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AIRBUS

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AIRBUS

Optimise the skies

Air Traffic Management (ATM) modernisation programmes

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With air traffic set to double over the next 15 years, ATM modernisation programmes around the world are aiming to ensure a high performance infrastructure that will allow airlines to expand their business.

In addition to this, airlines are demanding more cost-efficient air traffic management and more environmentally-friendly operations are expected.

ATM modernisation is therefore key to the commercial aircraft industry and a priority for both operators and Airbus. There are however several challenges to be considered:

- **Political:** The ATM context is fragmented due to states exercising national sovereignty
- **Transitional:** New ATM concepts have long development cycles, typically 10 to 15 years
- **Complexity:** ATM covers Air Traffic Control, Network Management systems, airports, airlines' operational control centres and aircraft

The stakeholders

Airlines

Aircraft manufacturers with avionics suppliers

Air navigation service providers

Airports

Ground infrastructure

Several ATM modernisation programmes have been launched to respond to the specific needs of different regions of the world (see fig.1). It is hoped that many of these will set ambitious performance objectives along the lines of SESAR and NextGen, such as 50% reduction of navigation fees, reducing CO_2 emissions by 10%, or having the potential of a 3-fold increase in ATM capacity. These programmes also have the merit of federating the various ATM stakeholders and of progressing in a collaborative manner that is beneficial for all.

NextGen

NextGen is the Federal Aviation Administration (FAA) programme to modernise the air transportation system for the United States of America.
This comprehensive initiative relies on satellite navigation and advanced digital communications, to help improve and evolve the National Airspace System.

SESAR

Single European Sky ATM Research is the European programme launched in 2009 in order to provide Europe with a high-performance ATM infrastructure.

2016 marked the completion of the first phase of SESAR research and innovation (SESAR 1) and the delivery of mature technological and operational solutions. The second phase (SESAR2020) will support the early deployment of major improvements, such as the initial-4D concept, through very large scale demonstrations running from 2018 to equip more than 100 aircraft.

The ICAO GANP

The fifth edition of the International Civil Aviation Organization (ICAO) Global Air Navigation Plan (GANP) is designed to guide complementary and sector-wide air transport progress over 2016-2030 and is approved triennially by the ICAO Council.

The GANP represents a rolling, 15-year strategic methodology which leverages existing technologies and anticipates future developments based on an harmonisation of SESAR and NextGen concepts and state/industry agreed operational objectives.

This structured approach provides a basis for sound investment strategies and will generate commitment from states, equipment manufacturers, operators and service providers.

The advantages that harmonised ATM solutions would bring to worldwide interoperability has encouraged Airbus (along with other aircraft manufacturers) to strongly support the ICAO initiative to federate regional ATM modernisation programmes through the GANP.

Fig. 1 - Leading ATM modernisation programmes

New concepts in aircraft operations - ready to deploy

Next generation Air Traffic Management system(s) will require more interactions and cooperation between the aircraft and the ground.

By participating in regional modernisation programmes and ICAO harmonisation activities in the GANP, Airbus is ensuring that:

- The future operational concepts make the best use of existing and future aircraft capabilities and that these create value for airlines
- Air and ground development /deployment are synchronised

As a result, (and thanks to its work with SESAR in particular), Airbus has contributed to progress on several topics, among which the following are ready for deployment and constitute breakthroughs in terms of aircraft operations, with significant benefits on ATM capacity, efficiency and safety:

- Trajectory-Based Operations
- Ground Based Augmentation System
- Airport Surface Indicating and Alerting

ICAO definition of Trajectory-Based Operations (TBO)

A concept enabling globally consistent performance-based 4D trajectory management by sharing and managing trajectory information. TBO will enhance planning and execution of efficient flights, reducing potential conflicts and resolving upcoming network and system demand/capacity imbalances early. It covers ATM processes starting at the point an individual flight is being planned through flight execution to post flight activities.

Trajectory-Based Operations (TBO)

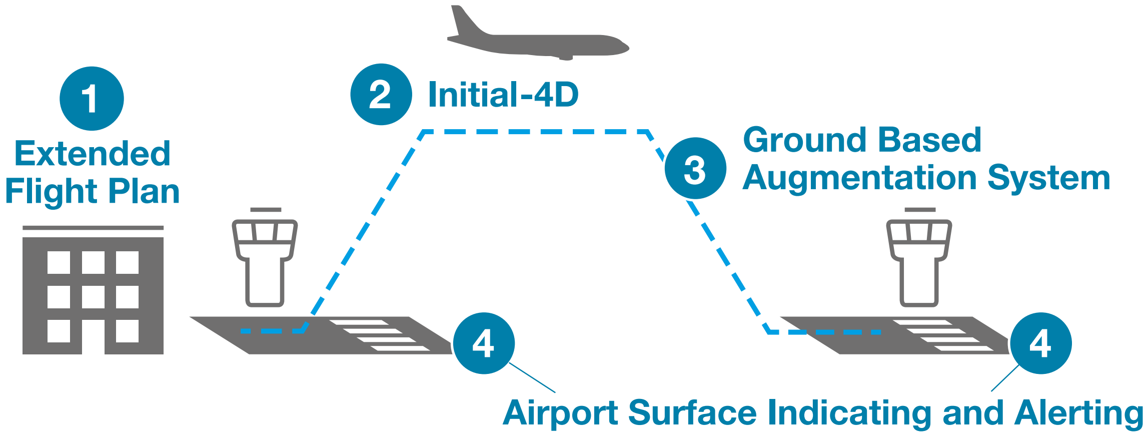
The overarching concept of ATM modernisation is the move from airspace-based operations (e.g. traffic separation based on current position and radar plot) to Trajectory-Based Operations, relying mainly on **accurate flight planning data**, and **accurate predictions of aircraft positions** (the 4D aircraft trajectory), shared and synchronised between all stakeholders, including the Network Manager, the Air Traffic Control Units, the Airlines Control Centre and the aircraft.

Video

PEGASE, Providing Effective Ground & Air data Sharing via Extended Projected Profile

This paradigm shift will enable conflicting trajectories to be resolved upfront and the controller's role will evolve from short term tactical control to more strategic and monitoring tasks.

As part of the TBO concept, Initial-4D (i4D) and Extended Flight Plan (EFPL) have been developed over recent years to improve ATM predictability. While EFPL improves and supports mainly the flight planning phase, i4D contributes to improve flight predictions during the execution phase.



1 Extended Flight Plan (EFPL)

Today, an aircraft operator's flight plan delivered through ICAO FPL 2012 includes only limited information of the 4D trajectory.

Both the Network Manager and Air Traffic Control Units receive the flight plan and recalculate its profile which may result in misaligned trajectories.

Key parameters of the 4D trajectory, or flight specific performance data are not all given to both parties who will tend to exercise caution, often leading to a wrongly rejected or wrongly accepted flight plan.

Therefore, the Operational Flight Plan released to the crews in some cases does not provide the optimum vertical profile. This is due to the fact that the trajectory is refined to get it accepted by both parties.

Thanks to the sharing of Extended Flight Plan (EFPL) data during the planning phase, these misalignments will gradually disappear.

EFPL as a new flight plan type will be aligned with the upcoming international standard 'FF-ICE1' and will mainly provide the following information:

- 4D trajectory (altitude, time, aircraft mass and speed at every waypoint)
- Flight specific performance data (optional information)
- Unconstrained climb and descent profiles

Expected benefits:

- Potential decrease of 15% for the rate of rejected flight plans
- More optimised trajectory computation and acceptance processes
- Alignment of airlines and ATM planned trajectories
- Enhancement of traffic predictions
- Improvement of demand/capacity network calculations

The flight dispatcher will have a better understanding of the errors and will solve them more efficiently in the case of rejected flight plans while the flight planning procedures should remain the same.

Deployment is expected to start in 2019 and will gradually integrate Air Navigation Service Providers until 2021.

Video

Extended Flight Plan-2015 validation exercise

2 Initial-4D (i4D)

During the **flight execution phase**, the aircraft downlinks the updated 4D trajectory information that augments the ground trajectory predictions.

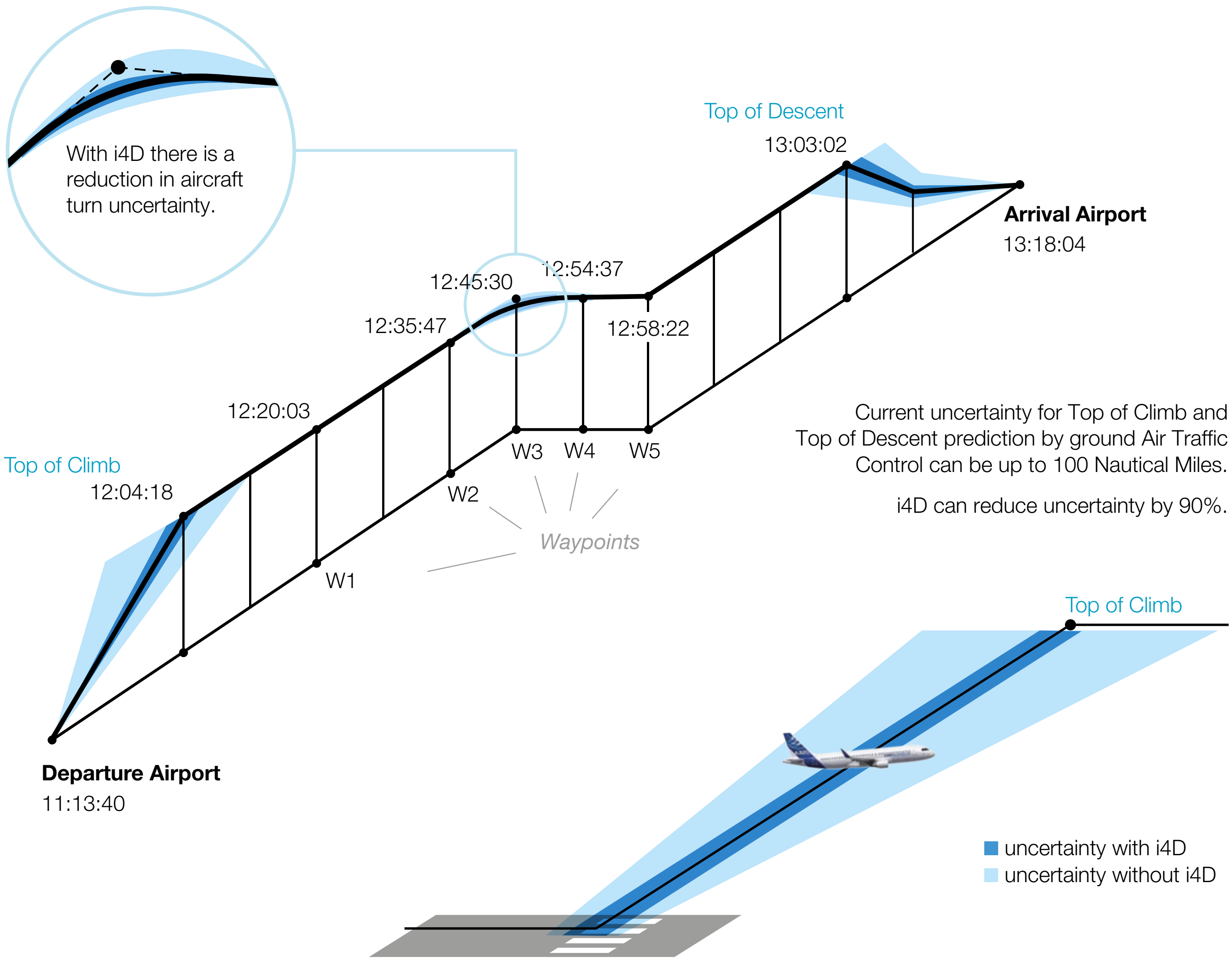
As shown in SESAR i4D demonstrations, the Flight Management System (FMS) provides the most accurate predictions relying on aircraft systems and sensors. This has been recognised in the European Commission mandating the 'initial trajectory information-sharing', i.e. mandating i4D for the airborne and ground segments.

With i4D, the aircraft Flight Management System computes flight trajectory predictions, enhanced with estimates of altitude and time (4D trajectory). These predictions are updated with ATC clearances as the flight progresses and benefit from real-time aircraft data (weight, cost index, actual wind…) specific to each individual flight. Then, these FMS trajectories are sent to ATC using datalink, (through Automatic Dependent Surveillance - Contract (ADS-C)), either on ATC request, or periodically or on event, where they are processed to augment ground trajectory predictions.

The European Commission has mandated the 'Initial Trajectory information sharing'.

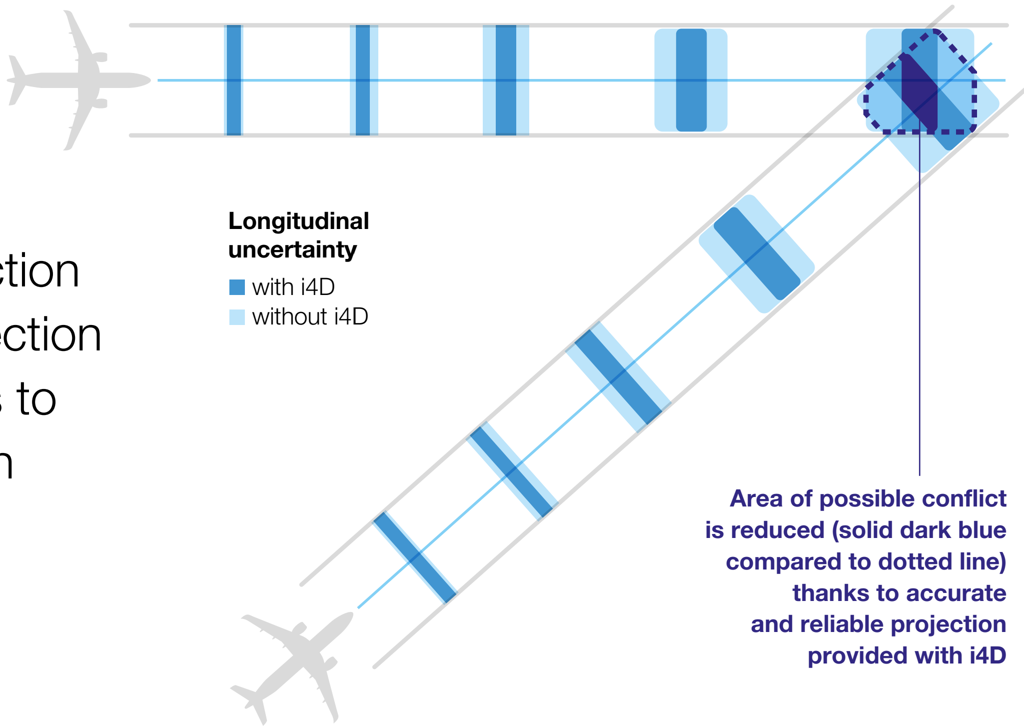
As part of the deployment plan, 45% of flights in Europe will be operated by aircraft fitted with the Initial-4D function in 2025.

