,
- The coordination of the kit and equipment deliveries.

Flight Warning Computers and maintenance computers' standards should accept messages provided by the FTIS (see information for the requested corresponding standards). Upon request, technical support on site can be provided. Airbus will also provide relevant training courses to your maintenance staff.

EMBODIMENT ON AIRCRAFT

About 500 man-hours are needed with a lead-time of 7/8 days if done in one operation (provisions and installation). This takes into account the aircraft preparation (scaffolding, centre tank venting and all the tests). The work can be done in two packages (provisions, then equipment installation) allowing the operator to perform the modification within two C-checks.



information

Airbus documentation

- SFAR 88: S.I.L. 28-072
Fuel tank protection against ignition source,
- FTIS: OIT 999.0007/06
ATA28-FAA NPRM on flammability reduction system retrofit,
- FTIS: OIT 999.0084/08
ATA47-FAA flammability, reduction system introduction
- AirbusWorld portal: dedicated page 'Comply with Fuel Tank Safety'.

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Brake-to-Vacate system

The smart automatic braking system for enhanced surface operations

The Brake-To-Vacate (BTV) is an Airbus innovation in pilot aid to ease airport congestion and improve runway turnaround time. The BTV system, which will be available on the A380 (2009) and A320 Family (2012/2013) as an option and on A350XWB basically, helps reducing taxiing time at busy airports by optimizing the runway occupancy time and lowering braking energy while maximizing passenger comfort. The BTV system, which is designed by a multi-disciplinary team (avionics, flight controls

and auto-flight, landing gear, flight tests, aircraft performance and human factors) under the scope of a multi-programme project, allows pilots to select the appropriate runway exit during descent or approach preparation. The Airbus-patented innovative system uses the GPS (Global Positioning System), Airport Navigation, Auto-Flight and Auto-Brake Systems to regulate deceleration, enabling the aircraft to reach any chosen exit at the correct speed in optimum conditions.



Fabrice VILLAUMÉ
Multi-Programme Project Leader
Airbus Systems Engineering



Final approach on LFBO 32L runway with S10 exit selection for BTV

The project began in 1998 via a PhD thesis. Following a feasibility phase until 2001, it completed a prototype phase on an A340-600 prototype in 2006, with a first test flight in April 2004 under various operational conditions. These preliminary demonstrations were performed within a research framework. A successful flight test in March 2005 has been performed in real-time conditions at Charles de Gaulle Airport in Paris. The industrialization began on A380 in October 2006 with a first test flight in May 2008.

To better understand what is the BTV system, this article will highlight the current use of the already existing auto-brake system and its impact on aircraft operations, the evolving airport operation context and will detail the Airbus BTV operational answer.

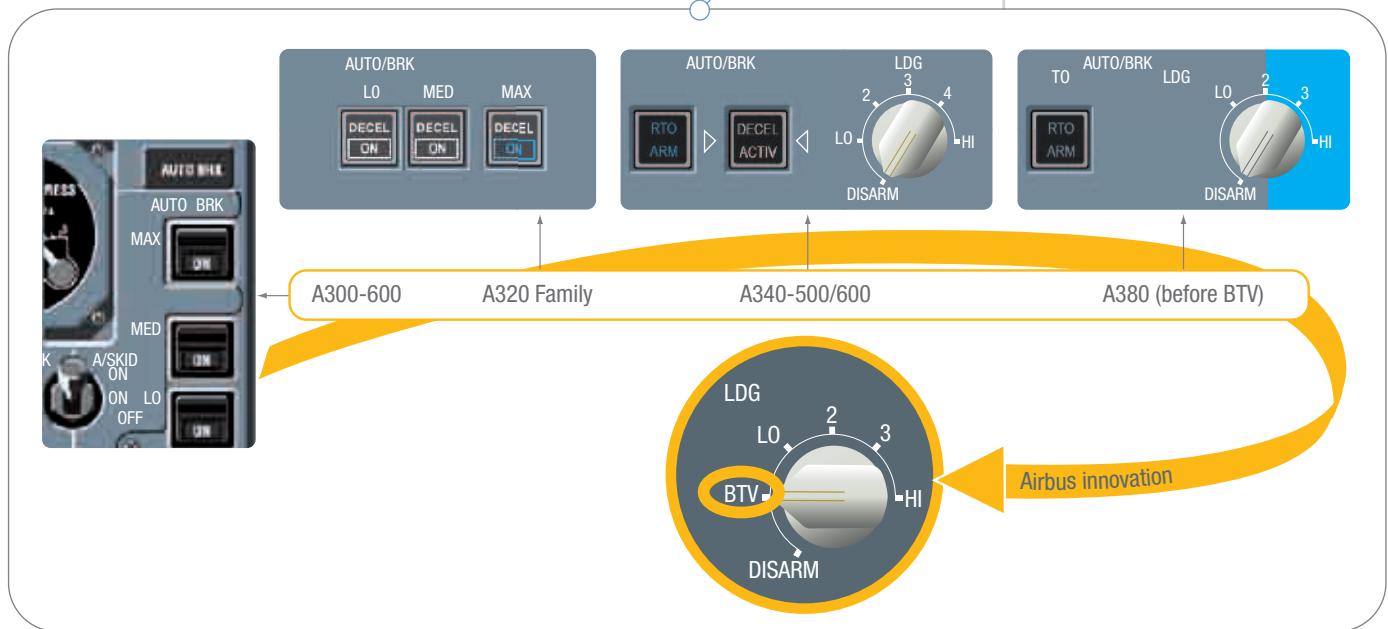
The automatic braking system at landing: Historical perspective of evolution

Automatic braking system, also called auto-brake system, is a type of automatic wheel-based hydraulic brake system for advanced airplanes (Airbus, Boeing, etc.). In order to keep the pilot free to perform other tasks, the auto-brake has been designed to control, robustly and rustically, aircraft longitudinal deceleration during rollout and down to full stop. The automatic deceleration control roughly starts at the nose landing gear impact with an onset transition ramp for comfort.

Since the A300-600 model, auto-brake modes are selectable for landing using either LO and MED, which provide low and medium fixed deceleration control. In order to give more operational flexibility, A340-500/600 models are fitted

Automatic braking systems on Airbus aircraft

Figure 1



with an auto-brake system enriched by five fixed deceleration modes through a new rotary switch: LO, 2, 3, 4 and HI (see figure 1). The A380 is fitted with a four-modes auto-brake system (LO, 2, 3 and HI).

In everyday operations, analysis shows that the auto-brake system cannot be adapted to each landing situation, which has specific touch-down characteristics (position and speed) with respect to the desirable exit taxiway foreseen by the crew (type, position and speed).

The use of the auto-brake system is recommended when the pilot's workload is high, and has become since the year 2000, Airbus recommended Standard Operating Procedures (SOP) at landing, but there are some drawbacks:

- Firstly, onset nose high on some models would be stronger than the pilot would wish,
- Secondly, brake pedals override includes discomfort, as the pilot has frequently to brake more... to brake less, causing frequent assymetric braking.

Since the A380 models, a smooth and symmetric system has been introduced by allowing auto-brake system disconnection through the Auto-Thrust Instinctive Disconnection button located on the thrust levers,

- Thirdly, associated to crosswind operations, it may induce on some models asymmetric braking, which helps lateral control, but has a negative impact on Turn Around Time (TAT): There is more braking energy on the more loaded wheels, so those brakes get to reach higher temperatures and need more time to cool down before the next departure,
- Finally, it is highly recommended to reduce as much as possible the number of brake pedal applications during landing roll to limit carbon brake wear.

