Airbus Resident Customer Support Managers are based at their operator's premises. With over 25 nationalities represented, they can be relied upon to understand your country's culture, ensuring a close relationship based on mutual trust. Many have an airline background, which means they're at home with your operation and aircraft. In fact, whatever you require, you can be sure our Resident Customer Support Managers are all ears. Airbus Customer Services. Dedicated to meet your requirements. Airbus. Setting the standard.
TRAINING PHILOSOPHY FOR PROTECTED AIRCRAFT IN EMERGENCY SITUATIONS
CAPTAIN ETIENNE TARNOWSKI

AVOIDING ELEVATOR VIBRATION - A319, A320, A321
SONIA BOURCHARDIE

CUSTOMER SERVICES CONFERENCES

COMMON, RELIABLE AND PUNCTUAL...
THE PATH TO LOWER SPARES COSTS
OLYMPIOS PANAYIOTOU AND MARTIN WOODS

COMBINING ENVIRONMENT PROTECTION AND WINDSHIELD RAIN PROTECTION ON AIRBUS AIRCRAFT
FRANCOIS POVEDA

SERVICE BULLETIN REPORTING
TECHNICAL PUBLICATIONS WHICH REFLECT THE CONFIGURATION OF YOUR AIRCRAFT
CLAIREE HAREL

ENVIRONMENTAL PROTECTION - PART II

RESIDENT CUSTOMER SUPPORT REPRESENTATION

The articles herein may be reprinted without permission except where copyright source is indicated, but with acknowledgement to Airbus Industrie. Articles which may be subject to ongoing review must have their accuracy verified prior to reprint. The statements made herein do not constitute an offer. They are based on the assumptions shown and are expressed in good faith. Where the supporting grounds for these statements are not shown, the Company will be pleased to explain the basis thereof.

Publisher: Airbus Industrie Customer Services, 1 rond-point Maurice Bellonte, 31707 Blagnac Cedex, France
Editor: Denis Dempster, Product Marketing
Telephone +33 (0)5 61 93 39 29, Telex AIRBU 530526F, Telefax +33 (0)5 61 93 27 67
Graphic design: Agnès Lacombe, Customer Services Marketing
Photo-engraving: Passion Graphic, 60 boulevard Déodat de Séverac, 31027 Toulouse Cedex, France
Printer: Escourbiac, 5 avenue Marcel Dassault, 31502 Toulouse Cedex, France

This issue of FAST has been printed on paper produced without using chlorine, to reduce waste and help to conserve natural resources. Every little helps.

FAST may be read on Internet http://www.airbus.com
PROTECTED AIRCRAFT IN EMERGENCY SITUATIONS

The civil aviation environment has evolved considerably in the past decade. The passenger and cargo airlift have increased enormously, leading to a far larger number of aircraft in service. Also flight safety criteria have become more and more stringent. Furthermore, the media and the expectations of the public, in terms of safety, have set even greater pressure on the civil aviation industry. Although the accident rates have dropped considerably, the number of aircraft in service, accidents do not seem to be much less frequent, and it is this factor which may influence public opinion. Consequently, the civil aviation industry has to fight unceasingly against the main causes of accidents which occur mostly in approach phases: controlled flight into terrain, and to a lesser extent, windshear.

Since 1985, Airbus Industrie has designed a fly-by-wire aircraft family: the fly-by-wire control laws include protections that have been provided as an assistance to the pilot in emergency situations. Crews are being trained to face emergency situations such as evasive manoeuvres to avoid Controlled Flight Into Terrain (CFIT). The Flight Safety Foundation (FSF) has sponsored a large programme regarding “how to train for CFIT escape manoeuvres”, and Airbus Industrie has released a training manual on this issue to Airbus operators. This article aims to inform the aviation community on the safety benefits of those protections, and on the ways they are implemented in the training philosophy, which are:

- Explain the protection philosophy
- Explain and demonstrate the achievable performance
- Provide alertness training for pilots by flying realistic scenarios in full flight simulators (FFS).

THE PROTECTION PHILOSOPHY

Most late-technology aircraft carry the most up-to-date systems to assist the pilots in achieving their tasks, without changing the nature of the tasks themselves. The protections built in the fly-by-wire system is one of them. These systems have been designed to be a COMPLEMENT for the pilots, after a thorough analysis of pilots’ strengths and weaknesses; basically they have been added wherever they could do better than man, to compensate for those weaknesses.

These systems are merely operators which work repetitively, accurately and consistently, according to built-in logic, but with no intuition, no discernment, no decision capacity. However pilots need an understanding of those systems to operate them properly. As a consequence, if the main goal of training is to make flying more instinctive, more natural, the pilots have to be taught the why’s of those systems. Then the pilots understand the process and become naturally part of it and will apply the associated procedures instinctively and naturally. This statement applies to the protections that are implemented on essential systems of the aircraft.