By 1st January 2026, ATC systems in Europe will be able to receive and use aircraft 4D trajectory predictions sent via the datalink infrastructure.



Expected benefits:

- Reduction of aircraft delays by using ATC enhanced tools (better aircraft trajectory prediction, enhanced conflict detection…)
- Reduction of fuel burn / CO_2 emissions and noise (flying optimum trajectories including continuous climb and descent operations)
- Increase of capacity due to better predictability of ATC sectors load, enabling a reduction of ATC margins while maintaining safety



Trajectory prediction and conflict detection improved thanks to initial-4D function

Airbus and partners of the European ATM modernisation programme SESAR have been working on the research and prototyping phase of i4D, with initial demonstrations and flight trials performed in 2012 to validate the concept. The next step will be the full validation of the function in a real environment. This will be possible thanks to the very large-scale demonstrations planned in 2018/2019 with commercial revenue aircraft exchanging data with the Air Navigation Services of UK (NATS), Germany (DFS), Italy (ENAV) and Maastricht-controlled area (MUAC). As planned by the SESAR Pilot Common Project, this function will be fully operational in 2025 on nearly half of the European flights.

Outside Europe, Airbus has recently signed a contract with Chinese partners to promote the i4D technology. It is planned that in 2019, a China Southern Airlines A320neo equipped with i4D capable systems will fly in Chinese airspace with an i4D-equipped Air Traffic Control (ATC) centre.

Further cooperation concerning i4D technology is being explored with other ATM world partners.

Using the Initial-4D function to support trajectory-based operations is foreseen as a game changer in Air Traffic Management, with an impact on aircraft systems limited to software upgrade.

Operational benefits will get stronger as the ATC ground systems progressively extend use of data from the flight planning phase to arrival traffic sequencing.

Video

i-4D, Introducing a new dimension of flight

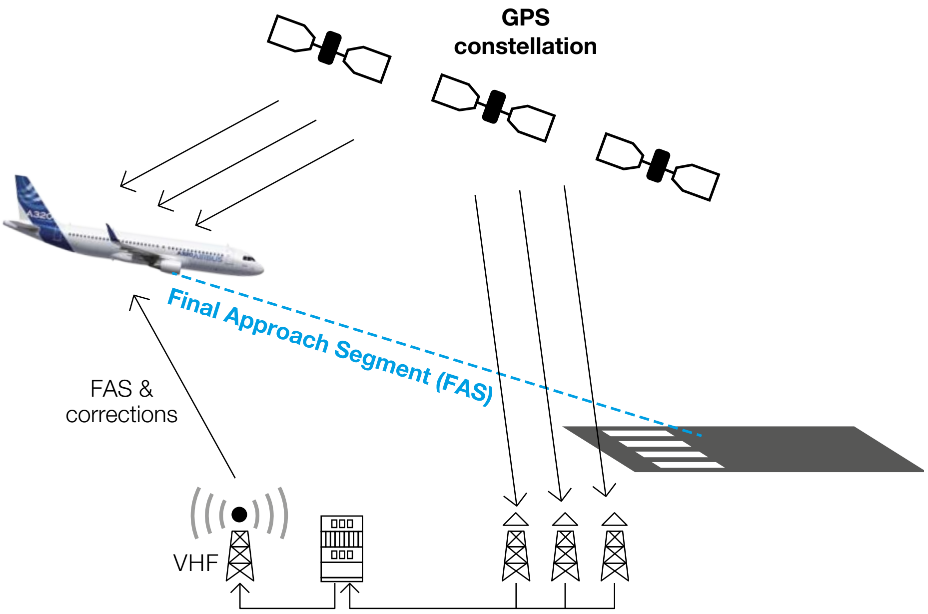
3 Ground Based Augmentation System (GBAS)

The Ground-Based Augmentation System (GBAS) is a safety-critical system that augments the Global Positioning System (GPS) and provides enhanced levels of service that support all phases of approach, landing and departure. GBAS overcomes some Instrument Landing System (ILS) challenges and meets the more demanding needs of the future in a more cost-efficient way.

The function on board Airbus aircraft called GBAS Landing System (GLS) respects an 'ILS look-alike' concept. It means that the pilots fly these approaches with the same type of Human Machine Interface in the cockpit as conventional ILS approaches.

Most Airbus aircraft types have been certified for existing GBAS CAT I operations.

The SESAR programme has validated the development of GBAS to support low visibility operations (so-called CAT II/III).



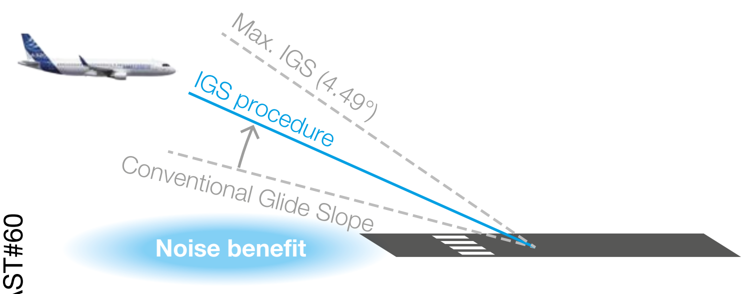
Expected benefits:

- GBAS provides a cost-efficient solution, since only one ground station is needed to service multiple approaches to all runways at an airport and requires less maintenance and flight inspection compared with ILS.
- GBAS-optimised low visibility operations primarily address busy airports which have capacity limitations, as they need smaller protection zones than with ILS.
- GBAS advanced procedures can directly support airports seeking to address noise issues and to use efficient arrival paths.
- With the ILS look-alike concept, no additional flight crew training is required.

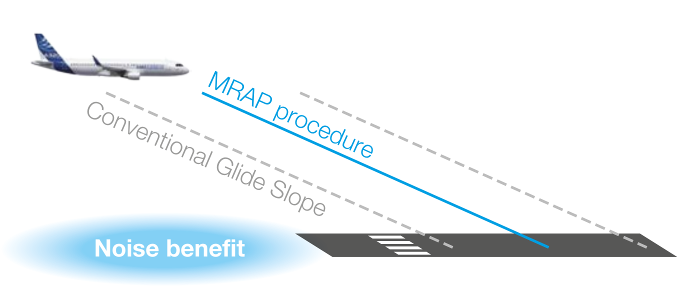
With regard to airports, GBAS advanced operations based on increased glide slopes and Multiple Runway Aiming Points are expected to:

- Reduce runway occupancy times and lower the risk of wake vortex encounter problems, due to displaced runway thresholds
- Increase runway throughput in low visibility conditions and adverse weather conditions by supporting reduced spacing on final approach
- Reduce noise concerns in the vicinity of airports through GBAS increased glide slopes and curved approaches

Increased Glide Slope



Multiple Runway Aiming Points



4 Airport Surface Indicating and Alerting (SURF-IA)

Runway incursions are a major hazard with around 2 occurrences a day in Europe. Most of these events could be avoided by providing flight crews with relevant information to make the right decision in a timely manner.

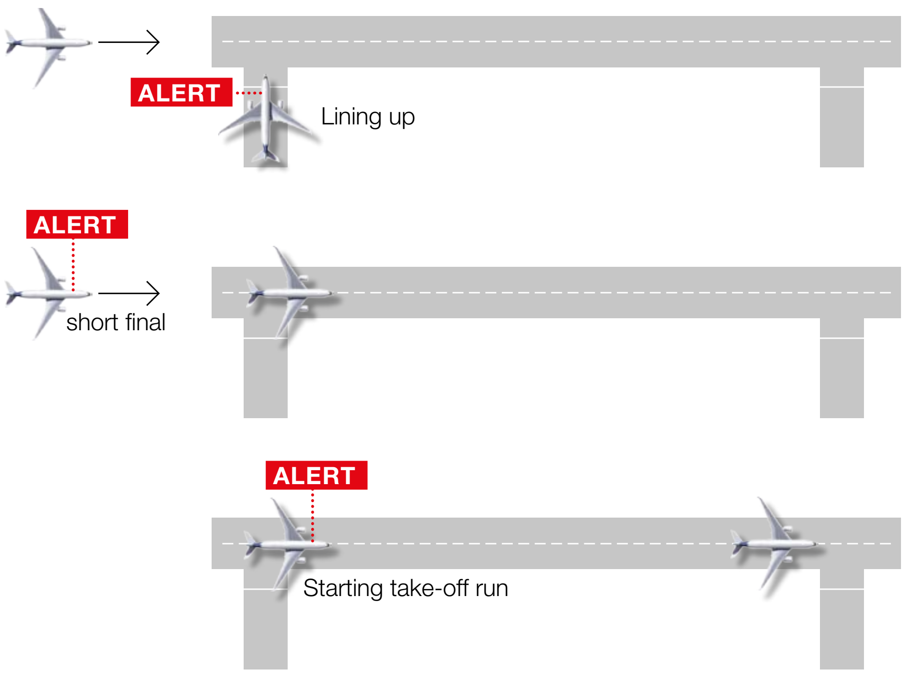
Runway Incursion Traffic Alert is a safety net which provides both an aural alert and an intuitive visual cue in the primary field of view of each pilot. It is visible whatever the situation in the vicinity of the runway.

It requires Automatic Dependent Surveillance-Broadcast (ADS-B) In data (position, ground speed, altitude, direction) from aircraft or other vehicles in the vicinity, as well as airport runway data. No infrastructure or interaction with ground is required.

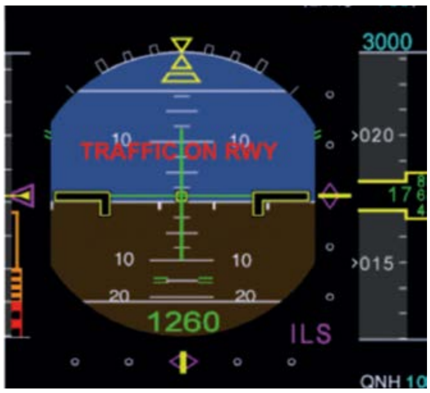
Expected benefits:

SAFETY

- Being primarily designed to prevent high speed collisions with another aircraft or vehicle, Runway Incursion Traffic Alert constitutes a major safety enhancement in surface operations.
- The prevention of situations of collision or quasi-collisions will also contribute to reducing the disruption of operations.



Runway Incursion Traffic Alert is a safety net which provides both an aural alert and an intuitive visual cue in the primary field of view of each pilot.



CONCLUSION

ATM modernisation is underway with key players, including Airbus, actively participating in both research and development programmes around the world and in the industrialisation of new airborne capabilities required by ATM concepts, enabling safer operations in the future.

The overall objective is to accelerate the transition to a performance-based ATM, allowing operators to fly their preferred trajectories. Airbus thereby supports the inclusion of 'Best Equipped Best Served' operational incentives within the new ATM concepts in order to make current ATC practices (such as altitude constraints, holding stacks, tactical vectoring, time and fuel consuming open-loop instructions) the exception.

Airbus is also urging for worldwide interoperability of the new ATM concepts in order to coordinate aircraft development, and enable seamless flight around the world.

RSC traceability

Removable Structural Components

Article by

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Removable Structural Components (RSC) – such as doors, flaps, slats – may be transferred between aircraft, resulting in a different utilisation profile than the airframe on which they were originally installed. Controlling and/or tracking maintenance requirements or limitations associated with these components are essential to ensure continuing airworthiness management.

As the world fleet of aircraft grows and ages, movements of RSCs are increasing. The industry has recognised that more focus on the traceability of RSCs on and off the aircraft must be brought to the attention of operators, MROs (Maintenance, Repair and Overhaul organisations), suppliers and manufacturers to satisfy continuing airworthiness.

Traceability steps in the life cycle of components

Some of these RSCs contribute to the airworthiness of the aircraft. Indeed, they may be subject to mandatory requirements, such as inspections, modifications, repairs or any other limitation (i.e.: Flight Cycles (FC), Flight Hours (FH) or calendar, weighing, etc.).

The life monitoring and control of these structural parts and their instructions for continuing airworthiness is a need, especially when RSCs have been removed from the first aircraft on which they were installed. It ensures that these parts meet their associated mandated requirements and limitations, and ensures safe operation.

Component production

Design

Engineering

Production

Concessions
if required

Data Management

Tech data

Component technical justification and limitations
- Component service goal justifications, maintenance requirements and limitations.

Industrialisation/ production
- Component identification, marking and production tracking.

Management of associated technical documentation
- Technical documentation management adapted to RSCs (AMM, NTM, SB, SRM, ALS...).

Delivery

Component service life

Support

Repairs

Spares & out-of-production parts

Support to operations
- New support or services proposals on demand.