Additionally, current auto-brake system shortcomings at landing are magnified with its systematic use. Everyday use leads to reach the desired exit speed too far or too short from the desired exit.





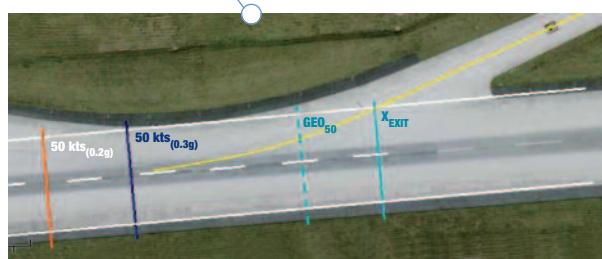
information

Synthetically, current auto-brake system

drawbacks (induced by its useful rusticity) are, in everyday averiations, an approximate optimization achieved by the pilot (i.e. too high deceleration followed by too long speed taxi on the runway), a partial awareness of the estimated and measured braking distance, a lack of flexibility with respect to operational constraints and an 'Airport Navigation' unawareness.

BTV is capable of high speed turn off

Depending on exact geometry, taxiway exact angle, turn radius and RWY width, aircraft can be at 50 KTS with yellow line having slightly started to turn



High speed turn off angle slightly steeper than 30°, with 45m wide runway (in Nice - France exactly 30°)



The only way to improve this situation is the pilot's compensation by overriding the auto-brake system at the right time. The override decision criterion then depends on the pilot's feelings, view and experience inducing an everyday very limited brake optimization. In low visibility conditions (crew blindness), the pilot cannot compensate the classic auto-brake system blindness, being blind himself. In that operational case, auto-brake MED deceleration level or equivalent is mostly used, bringing the aircraft at low speed in the middle of nowhere. Then, the pilot taxies on the runway until...
...an exit literally appears!

The auto-brake system control principle is a closed-loop control on deceleration. Hence, more reverse thrust results in less braking, but without shortening landing distance. At first sight, this is really beneficial by reducing brake energy. Nevertheless, this everyday situation increases the risk of runway end overrun in case of long flare on short runways; even if the pilot selects, as committed, the maximum reverse thrust.

In terms of Human Machine Interface, the pilot, through the DECEL light extinction does a

simplistic auto-brake system monitoring when current deceleration is 20% below the target deceleration:

- The DECEL light might be extinguished at high speed on slippery runways while auto-brake system is operating normally,
- A partial improvement has been introduced on A340-500/600 by adding an ACTIV light in order to confirm the correct operation of the auto-brake system. Nevertheless, it will not help the pilot in achieving an intended exit or in preventing a possible runway overrun.

An evolving airport operation context

Innovative solutions are urgently required because congestion is already a serious issue at some airports. A minority of airports generates the majority of demands, and these airports are already operating at their maximum throughput for sustained periods of time. Among other topics, the ongoing SESAR (Single European Sky for Air Traffic Management Research) project focuses on making best use of airport airside capacity based on the available infrastructure, because new constructions are in many instances strictly limited by political and environmental constraints. The airport's airside system capacity is significantly influenced by the runway capacity, which should be considered as key determinant for the overall intake. It has the potential to significantly reduce the total amount of delays at airports. This will in turn reduce the requirements for the airport's development, the impact on the environment and its resource use.

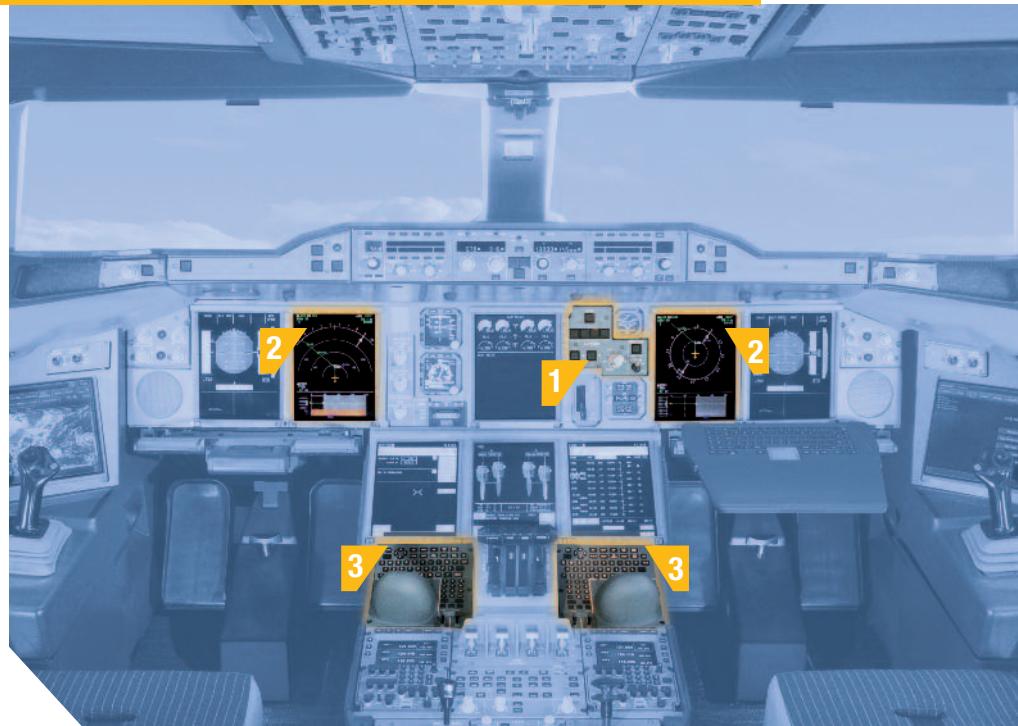
Among the wide spectrum of runway capacity elements, reducing the time spent by aircraft on the runway is one of the most important issues.

This does not alter the fact that Runway Occupancy Time (ROT) is inextricably linked to other issues such as wake vortex separation minima and minimum separation standards for both arrival and departure. Minimizing the separation between arriving and departing traffic is equally crucial in reducing ROTs. Even environmental aspects, such as use of preferential runways, etc., may also have an impact on occupancy time.

Studies have shown that depending on the traffic mix (various aircraft types), runway capacity can be increased between 5% (in the case of single-runway airports) and 15% (multiple-runway airports) by reducing ROTs. A remarkable example is the 19% capacity increase achieved over a period of three years on the single runway at Manchester, U.K.

It should be stressed that increasing runway capacity by minimizing runway occupancy is a matter of seconds per operation. Indeed, aircraft that unnecessarily occupy the runway for additional seconds potentially provoke delays of at least one order of magnitude greater, (i.e. close to the minute or worse). If this develops into a domino effect, then overall system capacity will be reduced, causing losses of slots. On the other hand, the saving of a few seconds per movement can represent an important capacity increase. Enhancing runway capacity is not necessarily a matter of seeking absolute minimum occupancy time but rather one of achieving consistent performance, thereby building up the confidence of pilots and controllers, which is necessary to optimize runway capacity.

Finally, in case of low visibility, the runway capacity is drastically reduced due to lack of the operational guarantee between the pilot and the controller, inducing an important increase of safety margins added to everyday separation between two consecutive aircraft.



1 Control using Auto-Brake existing selector.
BTV instinctive disconnection using A/THR existing instinctive disconnection button.