When a pilot faces an unexpected event, he normally has to react within seconds to save the aircraft. He is the one ultimately responsible for the safety of the flight. Dangerous unexpected situations are often linked to non-linear, discontinuous phenomena that appear at the border of the flight envelope. In such circumstances the pilot does not normally have any relevant past experience, to give him a spontaneously correct response. Therefore, the design of the main aircraft systems must aim at giving full authority to the pilot to consistently achieve the maximum possible aircraft performance in such extreme circumstances, with an easy, instinctive and immediate procedure, while minimising the risks of over-controlling or over-stressing the aircraft.

This design philosophy has been applied homogeneously throughout the essential systems of the Airbus fly-by-wire aircraft.

Protection in the brakes

A pilot may apply full pedals down, at take-off or landing when required (rejected take-off or landing a heavy aircraft on a short runway…), because the braking system is protected by the anti-skid system which releases the brake pressure whenever a skidding condition is detected.

The braking system with anti-skid allows the pilot to get the best braking performance with an instinctive action on the pedals; by no means does it limit the authority of the pilot.

Protection in the engines

The engine acceleration characteristics, on a high by-pass ratio engine, seems to be very sluggish to a pilot who needs full Take-off and Go Around (TOGA) thrust out of idle, in order to recover from a dangerous situation. As shown in the graph (Figure 1), there is hardly any thrust increase in the first 3 to 4 seconds; then the thrust increases very rapidly to its maximum. This character-

TYPICAL ENGINE ACCELERATION RESPONSE

<table>
<thead>
<tr>
<th>Time (sec)</th>
<th>Maximum thrust (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>50</td>
</tr>
<tr>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>3</td>
<td>150</td>
</tr>
<tr>
<td>4</td>
<td>200</td>
</tr>
<tr>
<td>5</td>
<td>250</td>
</tr>
<tr>
<td>6</td>
<td>300</td>
</tr>
<tr>
<td>7</td>
<td>350</td>
</tr>
<tr>
<td>8</td>
<td>400</td>
</tr>
</tbody>
</table>

Figure 1

Updated by Captain Etienne Tarnowski
Vice President Engineering Operations, Airbus Industrie
istic is common to all turbofan engines with high by-pass ratio. High by-pass ratio implies:
• High inertia, in particular in the low pressure assembly because of the size of the fan and turbine discs.
• Only a fraction of the airflow gets into the combustion chamber to produce energy in the combustion process.

Today, all engine manufacturers have programmed an engine acceleration schedule and a “bleed bias” system in the Full Authority Digital Engine Control (FADEC), in order to protect the engines against stall. This protection allows the pilot to get the best possible thrust increase rate, consistently and repetitively, by pushing thrust levers full forward instinctively and rapidly, while minimising the risks of engine stall and without limiting whatsoever the authority of the pilot.

Fly-by-wire protection in the flight controls

Fly-by-wire control systems in Airbus fly-by-wire aircraft protect the aircraft against a stall. This protection allows the pilot to get the maximum available performance of the aircraft with the minimum risk of over-controlling or over-stressing the aircraft. (Non protected aircraft provide a “stick shaker” when the AOA at which stalls. AOA is also known as \( \alpha \) (alpha)).

Suppose that an aircraft decelerates, stick free, with thrust at idle in level flight, the fly-by-wire pitch normal law will keep the aircraft roughly in level flight and auto-trimmed and when VLS (minimum normal speed) is reached, the pilot should take an action to prevent the speed from dropping further. If the pilot takes no action, the aircraft will continue to decelerate until it reaches Alpha Prot. This is where the angle of attack protection starts.
• If there is still no action from the pilot, the aircraft will sink to maintain the \( \alpha \) Prot and associated speed. This is a major change in the aircraft behaviour.
• If, due to the sink rate the pilot then pulls the side-stick back, he directly orders a higher angle of attack, till the aircraft reaches full back stick where he orders \( \alpha \) Max (Figure 2).

In order to achieve this, the FADEC controls the engine thrust to maintain the \( \alpha \) Prot and associated speed. This is a major change in the aircraft behaviour. If, due to the sink rate the pilot then pulls the side-stick back, he directly orders a higher angle of attack, till the aircraft reaches full back stick where he orders \( \alpha \) Max (Figure 2).

In addition to the aerodynamic protection, three energy features enhance that function since engine thrust is needed to maintain the flight path:
• When Autothrust (ATHR) is in SPED mode, it will adjust the thrust to the maximum possible, in order to maintain speed at, or above VLS.
• Should the aircraft energy drop below a certain threshold, a low energy aural warning is triggered calling “SPEED - SPEED”. The aircraft energy is a function of speed, acceleration and flight path angle, and the aural warning comes typically below VLS.
• Should the aircraft angle of attack reach the threshold of Alpha Floor the ATHR sets TOGA thrust automatically applied by the autopilot system.

The observed result is invariably AOA properly stabilised.