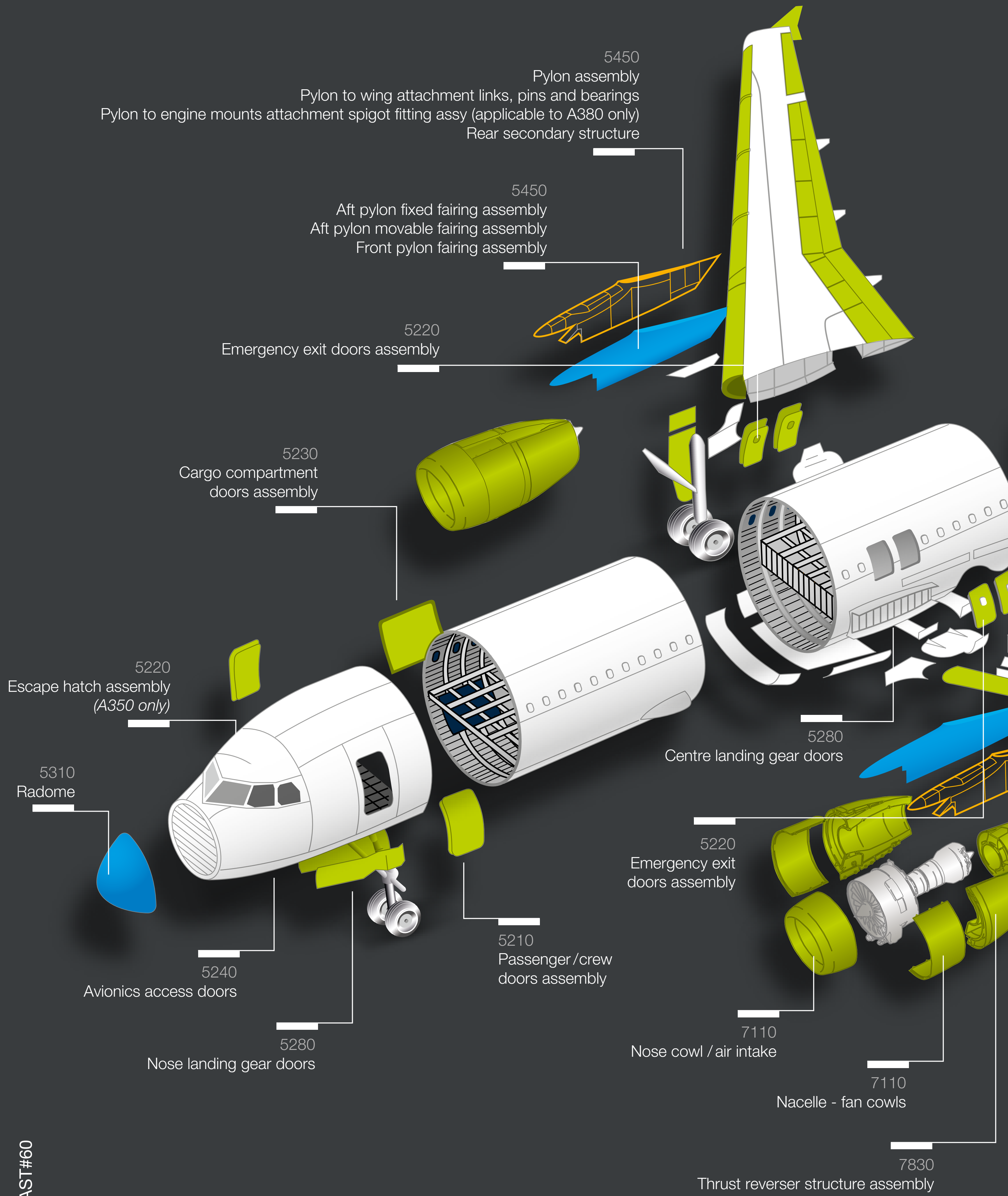
Repairs
- RSC specificities vs Repair limitations considered.

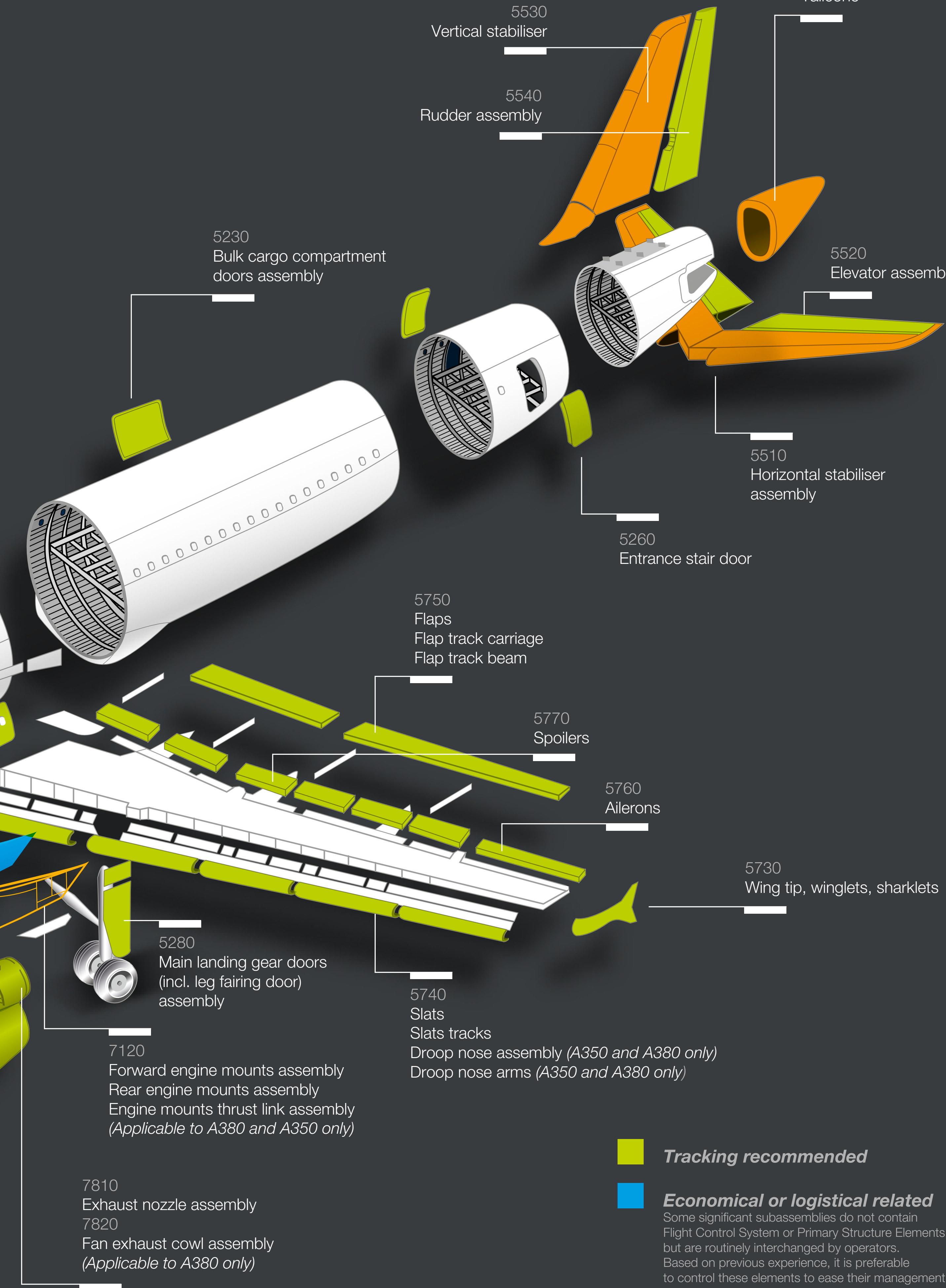
Spares management
- Parts availability and traceability in case of used parts.

ATA

Removable Structural Components

Main RSCs (high level assemblies) that Airbus recommends controlling





Tracking recommended

Economical or logistical related
Some significant subassemblies do not contain
Flight Control System or Primary Structure Elements
but are routinely interchanged by operators.
Based on previous experience, it is preferable
to control these elements to ease their management.

No transfer permitted without Airbus involvement

Current context of continuing airworthiness regulations

In accordance with applicable regulations, the continuing airworthiness record system put in place for each individual aircraft (including components installed) is an operator responsibility.

For example, an operator may control an RSC:

- At aircraft level when RSCs follow the life of the aircraft
- At component level when an RSC follows a different life than the aircraft it was initially installed on

Whatever recording system an operator puts in place, the control of these RSCs is an essential element to meet mandatory maintenance requirements such as inspections or modifications, and/or component limitations such as repairs, service goals or life limits.

Due to different approaches used by airworthiness authorities, both operators and manufacturers have worked together in different industrial forums.

The Airworthiness Assurance Working Group (AAWG) jointly with the Airline for America (A4A)) issued ATA Spec 120 to provide recommendations and guidance to operators.

Mandated limitations (Airworthiness Directive (AD) and Airworthiness Limitation Section (ALS)) are expressed at component level. This implies controlling the component parameters (Flight Cycles, Flight Hours, calendar, etc.) and means the history records of RSCs versus mandated requirements should be continuously maintained.

This was further confirmed by the EASA and FAA representatives who contributed to the development of ATA Spec 120.

An RSC can follow a different life than the aircraft on which it was initially installed

Adapting RSC recording practices

The industry has now recognised that, in order to satisfy continuing airworthiness, more focus on the traceability of RSCs must be brought to the attention of operators, Maintenance Repair and Overhaul organisations, suppliers and manufacturers.

During Airbus structure task groups, as well as regional seminars and symposiums, it was determined that the industry may need to adapt some of its recording practices, especially in the frame of transfers of RSCs.

Airbus therefore launched a comprehensive exercise in order to tackle the main aspects related to the traceability of RSCs, enhance its level of management and anticipate operators' needs for support.

A320 identification plate

New support, communications and deliverables are expected to result from this exercise. For example:

- Airbus has identified the baseline RSC list (high level assemblies) recommended for operator control, i.e.: doors, control surfaces, engine mounts, nacelles. This will be published in the 4th quarter of 2017.
- Several In-Service Information (ISI) documents have been published by Airbus to provide operators with a methodology and guidance to rebuild the life of a component when its history has been partially or totally lost.
- New supports are being developed by Airbus to retrieve component data back to its entry into service.
- The Repair Design Approval Sheet (RDAS) review process on RSCs is being developed by Airbus.
- Airbus is further confirming the robustness of the component tracking chain throughout the production line up to delivery to the customer.

CONCLUSION

The life cycle of a Removable Structural Component can be different from the life cycle of the aircraft on which it was originally installed, which can lead to de-synchronisation of airworthiness checks. The responsibility for the necessary RSC control and tracking is incumbent on the airline, and to this end ATA Spec 120 was recently published to provide guidance to operators.

Airbus has identified the baseline RSC list that is recommended for operator control, has issued In-Service Information to provide operators with a method to rebuild the life of a component, and can offer on-demand specific support.

The recommended baseline list of RSC will be issued via an OIT.

Aquarius

Dealing with water in jet fuel

Ask any airline and they will say that the drainage of water in their fuel tanks is one of the most costly maintenance burdens they face.

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Why is water drainage a costly maintenance burden?

- The aircraft is cold on landing and any free water* in the fuel tanks will be frozen. Consequently, it cannot be drained until it has thawed. This increases aircraft downtime, often overnight, in a heated hangar or using heating blankets or other heat sources to accelerate the thawing process. Apron and hangar space is very much in demand and costly.
- Drainage of water results in small quantities of a fuel-water mixture that has to be disposed of by suitable means, which can be quite expensive.
- Whilst the aircraft is on the ground, it is not in the sky earning money! Consequently anything that can reduce the cost of draining water or increase the time between events is welcomed by airlines.
- Water can also lead to unwanted substances such as microbiological contamination, which can require maintenance with biocides or even deep cleaning.

* The term free water is used to contrast with tiny proportion of water that has been dissolved into the fuel.

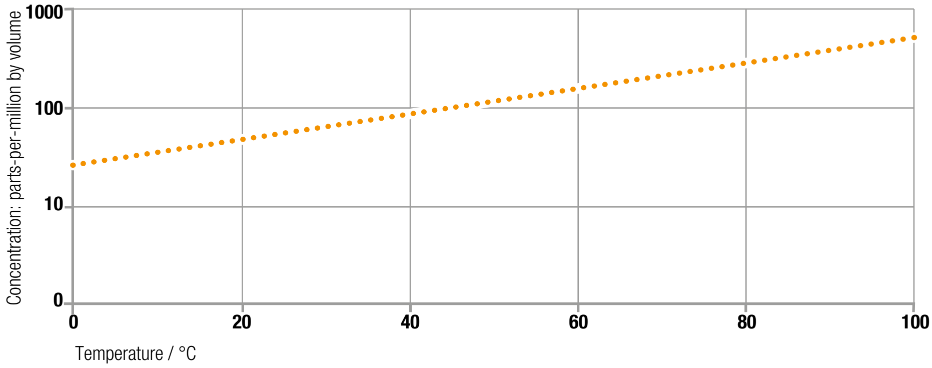
Some aircraft need draining more frequently than others, as specified in the AMM or agreed with the airline's local airworthiness organisation, dependent on the environment of routes and fuel quality. It is possible to extend this interval if evidence can be given to show that alternative means have been utilised.

Where does water come from?

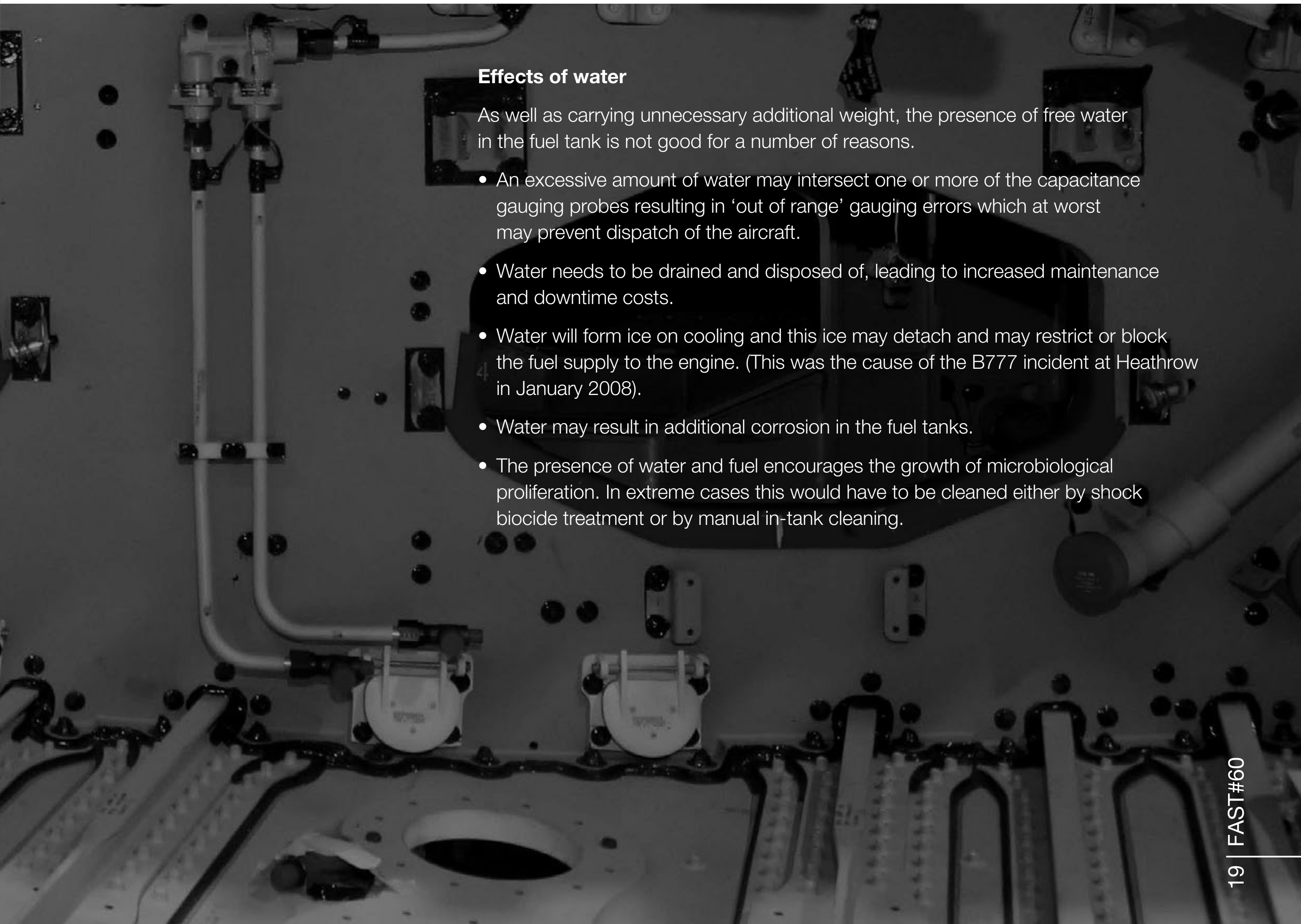
Water enters the aircraft tanks in two ways:

- **With the uplifted fuel.** Filter water separators or filter monitors will reduce the free water to low levels but the supplied fuel will contain dissolved water. In hot climates this could be up to 100 parts-per-million (ppm). But as the ambient temperature reduces in flight, the dissolved water will separate from the fuel-water solution and become free water.