2 Independent display on existing Navigation Display (ND)

3 Selection using existing Key Board Control and Cursor Unit (KCCU)

An operational answer: The Brake-to-Vacate function

It becomes natural to imagine an enhancement of the existing classical auto-brake system at landing which aims at reaching optimally a desired exit, by adding a new auto-brake mode (with the same activation/disconnection principles).

Brake-to-Vacate system design objectives can be expressed to:

- Ensure the best possible braking management at landing from main landing gear impact to runway exit vacation,
- Develop a crew intuitive selection, monitoring and termination of the BTV system,
- Propose a seamless and natural integration with: In-flight landing distances assessment during descent/approach preparation and execution, Runway Overrun Prevention and Warning Systems (ROP and ROW) below 500ft until aircraft runway vacation, Airport Navigation during taxi,



information

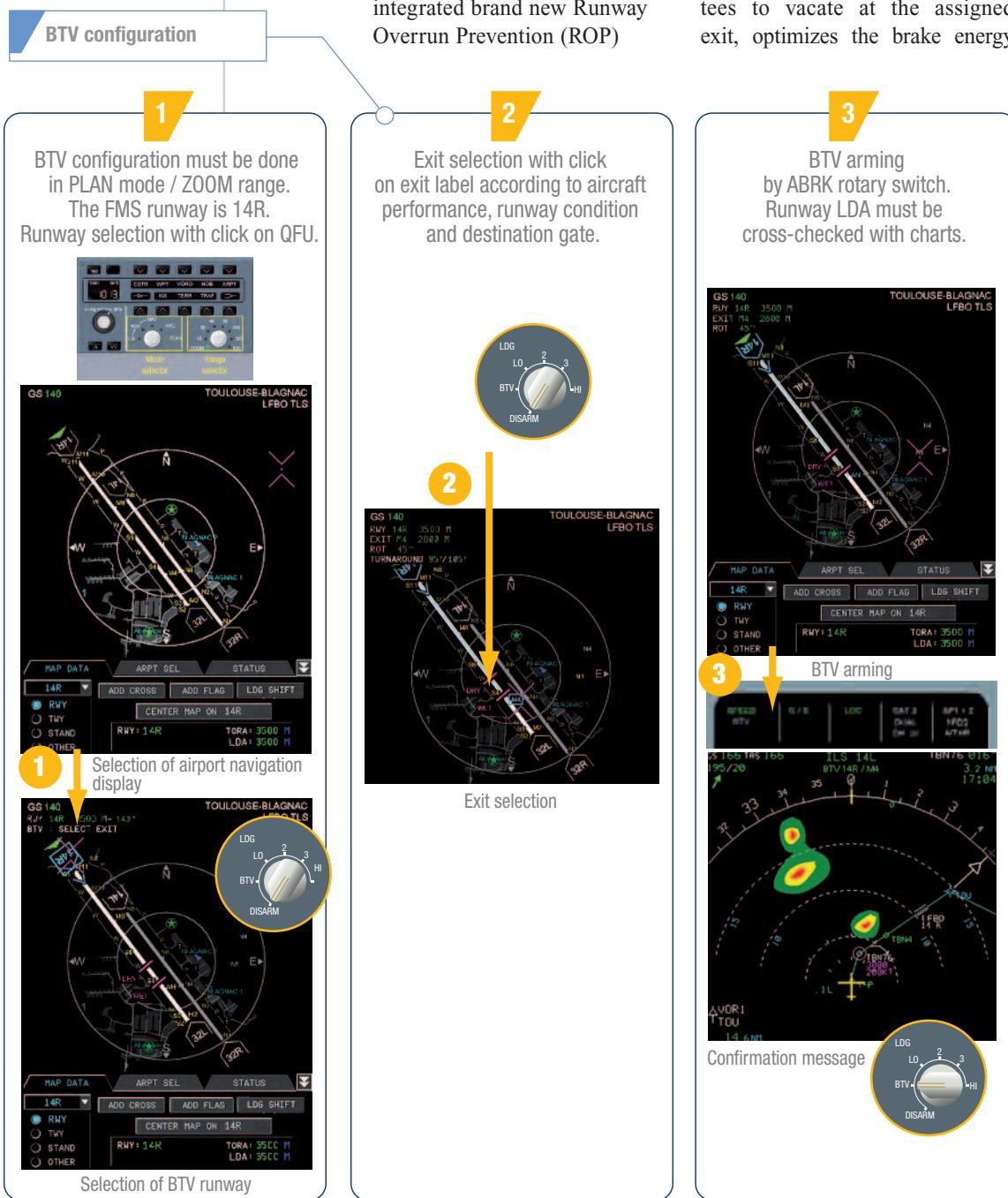
Synthetically, regarding present runway operations, current **on-board systems** cannot help improving runway capacity; therefore, runway capacity is not optimized and is drastically reduced in low visibility conditions.

- Ensure a safety improvement by increased crew situation awareness achieved with the in-flight landing distance computation continued on final approach and ground roll, even with low visibility operations,
- Ensure a safety improvement with the implementation of a brand new runway overrun prevention device covering most frequent cases on non-contaminated runways; feature which is also generalized to all other classical auto-brake modes. The description of BTV integrated brand new Runway Overrun Prevention (ROP)

system and display of operational landing distances, will be the object of two specific articles in July and December 2009 in the editions of Safety First magazine.

BRAKE-TO-VACATE GENERAL OPTIMIZATION PRINCIPLES: AIRCRAFT SIDE

In more details, ‘the best possible braking management at landing’, targeted by the BTV system, considers the most robust and simple compromise which guarantees to vacate at the assigned exit, optimizes the brake energy



regarding the current operational constraints, minimizes the runway occupancy time and improves the passenger comfort.

In an operation, the optimum exit selection depends on multiple criteria and constraints that can only be known in their full complexity by the pilot and the air traffic controller:

- Optimum braking energy (complex as function of taxi, of requested Turn Around Time (TAT), of noise abatement procedures preventing maximal reverse thrust usage out of safety needs),
- Minimum number of brake applications,
- Minimum runway occupancy time,
- Best exit for taxi duration.

A short exit selection can obviously produce lower runway occupancy time than a far exit, but with higher brake energy and Turn Around Time. At the end, no automatic selection of the optimum exit is possible.

Then, for an exit selected by the pilot, the BTV system guarantees that simultaneously the lowest brake energy and runway occupancy time are reached. For this, BTV system delays braking as much as possible, applies the maximum possible braking at the latest possible time while reaching the exit at suitable speed. But a design compromise has been found in order to respect the passengers' comfort constraints by fixing maximum level of deceleration and variation of deceleration over time, during the landing roll. Moreover, a special attention has been paid to the BTV deceleration profile computation regarding the visual perception of the pilot associated to late braking in the case of a selected exit close to the runway end.

To help the exit selection chosen by the pilot, the BTV system proposes a dedicated interface providing

intuitive information to assist the selection of an optimum exit and to monitor BTV operation. This dedicated interface provides also a predicted and guaranteed ROT (Runway Occupancy Time) and an estimated TAT in a sense of brake cooling time (assuming thrust idle or maximum reversers' usage as per Standard Operating Procedures indication).