Water solubility in jet fuel



- **In-breathing.** As the aircraft ascends, the pressure will decrease and the vapours above the fuel in the tank will be expelled. As the fuel level decreases, the volume above the fuel will be replaced by air, and as the aircraft descends, more air will enter to fill the tank due to the reduced volume of vapours at the increased pressure. Since this will usually involve descending through clouds, the air will be very humid resulting in condensation and freezing on the cold surfaces inside the tank. On thawing, this ice will add to the free water at the bottom of the tank.



Effects of water

As well as carrying unnecessary additional weight, the presence of free water in the fuel tank is not good for a number of reasons.

- An excessive amount of water may intersect one or more of the capacitance gauging probes resulting in ‘out of range’ gauging errors which at worst may prevent dispatch of the aircraft.
- Water needs to be drained and disposed of, leading to increased maintenance and downtime costs.
- Water will form ice on cooling and this ice may detach and may restrict or block the fuel supply to the engine. (This was the cause of the B777 incident at Heathrow in January 2008).
- Water may result in additional corrosion in the fuel tanks.
- The presence of water and fuel encourages the growth of microbiological proliferation. In extreme cases this would have to be cleaned either by shock biocide treatment or by manual in-tank cleaning.

The solution: Kerojet® Aquarius additive

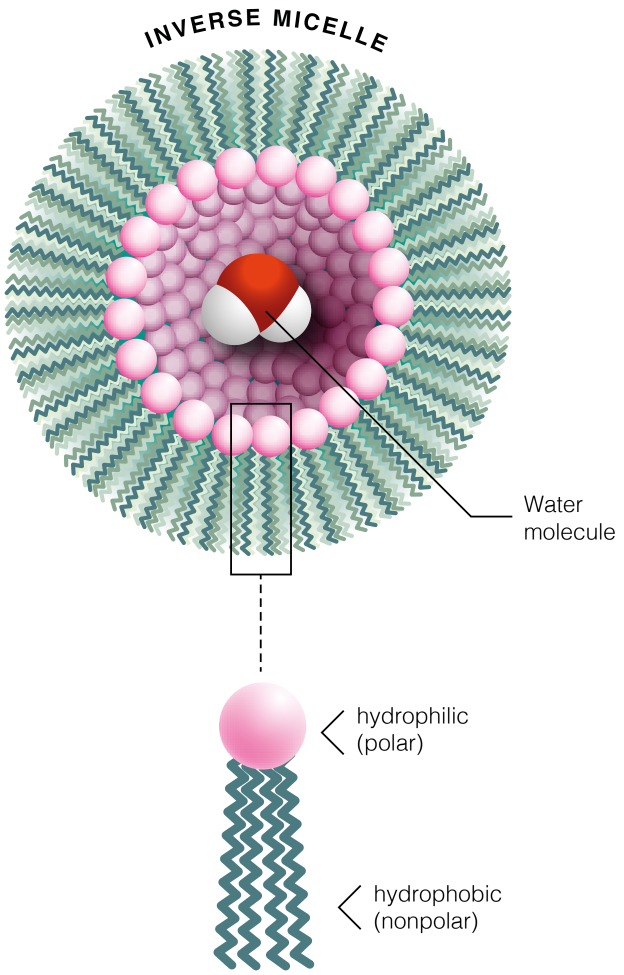
Many aircraft are equipped with low-level suction pickups that scavenge free water and feed it with the fuel to the engine but there is still a residual amount of water to be dealt with.

Aquarius is an additive that has been developed to sequester the free water into the fuel.

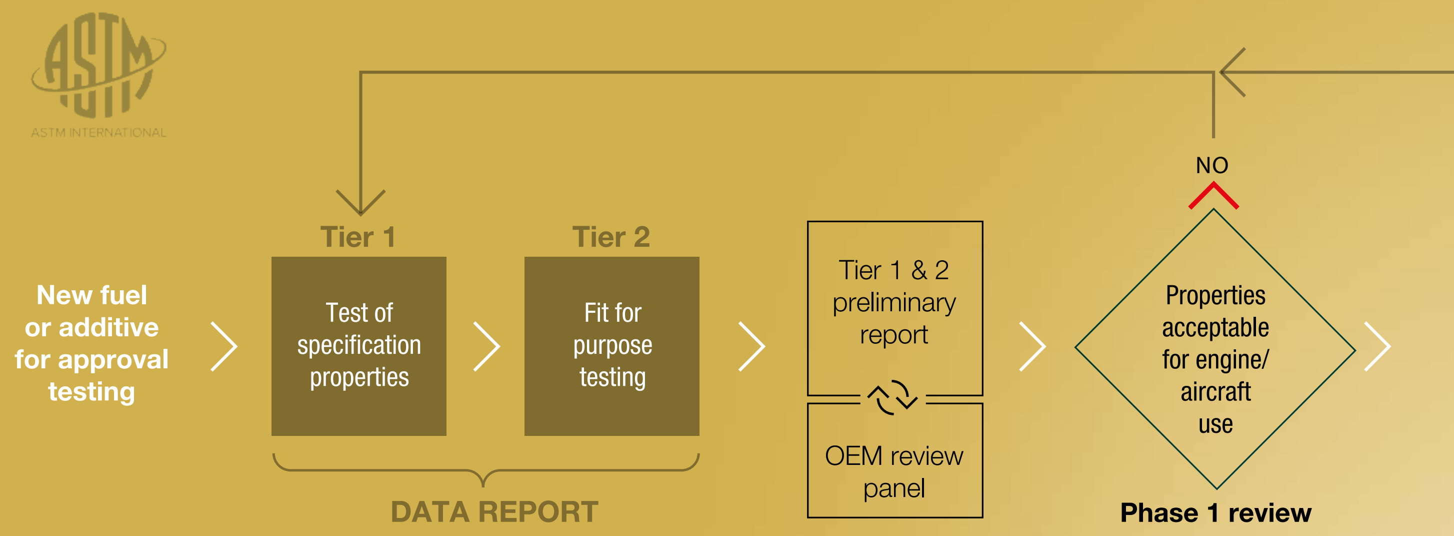
How does Aquarius work?

Aquarius binds the water molecule into the fuel using a 'micelle' (or molecular cage) rendering the water molecule physically inert.

Kerojet® Aquarius will maintain the solubility of the dissolved water in the aircraft fuel tanks down to the fuel's freeze point.
In addition, the Aquarius micelle cannot bind salts, bacteria or other contaminants that might usually be found in the water with the fuel, only the water molecule itself. The normal dose rate of Kerojet® Aquarius is 250ppm by volume and, depending on the type of fuel, temperature and humidity levels can increase the solubility of water to around 230ppm which is sufficient to handle the in-breathed moisture even at low tank levels.



ASTM D4054 Industry Fuel & Additive 'clearing process'



Note: Additives can also require specific equipment approval through each OEM (not shown)

Route to Approval of Kerojet® Aquarius

Aquarius was invented by Palox Ltd and has been licensed to BASF, one of the world's leading chemical companies. Palox have invested heavily in the testing required by the American Society for Testing & Materials (ASTM) D4054 process. This testing includes the usual D1655 specification properties (density, viscosity, etc.) and D4054 Fit-for-purpose properties. In addition several tests have been carried out on engines and Airbus has carried out extensive testing looking at the accretion of ice in cold fuel. Additionally Airbus has carried out a confidence flight using A340-600 flight test aircraft MSN360 to verify the calculations and rig test observations.

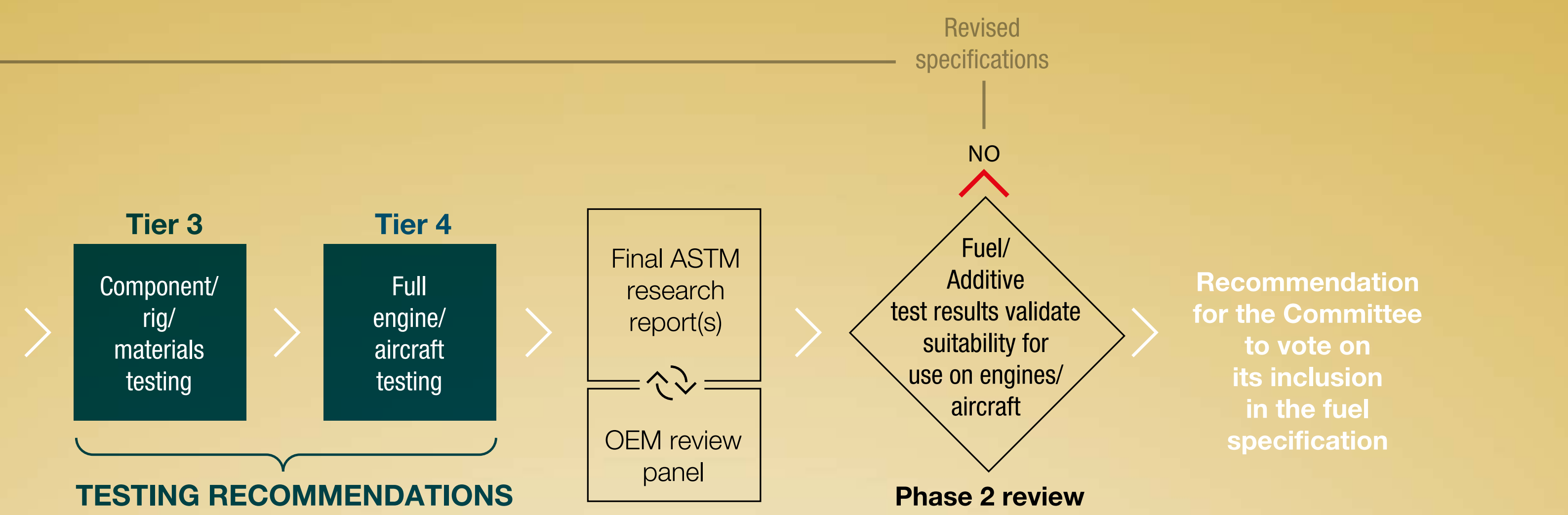
The Airbus Corporate Innovation team has encouraged the development of Aquarius since 2014, putting in place a Technical Co-operation Agreement to enable BASF and Palox (the inventor) to submit Kerojet® Aquarius to the ASTM for approval as an additive for jet fuel. Airbus has continued to support this project as it has progressed through the various milestones and as new unforeseen requirements have emerged. The project is now in its final stages with ASTM approval and an anticipated final incorporation into the list of approved additives by early 2018.

Kerojet® Aquarius is at the stage where all Original Equipment Manufacturers (including Airbus, Boeing, Rolls Royce, Pratt & Whitney, GE and Honeywell), should read the D4054 research report summarising the results of all the test work and then vote whether or not Aquarius should be included in the D1655 specification. Currently, the OEMs are reviewing the report and submitting any questions/ comments. An ASTM subcommittee will then vote on approving the additive. If this ballot is successful, a larger subcommittee will ballot its inclusion in the specification. These ballots are anticipated before end of 2017.

BASF plan to introduce Kerojet® Aquarius to the market in a phased approach, starting with an in-service evaluation with Lufthansa to confirm the performance of the additive and optimise the dosing equipment.

Aquarius will be metered into the fuel at refuel hence each airport served will require dosing equipment. BASF and Faudi* have developed a trailer-mounted dosing skid which interfaces with the refuel bowser to ensure that the Kerojet® Aquarius is dosed at the correct concentration.

*Dosing equipment manufacturer



What has been Airbus's role?

Airbus was engaged in 2014 to investigate the effect of Aquarius on the threat of ice forming - a certification requirement following the B777 incident at Heathrow in 2008 - and any other fuel system level effects to support BASF conducting an in-service evaluation and to support the ASTM process for approval of the additive.

Airbus was able to use its A330/A340 engine feed test rig at the fuel test facility at Airbus, UK. This is an actual size replica of ribs 1-4 of an A330 wing and features genuine A330 feed pumps. However, it is fabricated from steel and equipped with cooling facilities to allow its use under vacuum, simulating elevation up to 43,000 feet and temperatures down to and beyond -40°C.