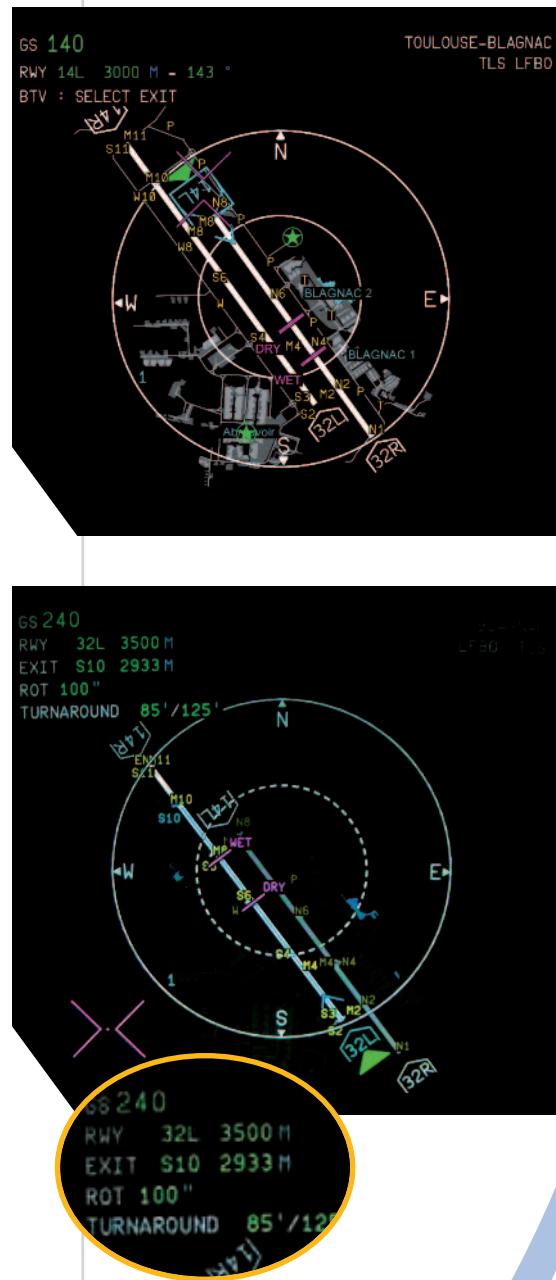
Nevertheless, the selection of the 'optimum' exit remains the pilot's responsibility. These indications then help the crew on the optimal thrust reversers' usage strategy during the landing roll on dry runway.

BRAKE-TO-VACATE GENERAL OPTIMIZATION PRINCIPLES: ATM (AIR TRAFFIC MANAGEMENT) SIDE

The main principle is to use efficiently the runway occupancy time reduction allowed by BTV-fitted aircraft in the whole traffic converging on the considered airport; particularly, it takes benefit from the knowledge of the effective and guaranteed runway occupancy of the BTV-fitted aircraft using the 'runway resource'.

Then, the followed dedicated arrival procedure is today imagined (still under study with the ATM community):

- Since the 'approach' controller manages the BTV-fitted aircraft, the pilot and the controller agree on the in-service landing runway and exit taxiway, which depends on several points as the airport layout configuration, aircraft landing performances, airline operational procedures and all other current landing conditions,
- The pilot (or in the future the aircraft itself) communicates the predictive runway occupancy time, which will be guaranteed,
- The 'approach' controller manages arrivals considering separations to be respected and the forecasted arrival time on the landing runway threshold.



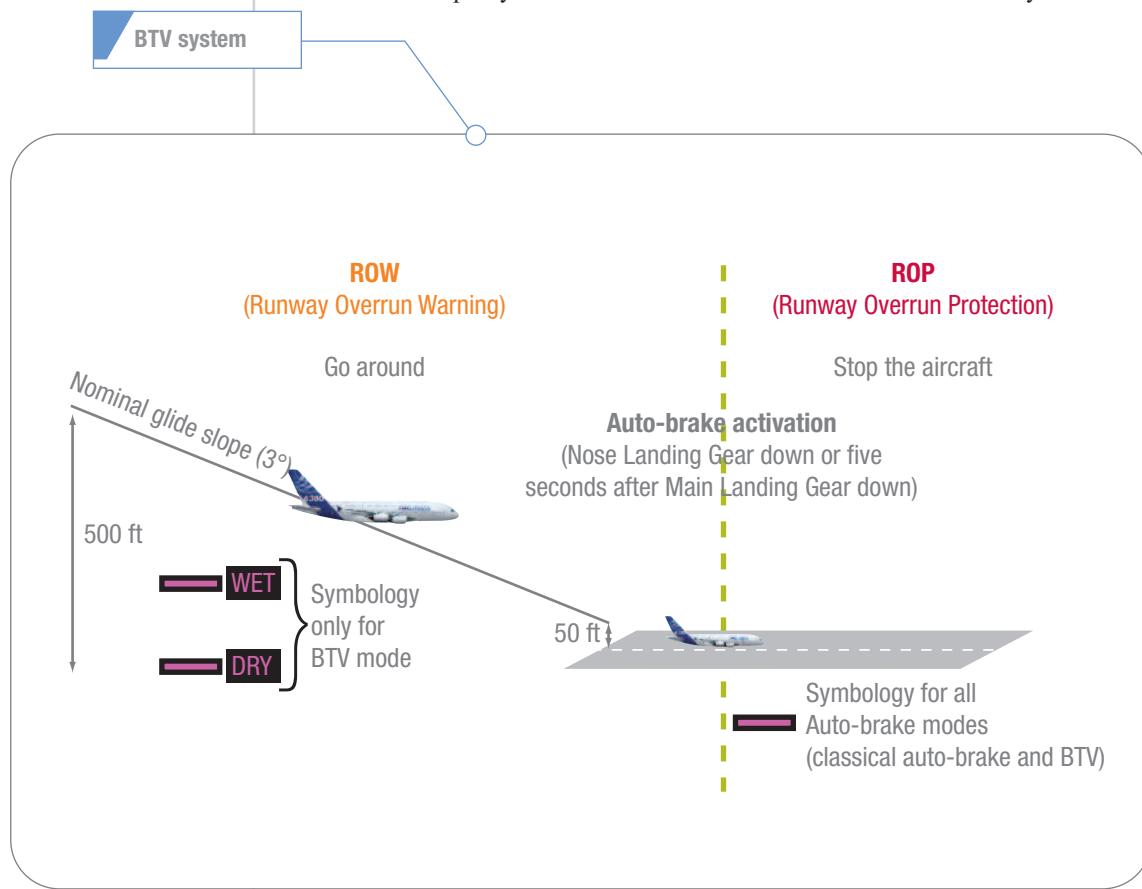
The results of this sequencing task is the location of all aircraft in final approach in order to optimize the arrival flow with respect to the runway occupancy time, but also allowable minimal separations (radar and wake vortex). Also, it results in managing forecasted separation in time on a given future position on the approach trajectory (runway threshold),

- Once the aircraft is established in final segment, the ‘tower’ controller monitors approaches so that the forecasted timing is respected (in the future, the aircraft itself will be able to manage these constraints),
- The ‘tower’ controller gives the landing clearance with respect to its own conviction that the runway will be vacated on time.

The operational management of mixed traffic (BTV-fitted and non-BTV-fitted aircraft) is obviously much more complex. Nevertheless, it remains consistent. In this case, conservative forecasted runway occupancy time would overestimate

known mean values with a sufficient margin to take into account uncertainties (like it is practised today). For non-specialized runways (used simultaneously for takeoff and landing), the arrival timing has to be also optimized; a takeoff can immediately follow the vacating of the previous just-landed aircraft and then take benefit of the time saved.