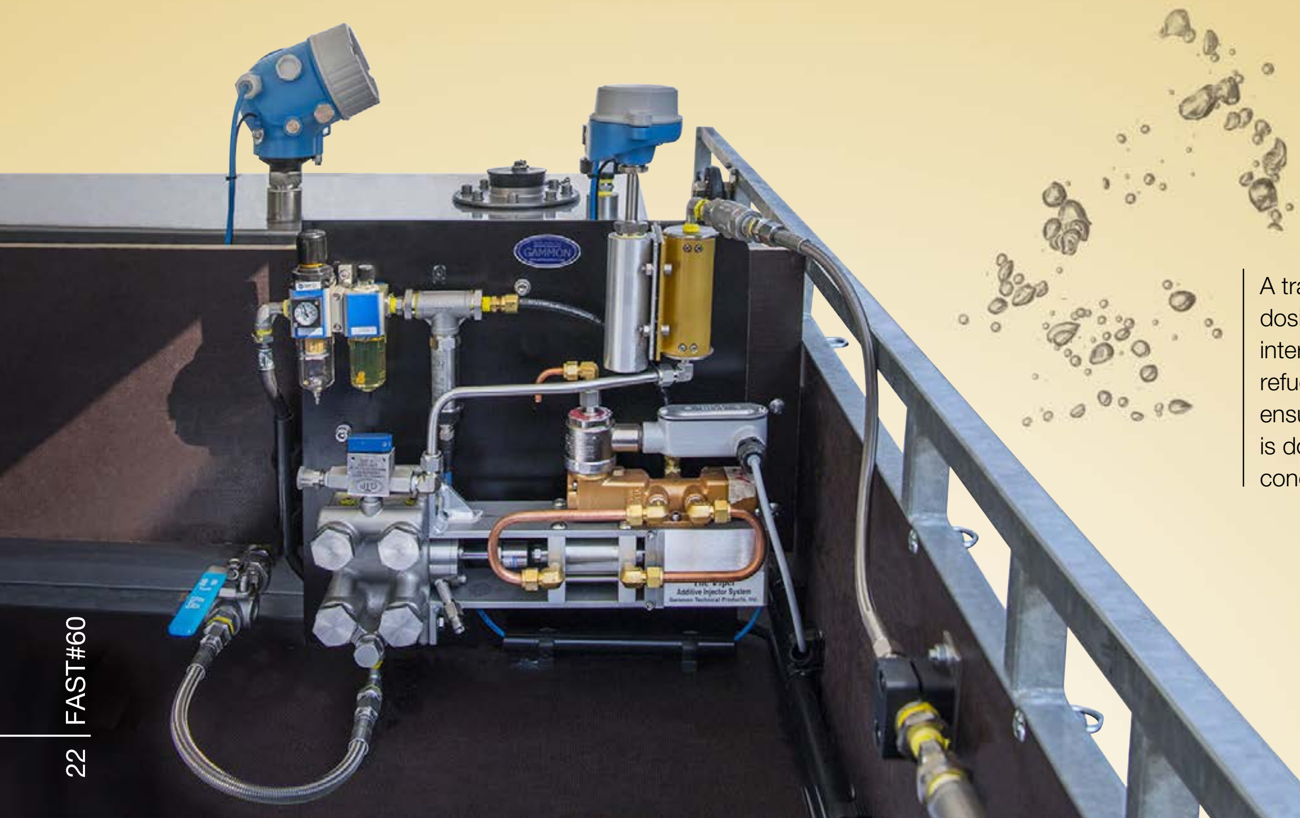
Several test runs were carried out using different concentrations of Aquarius and water to simulate various operating conditions following temperature profiles typical of long haul flights. It became clear that the use of Aquarius significantly improved the ice threat reducing the amount of ice deposited on the cold surfaces - the increased amount of water remained in solution rather than precipitating out as would occur without the use of Aquarius.

Whilst there was little doubt that Aquarius would not increase the threat of ice formation, a remark by one of the rig operators, plus the observance of some white emulsions, led to further investigation.

The operator, who had run many ice tests on this same test rig following the Heathrow crash, noted that the rig was much cleaner and suggested that the surfactant* nature of Aquarius had cleaned the test rig! Likewise, the formation of the emulsion was initially thought also to be a result of the surfactancy*. This led to much further laboratory work which showed that the emulsion formation was a result of the test method – at the end of the test most of the fuel and any liquid water is drained off and then any deposited ice is allowed to thaw, resulting in a mixture which is excessively high in water content. Laboratory tests have proved that this accumulation of emulsion only occurred in a radically out-of-balance mixture which is excessively high in water, of the order of 50% water, which would never happen in-service. In flight, the water content is unlikely to exceed 250ppm (0.025%). In addition, measurements of the key transport properties of the emulsion have shown that they are no different to that of fuel or water.

*Also called: surface-active agent, a substance such as a detergent, that can reduce the surface tension of a liquid and thus allow it to foam or penetrate solids; a wetting agent.

The remark about the cleaning of the test rig also needed investigation. Palox Ltd showed by theory that Aquarius could not act as a cleaning fluid. The rig operator explained that in previous campaigns the test rig needed cleaning every 5 or 6 tests due to build-up of microbial contamination and other interfacial debris due to the presence of free water. In the case of the Aquarius tests, the rig started and remained clean throughout the programme. This supported the observation that the use of Kerojet® Aquarius reduces the likelihood of microbial growth.



A trailer-mounted dosing skid which interfaces with the refuel bowser to ensure that Aquarius is dosed at the correct concentration.

Flight evaluation

The original plan was to perform the in-service evaluation with Lufthansa using two A340-600 over a 6-month period of revenue service. However, in order to achieve this, airframe, equipment and engine suppliers would have to undertake a risk assessment and give clearance.

As a result of their own previous engine tests and hearing of the cleaning effect/ emulsions, the engine manufacturer required more evidence to support revenue flights with an unapproved additive. Consequently it was agreed to undertake some flight testing using an Airbus flight test aircraft, MSN360 rather than revenue flights - these will follow after ASTM approval.

A series of ground tests were carried out using Aquarius at four times the normal dosage to investigate the possible cleaning effect. There was concern that the Aquarius dosed fuel would release any dirt and debris that may have accumulated in the aircraft fuel tanks. An internal inspection was carried out before and after the circulation and ground engine runs (Rejected Take Off tests). One wing was fuelled with Jet A-1 dosed with Aquarius while the remaining wing's fuel did not contain the additive. Samples were taken from the water drain valves for laboratory analysis and particle counting. Since no increase in contamination was observed from the particle counting (dirt etc), a test flight was carried out over a 3-hour period. This featured the routine tests carried out in all flight test programmes (such as engine relight and gravity flow tests*). No difference was detected between the dosed and un-dosed wings. A final internal inspection showed no evidence of cleaning or of the formation of lasting emulsions. It was agreed that the flight test demonstrated that the concerns over cleaning and emulsion formation were unfounded.

A bonus from the flight test

BASF/Faudi took their dosing equipment to Airbus, France and were able to identify some minor improvements before going to a commercial operation with a flight test using the Aquarius dosed fuel.

*__Engine relite__, routine procedure carried out in flight test programmes involves switching off one of the engines in mid-air and switching it on again.

Gravity flow tests check the flow of fuel without pump at different altitudes and angles

CONCLUSION

Water in fuel tanks is a regular and costly maintenance burden for airlines. On freezing at altitude, this can even become a safety issue.

A new jet fuel additive named Kerojet® Aquarius is being developed that allows free water at the bottom of fuel tanks to be absorbed by the fuel, then expelled through the engines.

Aquarius has performed well on a test rig and in full engine/aircraft testing. The research report is now being analysed by OEMs before a final ballot. If the ballot goes through, Airbus and engine/APU suppliers would then be able to add Aquarius to the Consumable Materials List (CML) before using it on aircraft.

eQRH making the paperless cockpit a reality

electronic Quick Reference Handbook

Pilots used to be seen carrying a heavy flight bag on board each time they flew. Then came digital transformation which drastically reduced technical documentation and changed their ways of working.

Today, the last step of digital transformation has been reached with the introduction of the electronic QRH (eQRH) in the cockpit.

Article by

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Why go digital?

To appreciate the main advantages of digital documentation over paper documentation, consider how a simple update to the Flight Operations manuals used to be done.

Before digitalisation, Airbus used to print, prepare, and ship tons of paper documents at each update of the Flight Operations manuals and for each Airbus aircraft. The airline had to receive, prepare and update this paper documentation on each operated aircraft, for potentially hundreds of aircraft and thousands of pilots. Compare this laborious, costly, and risk-ridden method to the automated, instant, free, digital updates sent to the Electronic Flight Bag (EFB). And updates are only the beginning of the advantages of digitalisation; cockpit operations are also significantly enhanced: searching is instant rather than having to thumb through hundreds of pages, and hyperlinks direct pilots to relevant sections. Information is now given on a need-to-know basis.

Timeline of paperless cockpit operation on Airbus aircraft

Moving standards from paper to digital across the fleet

Digitalisation of Flight Operations documentation is being adopted across all Airbus families, the more recent families having already integrated it from the start.

Back in the 1980s, A320 and A330/A340 families were initially designed with a Flight Operations standard based on the use of paper documentation. Then, in the 1990s, Airbus started the transformation of most of this paper documentation into an electronic format.

In 2005, Airbus implemented a new standard of Flight Operations on the A380. This standard was based on the use of electronic devices, namely EFB and ECAM (explained below) to compute aircraft performance, browse operational documentation and manage the flight. The A380 Flight Operations standard enhanced the cockpit Flight Operations and enabled significant cost savings in the management of the Flight Operations documentation. This same standard was then adopted for the Airbus A400M and A350.

More recently, Airbus has introduced further enhancements to the A320 and A330/A340 families' electronic documentation to be closer to the A380 and A350 standard. In fact, until end of 2016, most of the operational documentation of the A320 and A330/A340 families could be displayed and used on an Electronic Flight Bag (EFB). However, one operational document remained in paper format: The Quick Reference Handbook (QRH).

The flight crews use this document to check aircraft operations in normal situations. They also use it to manage some abnormal situations that are not monitored by the Electronic Centralised Aircraft Monitoring (ECAM).

In order to implement a paperless operational standard on A320 and A330/A340 families, with full electronic documentation, the QRH can now be managed in a new EFB application: The **electronic Quick Reference Handbook (eQRH).**

Flight Operations standards on A350 and A380

The Flight Operations standard on the A350 and A380 is based on the use of electronic devices in the cockpit, instead of paper, as follows:

- The Electronic Flight Bag (EFB) provides the flight crew with:
  - Performance applications to compute the aircraft loadsheet and performance in take-off, cruise and landing
  - A browser to access the Flight Operations documentation, e.g. Flight Crew Operating Manual (FCOM), Flight Crew Techniques Manual (FCTM), Minimum Equipment List (MEL)
  - Mission data, e.g. flight plan, navigation charts, flight folder
- The checklists and procedures are managed on an avionic system: the ECAM. This system displays to the flight crew the normal checklists and abnormal/emergency procedures. The flight crew can interact with this system in order to manage these checklists and procedures. The ECAM system is part of the aircraft definition and is therefore part of the aircraft certification.

A slim paper Quick Reference Handbook (QRH) is used for a very limited number of critical or specific procedures such as smoke-related procedures and emergency evacuation.

The use of an EFB on A350 and A380 provides significant benefits in the cockpit operations and in the management of Flight Operations documentation. The flight crew benefits from many smart features, such as:

- Enhanced documentation consultation thanks to the search function, the contextual access, the interactive display, the use of hyperlinks, coloured and more comprehensive illustrations, bookmarks, etc.
- Integration of the EFB applications. For example, in case of an aircraft system failure, the performance applications can automatically take into account the corresponding performance penalties and provide the crew with the relevant performance computation for the take-off, cruise and landing.

Not only the flight crew on board the aircraft benefit from this new standard of operations, but it also provides significant savings to the airlines in terms of time, logistics and cost to manage the documentation.

The documentation updates are provided on the AirbusWorld portal and the operators can customise this documentation thanks to comprehensive electronic tools such as ADOC or FODM. Finally, the electronic documentation can be dispatched wirelessly to the flight crew tablets/laptops or to the aircraft. This electronic process replaces paper printing, thus reducing the preparation and distribution costs, and enhancing the ecological footprint of Airbus and operators.

Initial Flight Operations standard on A320, A330/A340 families

A320 and A330/A340 families were initially designed with a Flight Operations standard based on the use of paper documentation. Then, as laptops and tablets became standard in the 1990s and 2000s, most of the Flight Operations data was transformed from printed manuals to electronic operational documentation in Airbus' pioneering EFB product: the Less Paper Cockpit (LPC). This first step of digitalisation included:

- Loadsheet computation
- Take-off and landing performance computation
- The Flight Crew Operating Manual (FCOM) and the Master Minimum Equipment List (MMEL) in an electronic format

Finally, after the development of eDOC concept (XML data) on A380 in the 2000s, Airbus generalised this concept on A320 and A330/A340 families with the 'Less Paper Cockpit - New Generation' (LPC-NG) and later with 'FlySmart with Airbus' on Windows and iPad. These Airbus EFB products brought the Flight Operations standard on A320 and A330/A340 families closer to the A350 and A380. However, the management of the checklists and non-ECAM procedures remained in paper format inside the QRH.

New Flight Operations Standard on A320, A330/A340 families

Airbus then launched a study in 2015 to digitalise the A320 and A330/A340 QRH, being the last paper document onboard these aircraft. The ambition was to get rid of the paper QRH and to provide flight crew with a smart way to electronically manage checklists and procedures, with two main objectives:

- Enhance cockpit operations compared to the paper QRH
- Alleviate the process for the operators to manage the QRH document

The ECAM of the A320 and A330/A340 families could not be upgraded in the short or mid-term to replace the paper QRH as the ECAM is a certified system with a long development cycle inherent to avionics systems. In addition, the current A320 and A330/A340 ECAM technologies are not compatible with such an industrial step. The solution was therefore to replace the paper QRH operations in the cockpit by an EFB application.

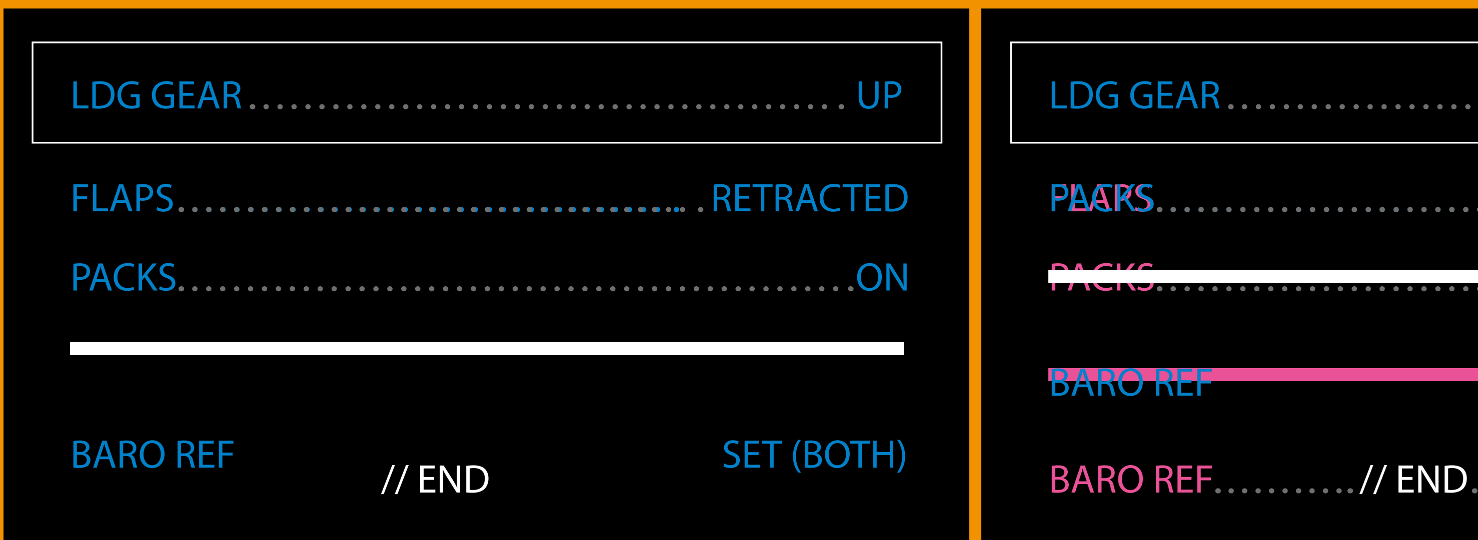
Airbus developed a demonstrator for iPad tablets to assess the feasibility of the concept. Thorough testing was conducted by flight test and training expert pilots, Human Factors experts and flight operations engineers. The European and American aviation authorities (EASA & FAA) were also involved in this assessment to ensure alignment from a regulation standpoint.