In addition to the operational and safety gains foreseen above, the immediate consequence is the minimization of strong constraints, which allow the improvement of admissible cadences. The induced ATM operational gain is based on the increase of runway technical capacity. This gain is particularly remarkable in case of low visibility conditions because standard separation can be reached thanks to BTV system (within the limits of sensitive radio electric protection zone constraints). The runway occupancy time can be then the same as in case of good visibility operations because low speed evolution on the runway is reduced



to its minimum. Moreover, as the runway occupancy time of the previous aircraft is known and respected, a certain number of go-around manoeuvres (due to non-cleared runway) will be avoided.

The reduction of the time spent on the runway can be translated by an operation time gain for the airline. It could be negligible for an isolated aircraft but important for a fleet. The most visible gains will be obtained on the delays reduction occurring during airport saturation periods. Operation gains can then be magnified by a network effect when considering sets of platforms that are interconnected with local BTV induced gains. They will be also sensitive to 'a hub effect' due to an important part of fitted aircraft.

Eventually, the airport manager will benefit from a declared improved operational capacity without doing expensive investments (additional and/or exit runway building, etc.).



Conclusion

Brake-To-Vacate (BTV) is an Airbus development effort for improving the pilot's management of the approach and landing phases. The well known GPS and the new on-board airport map database has permitted this innovation. Tangible value will be brought to our customers by:

- Reducing brake wear and temperature,
- Using less and even removing brake fans,
- Relieving maximum thrust reversers' usage on dry runways,
- Reducing noise level on ground, fuel consumption and gas emission,
- Controlling Turn Around Time before landing (guarantee for the next departure slot),

- Improving passengers' comfort during landing roll,
 - Avoiding missed exit situations,
 - And, minimizing runway occupancy time.
- BTV system is coupled to a Runway Overrun Prevention system, also called ROW/ROP. This Airbus patented solution offers a comprehensive and efficient answer to the runway excursion risk at landing. It can then be seen as a major safety enhancement feature. Through the minimization of the runway occupancy time, BTV helps also to reduce significantly the exposure time to a runway incursion risk.

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AIRBUS



Implementing RNP AR

The operational approval (Required Navigation Performance Authorization Required)

RNP is a navigation technique, which allows aircraft to fly precisely along a predefined route using state-of-the-art on-board navigation systems and Global Positioning System (GPS). RNP improves the efficiency, capacity and environmental performance of the global air transportation system. RNP AR will support the development of even more efficient procedures in terms of fuel emissions, aircraft noise, weather-related minima, access to mountainous areas and airport congestion (see figure 1). RNP AR is one of the possible solutions for future ATM (Air Traffic Management) requirements and optimized flight operations, being part of the Performance Based

Navigation (PBN) for which the ICAO (International Civil Aviation Organization) has announced that it must be implemented all around the world. Very soon, operators will have to challenge their future flight operations. Operators may have already noticed the publication of new RNP, RNP AR or RNP SAAAR (Specific Aircraft Aircrew Authorization Required) approaches at some airports. RNP AR operations cover approaches, missed approaches, SID (Standard Instrument Departure) and EOSID (Engine-out SID) procedures. This article describes the various aspects an operator has to cover when seeking for an operational approval for RNP AR operations.



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The Required Navigation Performance (RNP) is part of the PBN (see figure 2). It refers to aRea NAVigation (RNAV), based on performance requirements of the equipment on-board the aircraft operating along an ATS (Air Traffic Service) route, an instrument approach procedure, or in a designated airspace. Therefore, the navigation as per RNAV and RNP is independent from conventional ground navigational aids (navaids) such as the VOR (VHF Omnidirectional Range), DME (Distance Measurement Equipment), NDB (Non Directional Beacon), etc.

For RNP, the performance requirements of the aircraft are contained in the PBN navigation specifications. They are expressed in terms of accuracy, integrity, continuity, availability and functionality needed for the proposed operation. Additionally, the PBN navigation specifications require that for RNP operations, the aircraft be equipped with an On-Board Performance Monitoring and Alerting (OBPMA) system.

Recent RNAV operations are considered as performance-based and referred to as 'RNP RNAV' approaches. They require in fact a navigation solution based on GPS or GNSS (Global Navigation Satellite System).

In 2007, ICAO documented two types of approaches:

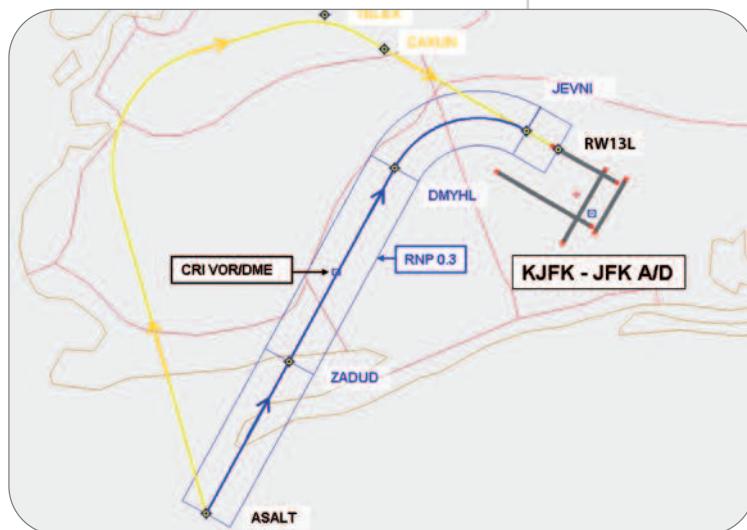
- RNP approaches (RNP APCH) charted RNAV (GNSS) or RNAV (GPS) and,
- RNP with Authorization Required Approaches (RNP AR APCH) charted RNAV (RNP). It is equivalent to the American SAAAR operations.

The RNP AR concept is not limited to approach procedures. It can also apply to SID, and EOSID procedures, although ICAO specifications are not yet published.

The RNP AR contains all advantages of the RNAV concept in terms of flight path tracking and

Comparison of RNP AR procedure (blue track) and current conventional procedure (yellow track) in KJFK airport

Figure 1



repeatability. RNAV already brings a solution to airport congestion, fuel economy requirements, or environmental requirements. Due to improved flexibility of the RNP AR procedure design, the benefits are even greater. It is therefore a solution for challenging areas (mountainous areas) thanks to improved accuracy and flexibility. By reducing the weather minima and improving the required visibility during approach, it may avoid weather-related disruptions.

The FAA (Federal Aviation Authority) has developed 157 RNP AR procedures. It plans to publish 300 additional RNP AR procedures by 2013. RNP AR is specified for highly integrated navigation systems, dual GNSS and FMS, Terrain Awareness Warning Systems (TAWS), etc. The crew training and the contingency procedures are also a key to achieve the required level of safety.

The implementation of the RNP AR operation is an airline project. It is a process involving several entities. The operator has the responsibility to obtain an operational process from its national Civil Aviation Authority, which will define the operational requirements.



glossary

PBN: Performance Based Navigation specifies system performance requirements for aircraft operating along an ATS route, on an instrument approach procedure or in a designated airspace.

RNAV: (aRea NAVigation) A method of navigation that enables aircraft to fly on any desired path defined by geographic fixes (latitudes, longitudes) and not necessarily by ground based navigational aids.

RNP: Required Navigation Performance is a statement of the navigation performance accuracy, integrity, continuity and availability necessary for operations within a defined airspace. RNP differs from RNAV by the additional requirement of On-Board Performance Monitoring and an alerting function.

RNAV 'X'/RNP 'X': 'X' refers to the lateral navigation accuracy in nautical miles that is expected to be achieved at least 95 percent of the flight time.

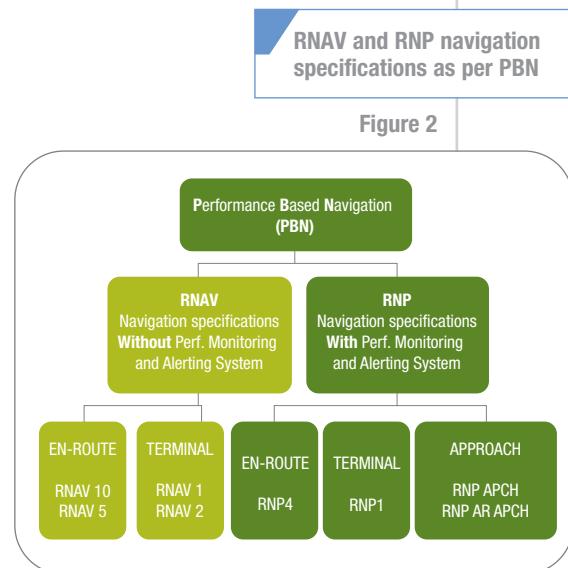


Figure 2

For the operational approval, the airline will have to address typically the following topics:

- Operational evaluation of each RNP AR procedure,
- Validation of the navigation database,
- Flight Operation Safety Assessment (FOSA),
- Operational documentation,
- Procedure charts, specific flight crew procedures, limitations,
- Aircraft capability,
- Flight crew training,
- RNP monitoring programme.

Airbus is supporting airlines as an aircraft manufacturer. It includes the aircraft definition, the operational documentation update and the RNP monitoring programme. A service provider may be involved, for the design of a new RNP AR procedure, with procedure charts, navigation database coding or procedure evaluation. The service offer may also include a FOSA as required, flight crew procedures and flight crew training.

The design of procedures

RNP AR operations are based on RNP AR procedures. RNP AR procedures are designed based on specific criteria like SAAAR procedures design criteria (FAA Order 8260.52) or ICAO Manual for Implementation of the Required Navigation Performance. ‘Public’ procedures are already available to all operators; an operator can develop ‘private’ or ‘tailored’ SAAAR instrument procedures with more flexible criteria.

RNP AR approach procedures are characterized by:

- RNP values $\leq 0.3\text{NM}$ (down to 0.1NM) and/or,
- Curved flight path before and after the Final Approach Fix (FAF),
- Protection areas laterally limited to $2 \times \text{RNP}$ value without any additional buffer.

RNP AR missed approach and instrument departures procedures include a reduced RNP ($<1\text{NM}$).

RNP AR procedures are predictable and repeatable trajectories based on sequenced of fixed legs composed of Track to a Fix leg (TF) and Radius to a Fix leg (RF) in WGS 84 coordinates. Sequences of TF and RF legs offer flexibility in flight path geometry that allows designing more efficient routes, thanks to RNP AR procedures.

The specific authorization requirement is indicated on the RNP AR procedure charts. RNP AR approaches are charted as ‘RNAV (RNP) RWY XX’.

Hundreds of public or private RNP AR procedures exist in the world. For example, access to Li Jiang Airport (ZPLJ) in China has been improved through RNP AR procedures developed with ENAC-GGX for Airbus aircraft (see figures 3 and 4)

Aircraft capability

Airbus proposes a set of RNP AR capabilities based on EASA (European Aviation Safety Agency) certification for the A320 Family and A330/A340 Family. Airbus RNP AR capabilities are available through RNP AR modification/Service Bulletins (SB) and are solutions to the different existing RNP AR operations with the appropriate on-board systems.

The following capacities are currently, or will be soon available on A320 Family and A330/A340 Family:

- RNP AR equal or below 0.3NM (in normal conditions: up to 0.1NM in approach and for most aircraft in departure and during a missed approach). This capability covers the low RNP values for all environments. Required systems’ configuration answers to EASA requirements for the low RNP values.

As an example, Airbus developed the lateral deviation scale (displayed on PFD) that answers to the EASA requirements.

- RNP AR limited to 0.3NM (in departure, approach and missed approach). This capability may be the solution for all environment limited to a 0.3NM RNP value. This capability is more flexible at equipment level as the lateral deviation scale display and the peaks mode function is not mandatory for certification of the RNP AR 0.3NM capability. Thus, current EIS1 and T2CAS standards are part of the system configuration for this capability.

Airbus RNP AR certifications cover normal conditions and abnormal conditions (system failures, etc.). This demonstration alleviates the Flight Operational Safety Assessment (FOSA) to be performed by the airline for its RNP AR project approval by authorities.

An airline that wishes to equip its aircraft for RNP AR should contact its Customer Support Director and submit a Request For Change (RFC).

The validation of procedures

Each RNP AR procedure needs to be thoroughly evaluated. This can be accomplished through either ground evaluation (e.g. simulator) or actual flight or a combination of both.

The purpose is to:

- Verify the flyability (in particular for private or tailored airlines' procedures),
- Define adequate normal and abnormal flight crew procedures,
- Validate the FMS navigation database coding,
- Confirm tracks, bank angles, descent and climb gradients, runway alignment, EOSID,
- Evaluate the absence of TAWS (Terrain Awareness and Warnings Systems) warning when the aircraft is on the nominal flight path.

Operational documentation

Airbus supports airlines' RNP AR projects by the delivery of RNP AR dedicated documentation. The Airbus RNP AR documentation, delivered with the RNP AR modifications/SB, consists of an update of the existing manuals and the delivery of a new RNP AR dedicated document:

- Flight Manual (FM) is updated to state aircraft RNP AR capabilities and regulations compliances,
- Flight Crew Operating Manual (FCOM). Standard Operating Procedure and special operation sections are updated to integrate RNP AR operational specificities,
- Airworthiness Compliance Document (ACD). ACD is a RNP AR dedicated operational document approved by EASA. ACD details all the assumptions, relevant information and limitations to be considered during the RNP AR approval process and design procedure.

Thus, Airbus, through this dedicated documentation, supports the airlines' operational procedures update and approval process for RNP AR operation.

Training

The airline needs to define a flight crew training that is adequate to the type of RNP AR operations being envisaged. It may need to be specific for operations that are significantly different considering the type of flight path, and/or environment. The flight crew training is comprised of the following modules:

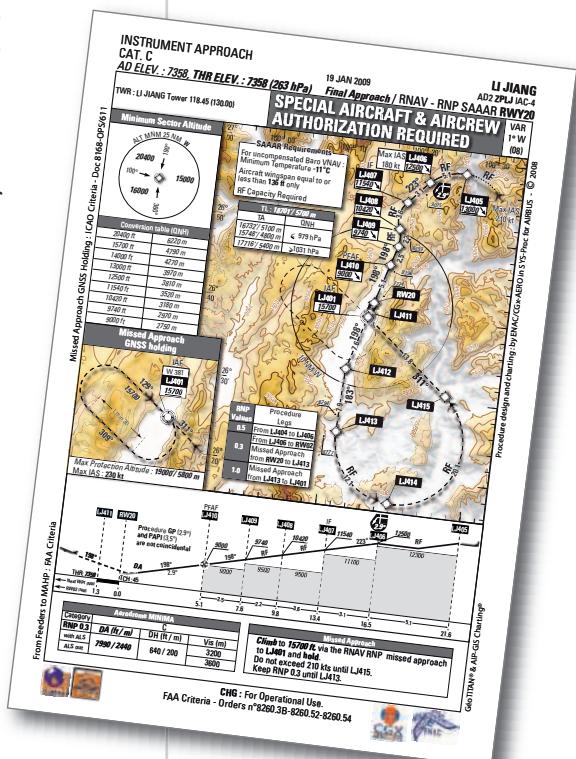
- Ground training,
- Flight training,
- Evaluation,
- Recurrent training.