These assessments, evaluations and discussions with the aviation authorities were conclusive and resulted in the launch of the definition of a new Flight Operations concept on A320 and A330/A340 families: a cockpit with no paper. This new concept is based on the following:

- As on the A350 and A380, the FlySmart applications are used by the flight crew:
  - To compute the aircraft loadsheet and performance in all the flight phases (take-off, cruise, and landing)
  - To access the Flight Operations documentation (FCOM, FCTM, MEL, etc.)
  - To manage the mission (flight plan, navigation charts, flight folder)
- The EFB includes a new application that enables the electronic management of the checklists and non-ECAM procedures: the electronic QRH (eQRH).

The ambition was to define and validate the first concept of paperless cockpit (no paper) operations worldwide: the eQRH was on its way.

Double-layer display mechanism In a normal operation (left), both the main layer and secondary layer are perfectly aligned, whereas spurious loss of data or spurious errors result in a misalignment of displayed data that is easily detectable by the flight crew. The error to the right illustrates the loss of one challenge/response line in the 'main layer'.



Normal operation display

How the eQRH concept was developed

Challenges and objectives of the eQRH concept:

- Developing the eQRH concept presented a few serious challenges:
  - *Regulation aspects:* A specific assessment had to be performed to demonstrate to the EASA and the FAA that the eQRH met the requirements of the applicable regulation. The main objective was to demonstrate that the eQRH operations were at least equivalent to paper QRH operations in terms of ‘reliability, accessibility, and usability’ (EASA AMC 20-25 and FAA AC 120-76 C requirements).
  - *Specific cockpit operations for the eQRH compared to other EFB applications:* Most of the EFB operations rely on the use of the applications by both flight crew members and on the crosscheck to ensure a high reliability of the displayed information and results. The Standard Operating Procedures (SOP) of Airbus define two roles in the cockpit: the Pilot Flying (PF) who is in charge of flying the aircraft, and the Pilot Monitoring (PM) who is in charge of actively monitoring the flight parameters.
    The QRH operation is therefore based on a single pilot use: the Pilot Monitoring (PM) reads the procedures and checklists in the QRH while the Pilot Flying (PF) either checks the aircraft status or performs the requested actions.
    This specific method of operation means that the eQRH cannot rely on crosschecks to ensure the reliability of the displayed information. This operational constraint required a solution to ensure a high level of reliability of the displayed information.
  - *QRH content:* This was adapted to paper operations and part of it was therefore not fully compatible with electronic display and operations.
- The eQRH had to respond to the following objectives:
  - Enhance cockpit operations thanks to electronic devices and ensure commonality of operations on all Airbus aircraft families
  - Ease the management of QRH updates without affecting savings.
    Therefore, the eQRH had to be compatible with the existing ground administration and update tools of the EFB
  - Avoid printing and shipping tons of paper every year

Finding the solution

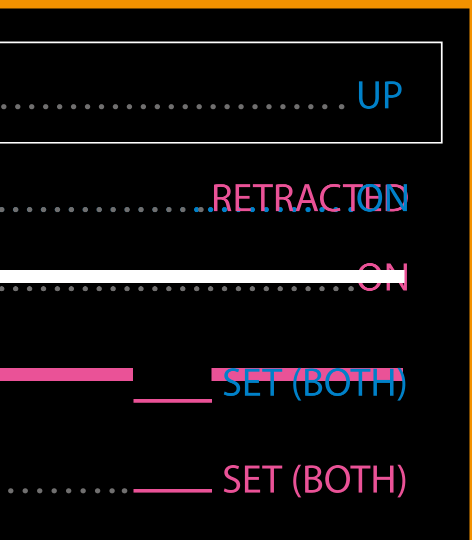
To achieve these objectives, and to meet the challenges, the eQRH implements some new, innovative and smart features. For example, the eQRH includes the following:

Reliability of the displayed information

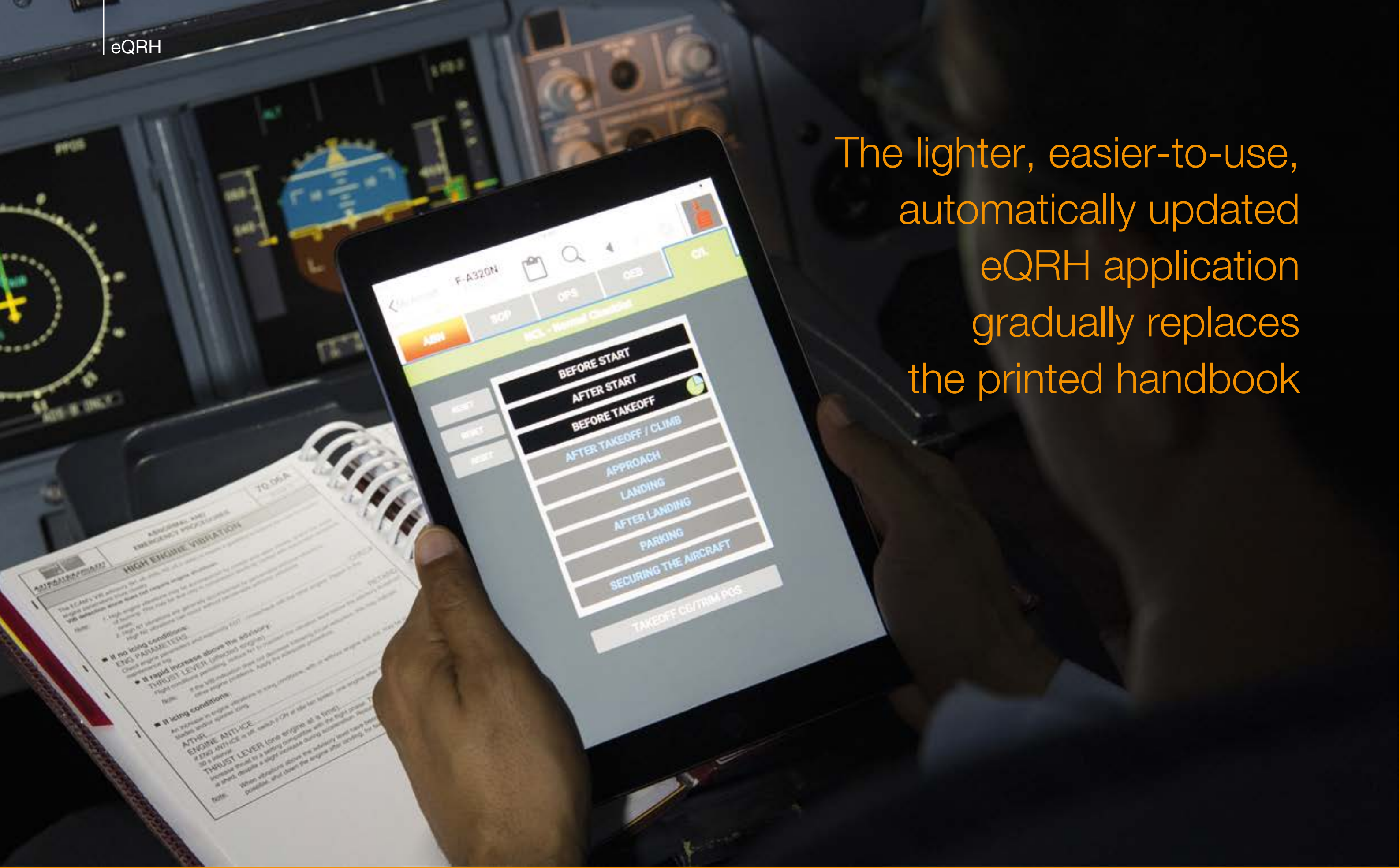
The eQRH display is based on a double-layer mechanism that enables the crew to detect spurious erroneous display of the data. In normal operations, both layers are displayed but only the main layer is visible to the crew. The secondary layer is perfectly hidden behind this main layer.

Airbus demonstrated that spurious loss of data or spurious errors in the displayed data cannot coherently impact both layers. A shift between the two layers is easily detectable by the flight crew in this case and pilots are trained to use backup means (e.g. opposite pilot device or additional device in the cockpit) to continue the flight.

Airbus submitted a patent on this mechanism.



Spurious erroneous display



The lighter, easier-to-use, automatically updated eQRH application gradually replaces the printed handbook

Airbus aircraft commonality

The eQRH benefits from the design of the A350 and A380 ECAM. Whenever applicable, the eQRH implements the same display, colour coding, and logics as the A350 and A380 ECAM. It remains also consistent with the A320 and A330/A340 ECAM. The eQRH is therefore fully in line with the Airbus cockpit philosophy.

New display features to ease operations

Some smart display features are included in the eQRH application, such as:

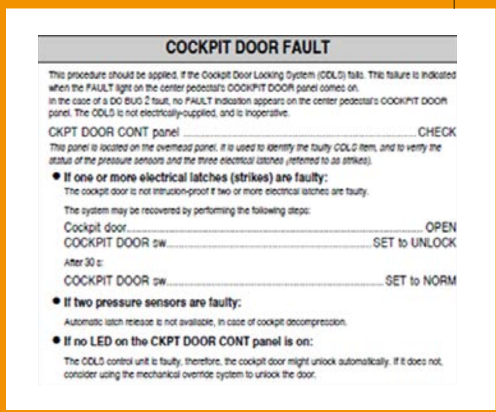
- The smart search function that displays only the procedures or checklists that contain the searched word in their title.
- The shaded display of non-applicable exclusive conditions.

The QRH content was also reviewed for the A320 and A330/A340 families to make it fully compatible with electronic display and operations. The objective was to keep only the 'need to know' information and to have an ECAM-like layout in the eQRH.

For example:

- The explanations that are not required for an immediate execution of the procedures were removed. This information is kept in the FCOM/FCTM for the crew to understand the procedural steps and intent, if necessary and when time permits.
- The classification of the abnormal chapter of the QRH was reviewed to reference aircraft systems rather than ATA chapters. This provides more pilot-oriented information.
- The performance section was set as applicable to paper QRH only. As the eQRH is meant to be associated with electronic performance computation, this section is therefore not displayed by the eQRH.
- Hyperlinks were added in the procedures where reference to another procedure or operational data is provided.

From paper to electronic



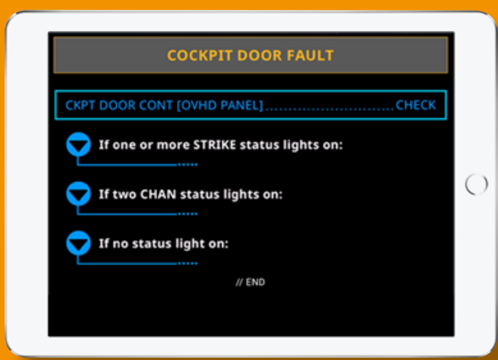
COCKPIT DOOR FAULT

This procedure should be applied, if the Cockpit Door Locking System (CDLS) fails. This failure is indicated when the FAULT light on the center pedestal's COCKPIT DOOR panel comes on.
In the case of a DC BUS 2 fault, no FAULT indication appears on the center pedestal's COCKPIT DOOR panel. The CDLS is not electrically-supplied, and is inoperative.

CKPT DOOR CONT panel .... CHECK

This panel is located on the overhead panel. It is used to identify the faulty CDLS item, and to verify the status of the pressure sensors and the three electrical latches (referred to as strikes).

- **If one or more electrical latches (strikes) are faulty:**
  The cockpit door is not intrusion-proof if two or more electrical latches are faulty.
  The system may be recovered by performing the following steps:
  Cockpit door .... OPEN
  COCKPIT DOOR sw .... SET to UNLOCK
  After 30 s:
  COCKPIT DOOR sw .... SET to NORM
- **If two pressure sensors are faulty:**
  Automatic latch release is not available, in case of cockpit decompression.
- **If no LED on the CKPT DOOR CONT panel is on:**
  The CDLS control unit is faulty, therefore, the cockpit door might unlock automatically. If it does not, consider using the mechanical override system to unlock the door.



Accessibility

A rapid access mechanism is always displayed to the flight crew to enable quick access to some critical procedures like the Emergency Evacuation.

This mechanism demonstrates to the aviation authorities that the access to these specific procedures is even faster than in paper operations.

The eQRH application and content went through extensive evaluations and validations, with Airbus flight test pilots, Training expert pilots and Human Factors experts, in order to ensure a mature, operational and user-centric concept of operations.

In addition, Airbus involved end-users from four airlines in the development of the eQRH: Brussels Airlines, easyJet, South African Airways and Smart Lynx Airlines. These airlines provided Airbus with very useful feedback that was taken into account in the eQRH application.

Finally, the eQRH was evaluated by the European (EASA) and the American (FAA) aviation authorities. Early 2017, both authorities provided their status of satisfaction, respectively in the EASA Operational Evaluation Board (OEB) Report and in the FAA Operational Suitability Letters (OSL). Airbus also validated the eQRH application with the Civil Aviation Administration of China (CAAC). Having received validation by the aviation authorities, eQRH has been available since March 2017 and has already been delivered to over 90 customers so far.

Link to the EASA OEB report

*GLOSSARY

ECAM - Electronic Centralised Aircraft Monitoring

EFB - Electronic Flight Bag

eQRH - electronic Quick Reference Handbook

FCOM - Flight Crew Operating Manual

FCTM - Flight Crew Techniques Manual

FODM - Flight Ops Documentation Manager

LPC - Less Paper Cockpit

LPC-NG - Less Paper Cockpit – New Generation

MEL - Minimum Equipment List

OEB - Operational Evaluation Board

OSL - Operational Suitability Letter

PF - Pilot Flying

PM - Pilot Monitoring

QRH - Quick Reference Handbook

SOP - Standard Operating Procedures

CONCLUSION

The eQRH provides a new Flight Operations standard, moving to full electronic Flight Operations.

The eQRH is available today on the A320 and A330/A340 families. It is gradually being deployed on all Airbus commercial and military aircraft, including the next Airbus helicopter: The H160.

As a long term objective, it will be upgraded to enable the management of other aircraft manufacturers' QRHs.

Fleet-wide systems maintenance

Priorities and status at a glance

Article by

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Operators need to manage and follow up on numerous fault messages and maintenance tasks with different priorities across their fleet. Managing the sheer volume of tasks, deciding how to prioritise them and following up on each one's status requires time and organisation.

Close on-site collaboration between an operator and its local Airbus field service team resulted in an automated process contributing to a significant improvement of the Operational Reliability.

The challenge for Maintenance Control Centres (MCC) and fleet management

If too many repeat issues are left unattended for too long, there is an increasing risk of combined failures and operational disruptions. Tracking down every fault message assists in keeping an optimal OR. This is the permanent challenge for an airline's Maintenance Control Centre (MCC) which needs to monitor its fleet and ensure all these faults are properly managed in a timely manner.

Nowadays, MCC teams have to cope with stringent aircraft schedules, short transit times and aircraft operating away from the main base. At the same time, the fleet may generate system fault messages which have different priorities, inducing maintenance work in various statuses. In addition, with teams working on shifts, engineers may not always have a complete overview of fleet health. The accumulation of all these conditions makes it difficult for an MCC to achieve its task.

Operational Reliability (OR)

OR is the percentage of revenue flights which depart and arrive without incurring a delay. This is an indication of an aircraft's profitability and a driver of passenger satisfaction. Achieving the highest Operational Reliability is therefore a priority, both for airlines and for Airbus. It is computed as follows:

$$\text{OR\%} = \left(1 - \frac{DY + CN + IFTB + DV}{TO\ rev}\right) \times 100$$

DY = Delay   CN = Cancellation   IFTB = In flight Turn Back   DV = Diversion   TO rev = Revenue Take-Off

Enhancing Operational Reliability: The Qantas/Airbus cooperation

Together, Qantas and Airbus developed a plan to enhance the Operational Reliability of the Qantas A380 fleet. One action was to integrate an Airbus Field Service Representative (FSR) - *see insert* - into the Qantas MCC to optimise fault management processes.

Following an auditing period during which the FSR worked alongside the MCC engineers, the outcome showed that the MCC was struggling with tracking fleet fault messages and managing the associated maintenance work. An automated process seemed an ideal solution to optimise the task.

Airbus Field Service

The frontline contact for customers

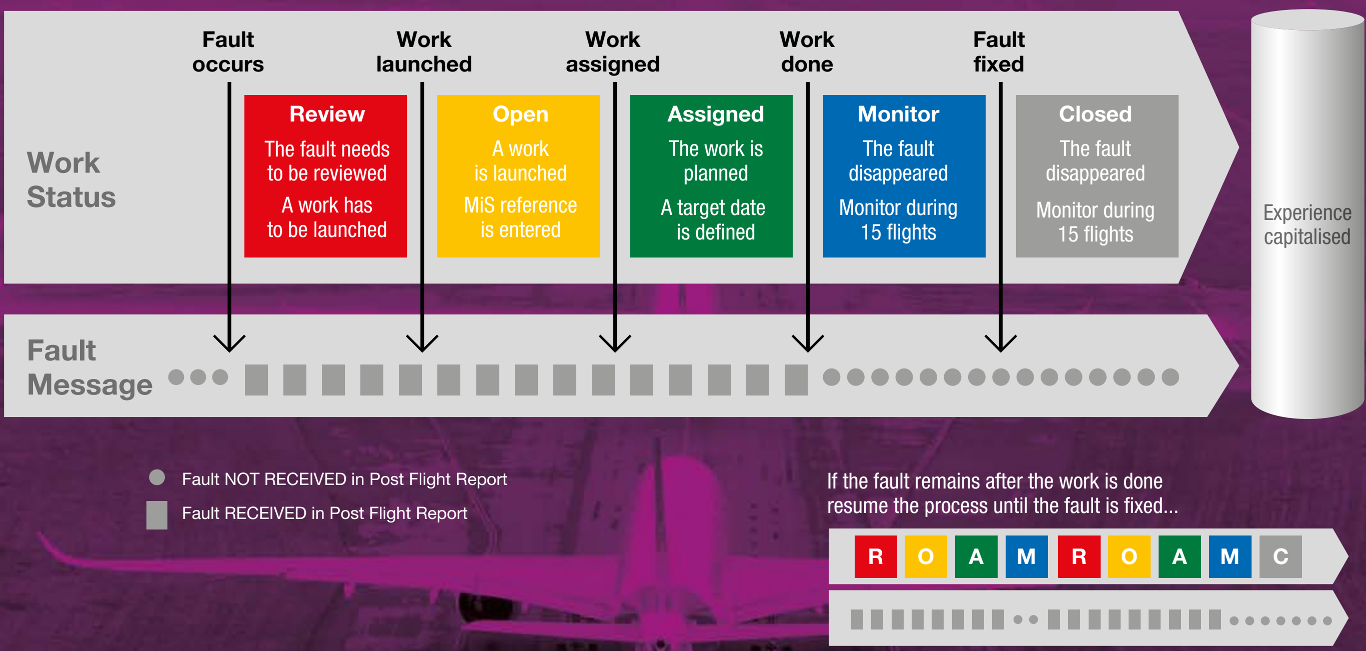
Mission:

- Maintain high customer satisfaction
- Represent Airbus Customer Services to all levels of the airline
- Identify the airline's technical priorities and other operational needs
- Facilitate at Entry-Into-Service
- Provide 24-hour technical assistance and AOG support
- Maintain highest level of customer relationship
- Ensure feedback to Airbus

The Fault & Work Management (FWM) concept

The MCC workflow was first translated into a process whereby the 'life' of a fault and its associated work were broken down into a series of statuses. This process provided a second level of prioritisation in addition to the classification of the fault messages.

Workflow management process



This process was transformed into an algorithm to develop a software solution for implementation within the MCC. The programming language Visual Basic and the platform Excel were chosen to develop a prototype, as they were readily available on every workstation.

How the Fault & Work Management was applied

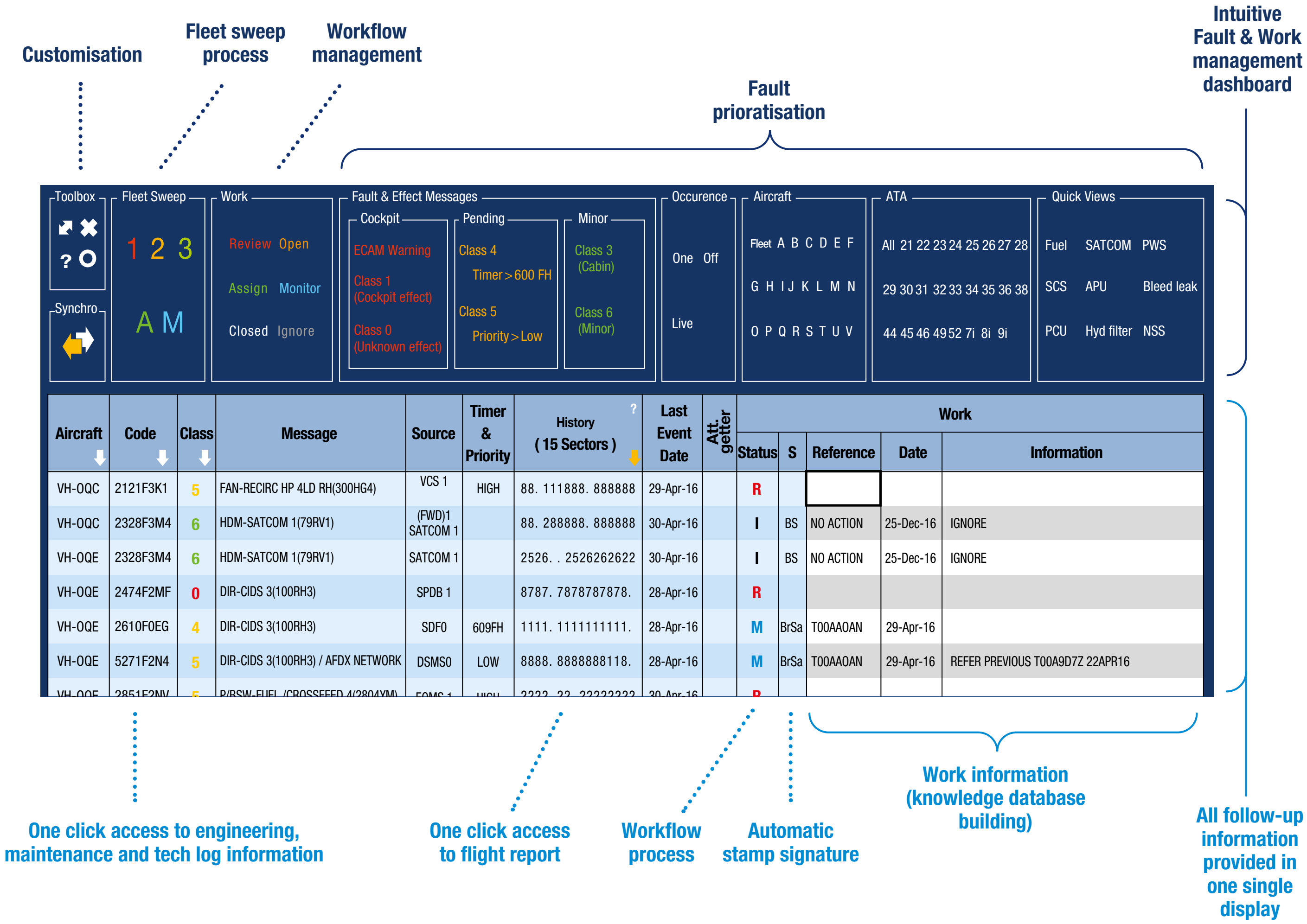
There were three basic requirements to meet the objectives of FWM:

- The application had to be fed with fault messages sent by the aircraft via the Aircraft Communications Addressing and Reporting System (ACARS). This was achieved by connecting FWM to the AIRMAN-web database.
- Qantas maintenance information needed gathering. For this, an automatic routine was created in the Qantas Maintenance Information System, which sent regular updates maintenance actions and pilot reports to FWM.
- Last but not least, FWM had to work on a network so that all stakeholders (MCC team members, fleet management, technical services…) could access the data according to their profile. This was achieved by giving users access to a shared FWM database installed on the Qantas network.

The FWM project involved teams from Airbus and Qantas, with support from their respective programme and fleet management. The MCC and FSR teams collaborated on the concept, design and development of the FWM application. The Qantas IT department assisted with the network implementation and the interface with the Maintenance Information System.

To ensure successful integration into the Qantas MCC A380 process, the Human-Machine Interface (HMI) was designed to fulfil end-user requirements. As it was developed in close cooperation with Qantas MCC teams, it was exactly adapted to their needs:

- Intuitive Fault & Work Management
- All information available in a single display
- One-click access to all functionalities



The advantages of using Fault & Work Management

Once implemented, the FWM application was quickly adopted by the MCC teams as it provided more efficiency and capacity inside their teamwork environment. The FWM concept allows constant monitoring of work over time and across MCC shifts. This concept also optimises work planning and prevents duplication. The filtering dashboard enables MCC engineers to ‘sweep’ the fleet fault messages faster and tackle them proactively according to priority. It was not long before the number of open fault messages over the fleet was reduced and consequently kept down to a manageable level.

The FWM concept fulfils the airline fleet management business objectives by enhancing the management of maintenance actions and by reducing unnecessary component removals and maintenance burdens. Above all, it enables increased focus on fleet health and ultimately reduces the risk of operational disruption events, hence assisting in maintaining an optimum Operational Reliability.

Moving forward with fleet management

On top of the fleet-sweeping feature, which enables better tracking and efficient management of issues, the FWM concept raises another question: How can capitalising on experience be made easier for airlines?

Simplicity and efficiency - the keys to success

Capitalising on experience is a key aspect to improving operations, but remains complex to put in place and hard to maintain up-to-date. The main reason is the human factor. Indeed, the task of logging experience can be seen as a short-term waste of time if there is no direct added value or if it requires extra effort.

Knowledge is spread throughout the whole maintenance organisation, from mechanics and engineers to the MCC; however, information may not be stored or it may be long to retrieve. This results in investigations and decisions relying exclusively on the experience of the maintenance team on duty, as opposed to relying on the accumulated knowledge from the whole maintenance organisation.

Experience may be available from different sources such as spreadsheets, locally developed applications, Maintenance Information Systems (MIS) or software such as AIRMAN-web. Unfortunately, there is no link between all these sources of information and no way to easily correlate both faults and work experience or to easily log experience.

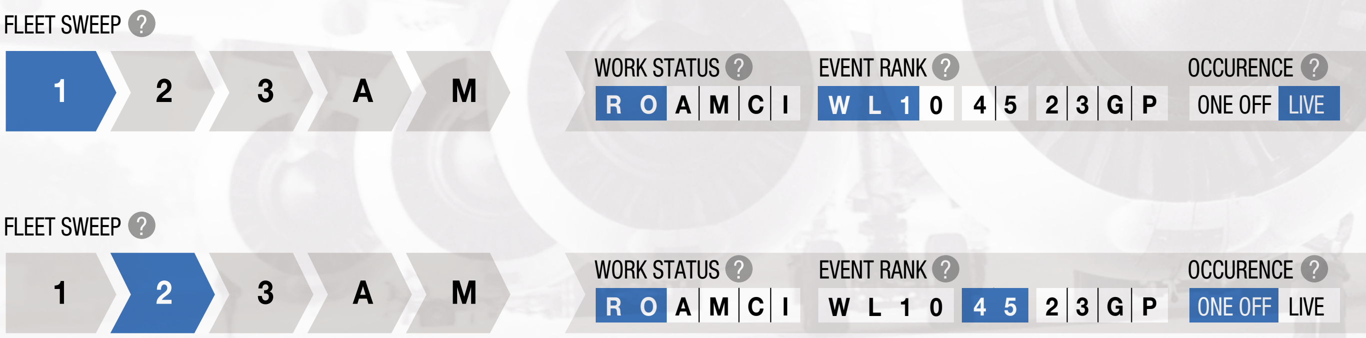
In the case of the FWM concept, a direct benefit for end-users of the 'log experience' function is that it facilitates their work with a direct and rapid positive impact.