The ground training segment should address the following subjects:

- General concepts of RNP AR approach operation,

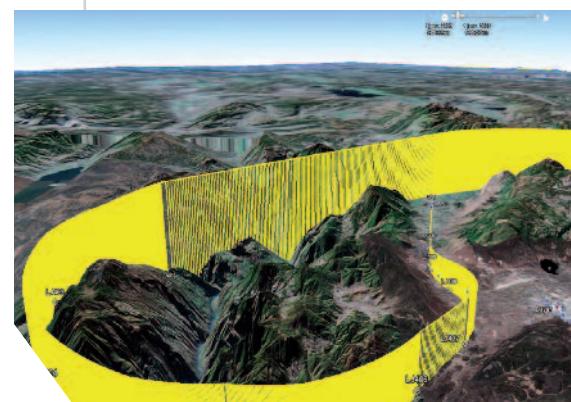
Development of an RNP AR procedure at Li Jiang Airport (China).

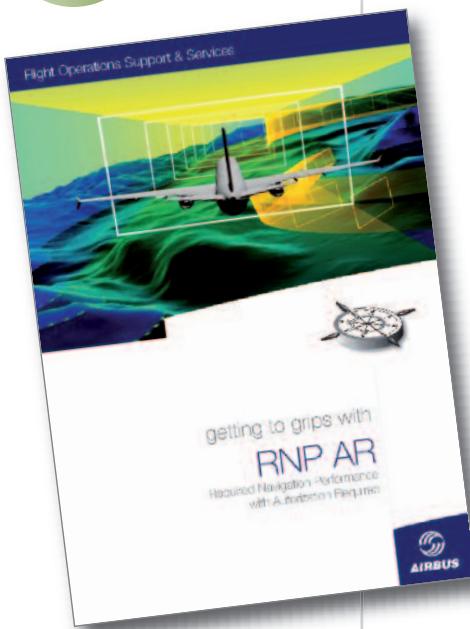
Figure 3



Li Jiang RNP AR in 3D

Figure 4





 **QUOVADIS**
an AIRBUS subsidiary

Conclusion

The RNP AR definitely benefits from modern navigation equipment. The Performance-Based Navigation (PBN) implementation plan is clear. And some countries (USA, Australia) have already started to widely implement the PBN and RNP AR, or RNP SAAAR. Airbus is also convinced of the operational benefits of the implementation of the RNP AR operations. The possible advantages of RNP AR can be found to:

- Reduce airport congestion,
- Improve fuel consumption,
- Reduce gas emissions when associated to track miles savings,
- Reduce aircraft noise,

- ATC (Air Traffic Control) communication and coordination for the use of RNP AR,
- RNP AR equipment components, controls, displays and alerts,
- AFM (Aircraft Flight Manual) information and operating procedures,
- MEL (Minimum Equipment List) operating provisions.

The flight training should address amongst others the following subjects:

- Normal RNP operations for departure, approach, and missed approach,
- Abnormal RNP operations for departure, approach, and missed approach,
- Contingency procedures, including existing local procedures.

The airline needs to evaluate each flight crew member on their knowledge of RNP AR procedures. The airline should include an RNP AR recurrent training in its overall flight crew recurrent training programme.

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- Reduce weather minima in mountainous areas.
- Airbus has been developing and certifying RNP AR capability on several aircraft types. Airbus believes that RNP is the future for Air Traffic Management (ATM) and fully support RNP AR implementation all around the world. Recently, Airbus supported several Chinese authorities and airlines in developing and deploying RNP AR procedures in Yan Ji, Li Jiang, Huang Shan and Lhassa airports, to name a few. The time has come for operators all around the world to consider implementing RNP AR as a way of preparing and optimizing the future of their flight operations.

AIRBUS

Brochure

Detailed information about the RNP AR concept is available for Airbus customers through 'Getting to Grips with RNP AR' (document on AirbusWorld). This document presents the RNP AR concept, as well as the Airbus solutions and airlines' activities to conduct their RNP AR project.

New subsidiary Quovadis

Airbus created a new subsidiary, Quovadis, in cooperation with the French Civil Aviation University, ENAC, and CGX AERO in SYS, a specialist in aeronautical and geographical information systems. Quovadis offers and sells services linked to RNP to airlines, authorities and airports. This includes design of the RNP procedures, validation and testing of procedures, flight operational approval and flight crew training.



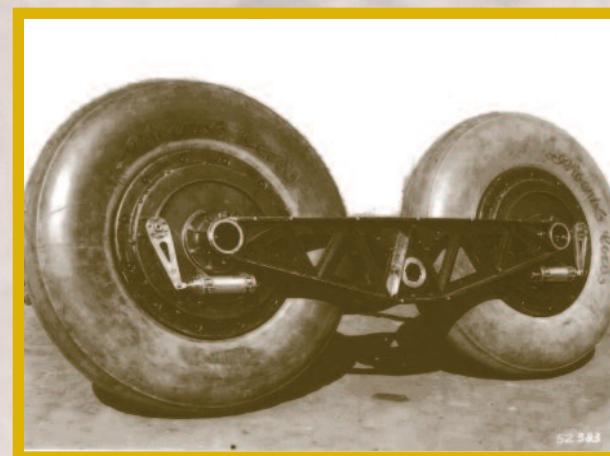
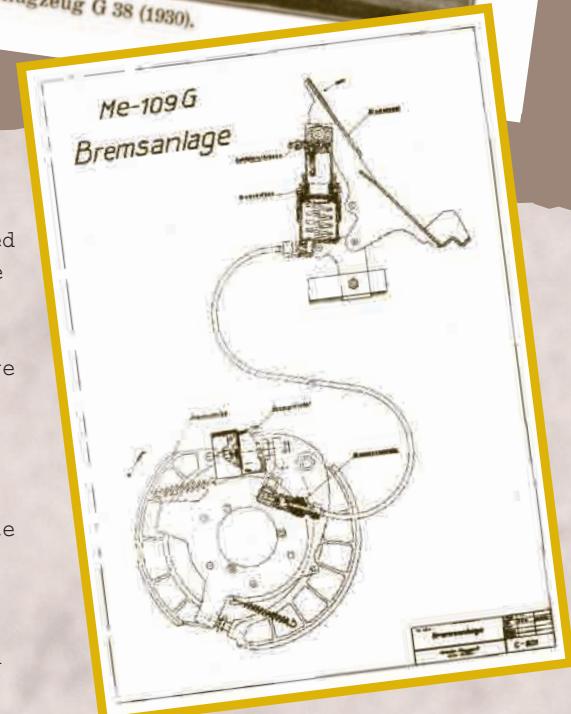
Junkers G.38

First air brake system

The Junkers G.38 first flew in 1929. Two prototypes were constructed in Germany. The G.38 carried a crew of seven. Structurally the G.38 confirmed to standard Junkers' practice, with a multi-tubular spar cantilever wing covered, like the rest of the aircraft in stressed, corrugated duraluminum. The undercarriage was fixed, with double tandem main wheels that were initially enclosed in very large spats. In flight tests, the G.38 set four world records including speed, distance and duration for airplanes lifting a 5000kg payload. The G.38, during its early life was the largest land plane in the world. Passenger accommodations were sumptuous by today's standards and were meant to rival those offered by the competing Zeppelin service offered by Delag. The plane was unique in that passengers were seated in the wings, which were 1.7m (5feet 7inch) thick at the root. On 1 July 1931 Lufthansa initiated regularly scheduled service between Berlin and London.

on flights carrying firstly up to 13 passengers. Six passengers were carried in two compartments in the leading edge of each wing. An air brake system with a tandem undercarriage for the wheels was used for the very first time.

Today's braking evolution systems brings the ultimate solution as explained in our 'Brake-to-Vacate' article (see page 17) to ease airport congestion and enhance passenger comfort.



Junkers G.38
Tandem carriage

Customer Services events

Just happened

A320 Family symposium

The 11th Airbus A320 Family symposium was held in Paris beginning of May. 188 representatives from operators, leasing, MRO (Maintenance, Repair and Overhaul) centres and suppliers attended it. During the 3 days of the symposium participants reviewed a wide range of subjects in the technical, economic and process domains. The symposium's key theme was working together to deliver solutions that are both technically and economically efficient. This was captured with the motto, 'Discuss, Decide, Deliver'. The symposium concluded with the caucus session that highlighted key areas for further work. These will compliment the areas of development that are agreed through the FAIR (Forum for Airline Issues Resolution) process. Feedback during and after the event indicated a high level of added value for the majority of participants.

Performance & Flight Operations conference

372 people and 111 airlines attended the 16th Performance and Operations conference in Paris from 11 to 15 May 2009. About one hundred presentations were shown, covering all flight operations activities, such as performances, Electronic Flight Bag and digital documentation, airline economics, etc ... The operators could also attend sessions dedicated to different aircraft types, and share their in-service concerns. The caucus, organized on the last day, enabled our operators to provide us with their feedback on our support in the field of flight operations, but also on the conference itself.

Coming soon

Supplier Improvement meetings

Our Supplier Support Management team is organizing two regional Supplier Improvement meetings later this year focusing on our

suppliers' aftermarket improvement initiatives. These meetings will be held in Hamburg on 15 and 16 September for European customers, followed by Dubai from the 5 to 7 October for Middle East customers. The goal is to share with our customers, the Airbus developments in supplier support management, following which, 10 of our major suppliers will present their improvement plans to the customer group and hold 'questions and answers' sessions. There will also be an opportunity for customers to have bilateral meetings with suppliers. The preliminary list of suppliers participating is: DASELL, EADS Sogerma, Eaton, Goodrich Interiors, Goodrich Power, Honeywell, Messier Dowty, Messier Bugatti, Panasonic and Zodiac Services. Invitations for European and Middle East customers will be sent in the coming days.

Airbus Leasing Support conference in Dublin, Ireland

The 6th Leasing Support conference will take place in Dublin, Ireland on 7 and 8 October 2009. This conference is organized for Airbus leasing companies and addresses dedicated support requirements of lessors and airlines, with a specific focus on aircraft residual value and maintenance events.

A300/A310 Family symposium

The next A300/A310 Family symposium will be held in Bangkok, Thailand from 9 to 12 November 2009. In order to make this event as productive as possible for all, Airbus will propose a basic agenda that will be augmented with your suggestions and input from FAIR (Forum for Airline Issues Resolution). As usual, adequate facilities will be available for side meetings during the event. Airbus Family symposiums are held for each Airbus programmes every two years, and target airline engineering and maintenance managers. The prime function of these meetings is to enable two-way communication, leading to an ever safer and more efficient fleet.





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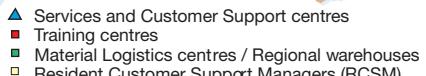
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RCSM location	Country
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Algiers	Algeria
Al-Manamah	Bahrain
Almaty	Kazakhstan
Amman	Jordan
Amsterdam	Netherlands
Athens	Greece
Atlanta	United States of America
Auckland	New Zealand
Baku	Azerbaijan
Bangkok	Thailand
Barcelona	Spain
Beijing	China
Beirut	Lebanon
Berlin	Germany
Bogota	Colombia
Bratislava	Slovakia
Bucharest	Romania
Budapest	Hungary
Buenos Aires	Argentina
Cairo	Egypt
Casablanca	Morocco
Changchun	China
Charlotte	United States of America
Chengdu	China
Chicago	United States of America
Cologne	Germany
Colombo	Sri Lanka
Copenhagen	Denmark
Damascus	Syria
Delhi	India
Denver	United States of America
Dhaka	Bangladesh
Doha	Qatar
Dubai	United Arab Emirates
Dublin	Ireland
Dusseldorf	Germany
Fort Lauderdale	United States of America
Frankfurt	Germany
Guangzhou	China
Guayaquil	Ecuador
Haikou	China
Hamburg	Germany
Hangzhou	China
Hanoi	Vietnam
Helsinki	Finland
Hong Kong	S.A.R. China
Indianapolis	United States of America
Istanbul	Turkey
Jakarta	Indonesia
Jeddah	Saudi Arabia
Johannesburg	South Africa
Karachi	Pakistan
Kita-Kyushu	Japan
Kuala Lumpur	Malaysia
Kuwait City	Kuwait
Lagos	Nigeria
Lanzhou	China
Larnaca	Cyprus
Lisbon	Portugal
London	United Kingdom

RCSM location	Country
Los Angeles	United States of America
Louisville	United States of America
Luton	United Kingdom
Luxembourg	Luxembourg
Macau	S.A.R. China
Madrid	Spain
Manchester	United Kingdom
Manilla	Philippines
Marrakech	Morocco
Mauritius	Mauritius
Melbourne	Australia
Memphis	United States of America
Mexico City	Mexico
Miami	United States of America
Milan	Italy
Minneapolis	United States of America
Montreal	Canada
Moscow	Russia
Mumbai	India
Muscat	Oman
Nanjing	China
New York	United States of America
Noumea	New Caledonia
Palma de Mallorca	Spain
Paris	France
Paro	Bhutan
Philadelphia	United States of America
Phoenix	United States of America
Prague	Czech Republic
Riyadh	Saudi Arabia
Roma	Italy
San Francisco	United States of America
San Salvador	El Salvador
Sana'a	Yemen
Santiago	Chile
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Fresher thinking about flying.

The Airbus A380 is a big aircraft full of fresh ideas. Its twin, full-length, wide-bodied cabin has exceptionally efficient air filters. With four high level air outlets instead of the traditional two, the cabin air gets refreshed every three minutes. Which helps passengers to feel fresher, both during and after the flight. There's a fresh approach to its environmental impact, too. With a new wing design and composite materials accounting for 25% of its structural weight, the A380 is a much more efficient aircraft all round. And by producing only about 75g of CO₂ per passenger kilometre, the A380 is contributing to the aviation industry's commitment to constraining greenhouse gas emissions.

Fresher thinking inside, fresher thinking outside. **Airbus A380. See the bigger picture.**



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New Standards. Together