Skywise is Airbus' open aviation digital platform, aiming at centralising and analysing data coming from the whole aviation ecosystem. Skywise provides a robust and secured infrastructure coupled with best-in-class analytical environments and tools to explore and visualise data. Some of the world's most innovative airlines are already benefiting from the platform to support their cross-domain digital operations (Maintenance, Flight Operations, Fleet management, Material management, Cabin, Passenger management, etc.).

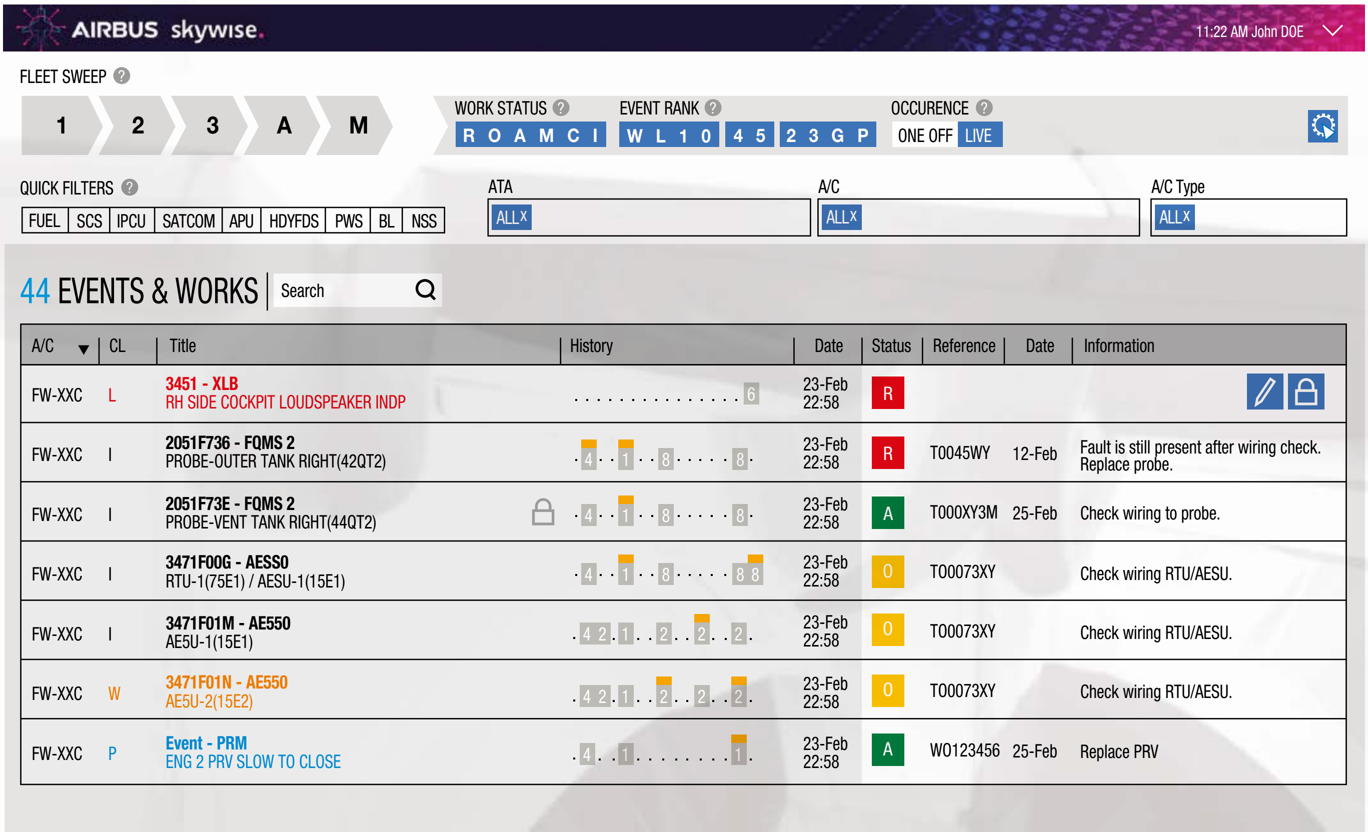
The first steps

The FWM concept success story with Qantas and the interest raised by the airline community have placed these principles at the core of future developments. Now that the concept has been proven with a customer, Airbus is preparing it for the market and is considering further opportunities to propose new ways to improve fleet performance.

Airbus believes that, in order to bring more efficiency, such a capability must be integrated into daily software where experience can be shared and accessed by the whole maintenance organisation. In addition, such a concept could easily be extended to cover the MCC activities with *real-time data* to ease decision-making.



The 'Work Status', the 'Event Rank' and the 'Occurrence' contribute to the prioritisation.



A/C	CL	Title	History	Date	Status	Reference	Date	Information
FW-XXC	L	3451 - XLB RH SIDE COCKPIT LOUDSPEAKER INDP	6	23-Feb 22:58	R			
FW-XXC	I	2051F736 - FQMS 2 PROBE-OUTER TANK RIGHT(42QT2)	4 1 8 8	23-Feb 22:58	R	T0045WY	12-Feb	Fault is still present after wiring check. Replace probe.
FW-XXC	I	2051F73E - FQMS 2 PROBE-VENT TANK RIGHT(44QT2)	4 1 8 8	23-Feb 22:58	A	T000XY3M	25-Feb	Check wiring to probe.
FW-XXC	I	3471F00G - AESS0 RTU-1(75E1) / AESU-1(15E1)	4 1 8 8 8	23-Feb 22:58	0	T00073XY		Check wiring RTU/AESU.
FW-XXC	I	3471F01M - AE550 AE5U-1(15E1)	4 2 1 2 2 2	23-Feb 22:58	0	T00073XY		Check wiring RTU/AESU.
FW-XXC	W	3471F01N - AE550 AE5U-2(15E2)	4 2 1 2 2 2	23-Feb 22:58	0	T00073XY		Check wiring RTU/AESU.
FW-XXC	P	Event - PRM ENG 2 PRV SLOW TO CLOSE	4 1 1	23-Feb 22:58	A	W0123456	25-Feb	Replace PRV

Future possibilities

Airbus is now fine-tuning the concept with real-time data on A320 and A330 Family aircraft, with the participation of a low-cost airline in October 2017.

The FWM concept is now taken as a basic principle of the next AIRMAN starting definition that will also benefit from the Skywise platform *(see insert)*.

The combination of both the Skywise digital platform capabilities, and the experience that could be captured on over 7,300 aircraft, could leverage and accelerate decision-making for MCCs by providing 'Advice for Dispatch' and 'Possible Causes' prioritisation to improve fleet performance management.

From the initial integration in the MCC and back office support, the concept will be extended thanks to Skywise to other areas such as structural issues, predictive events, logbook entries and servicing.

CONCLUSION

To help an operator manage fault messages and corresponding maintenance tasks across its fleet, Airbus developed a fault and work management function, thanks to a collaborative effort between the operator and the local Airbus field service team. The result was an automated prioritisation process which has facilitated fleet tracking for the operator and has contributed to significant Operational Reliability improvement.

This function also presents advantages for other voluminous MCC data management areas such as structural issues, predictive events, logbook entries and servicing. It is now destined to be integrated in Airbus' AIRMAN and Skywise digital platforms, bringing even greater capabilities for fleet management in the future.

FAST from the past

There wouldn't be any future without the experience of the past.

A paperless cockpit?

Almost 100 years ago, this Junkers F13 cockpit may have been 'no paper' - it was also 'no electronics'! The primary navigational instruments were simply an airspeed indicator, an altimeter, a clock, and a compass.

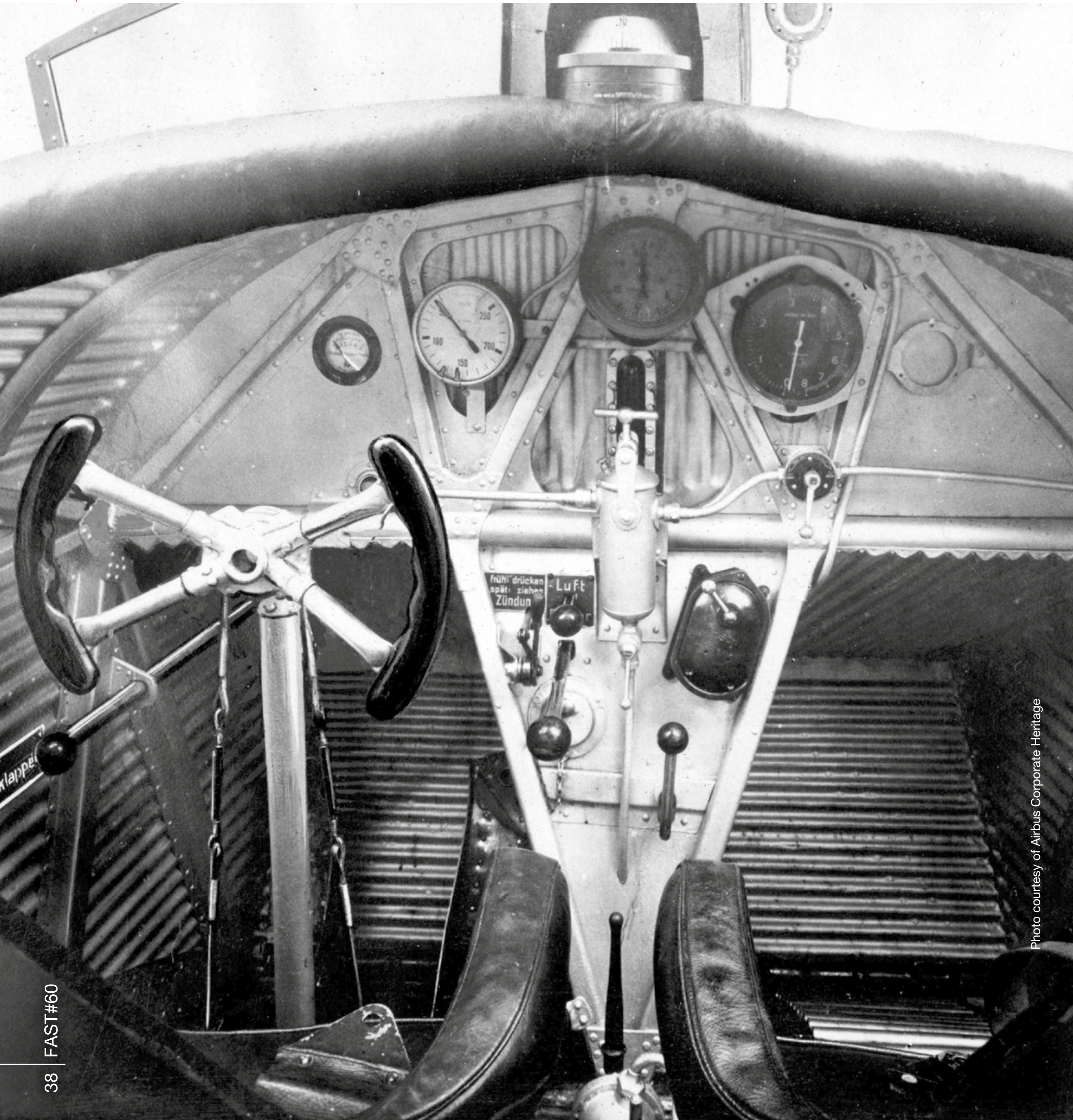
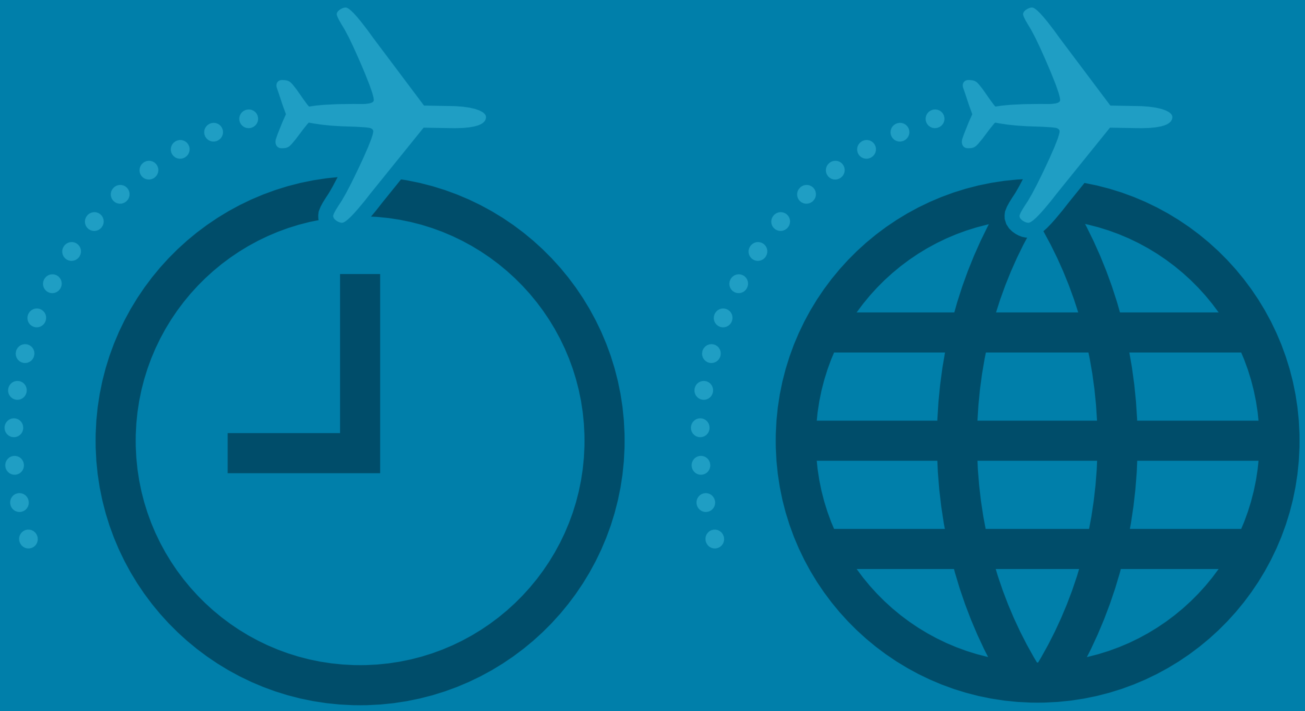


Photo courtesy of Airbus Corporate Heritage

Around the clock, around the world



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