How is this achieved?
By pulling the side-stick fully aft the pilot gets:
• maximum angle of attack giving maximum lift.
• \( \alpha \) floor* function giving maximum TOGA thrust.
• speed brake auto-retraction giving reduced drag.

(* see below - angle-of-attack where maximum thrust is automatically applied by the autopilot system).

How does this work?
The high angle of Attack (AOA) protection is an aerodynamic protection that prevents the aircraft reaching an AOA at which it is stalls. AOA is also known as \( \alpha \) (alpha).

There are three thresholds incorporated in the protection:
• \( \alpha \) Prot, which is the maximum attainable stick-free AOA.
The auto-trim stops there because there is no valid reason to fly at such a low speed for a lengthy period of time. The speed brakes, if extended, retract automatically.
• \( \alpha \) Floor, which is the AOA where engine thrust increases to TOGA even with autothrust selected off.
• \( \alpha \) Max, which is the maximum attainable AOA with the side stick held fully back.

Suppose that an aircraft decelerates, stick free, with thrust at idle in level flight, the fly-by-wire pitch normal law will keep the aircraft roughly in level flight and auto-trimmed and when VLS (minimum normal speed) is reached, the pilot should take an action to prevent the speed from dropping further. If the pilot takes no action, the aircraft will continue to decelerate until it reaches Alpha Prot. This is where the angle of attack protection starts.
• If there is still no action from the pilot, the aircraft will sink to maintain the \( \alpha \) Prot and associated speed. This is a major change in the aircraft behaviour.
• If, due to the sink rate the pilot then pulls the side-stick back, he directly orders a higher angle of attack, till the aircraft reaches full back stick where he orders \( \alpha \) Max (Figure 2).

In addition to the aerodynamic protection, three energy features enhance that function since engine thrust is needed to maintain the flight path:
• When Autothrust (ATHR) is in SPED mode, it will adjust the thrust to the maximum possible, in order to maintain speed at, or above VLS.
• Should the aircraft energy drop below a certain threshold, a low energy aural warning is triggered calling “SPEED - SPEED”. The aircraft energy is a function of speed, acceleration and flight path angle, and the aural warning comes typically below VLS.
• Should the aircraft angle of attack reach the threshold of Alpha Floor the ATHR sets TOGA thrust automatically applied by the autopilot system.

The observed result is invariably AOA properly stabilised.

There are three thresholds incorporated in the protection:
• \( \alpha \) Prot, which is the maximum attainable stick-free AOA.
The auto-trim stops there because there is no valid reason to fly at such a low speed for a lengthy period of time. The speed brakes, if extended, retract automatically.
• \( \alpha \) Floor, which is the AOA where engine thrust increases to TOGA even with autothrust selected off.
• \( \alpha \) Max, which is the maximum attainable AOA with the side stick held fully back.

In case of an emergency on approach (CFIT, windshear...) what matters to the pilot is the overall performance he is able to get from the aircraft (airframe & engines) during a recovery manoeuvre. He must always have in mind the capability of the aircraft, so as to be able to always fly ahead of the aircraft. This is the only way for him to react in time to any emergency warning.

For the pilot, the overall performance of the aircraft is materialised with the altitude versus distance profile the aircraft is able to fly in a recovery manoeuvre. This profile is essentially a function of two paramount parameters:
• The engine thrust spool-up characteristic, which is similar on all FADEC controlled high by-pass ratio engines, since ALL engine manufacturers have implemented an anti-surge protection.
• The aircraft’s response to the pilot’s inputs on the side-stick or on the yoke: this response depends significantly on the pilot’s flying technique, on how aggressively he acts.

The aircraft’s response will therefore be very tight linked to whether the aircraft is protected or not:
• If the aircraft is protected the pilot may apply full back stick immediately whenever an emergency is detected.

Achievable Performance

In case of an emergency on approach (CFIT, windshear...) what matters to the pilot is the overall performance he is able to get from the aircraft (airframe & engines) during a recovery manoeuvre. He must always have in mind the capability of the aircraft, so as to be able to always fly ahead of the aircraft. This is the only way for him to react in time to any emergency warning.

For the pilot, the overall performance of the aircraft is materialised with the altitude versus distance profile the aircraft is able to fly in a recovery manoeuvre. This profile is essentially a function of two paramount parameters:
• The engine thrust spool-up characteristic, which is similar on all FADEC controlled high by-pass ratio engines, since ALL engine manufacturers have implemented an anti-surge protection.
• The aircraft’s response to the pilot’s inputs on the side-stick or on the yoke: this response depends significantly on the pilot’s flying technique, on how aggressively he acts.

The aircraft’s response will therefore be very tight linked to whether the aircraft is protected or not:
• If the aircraft is protected the pilot may apply full back stick immediately whenever an emergency is detected.

Achievable Performance

In case of an emergency on approach (CFIT, windshear...) what matters to the pilot is the overall performance he is able to get from the aircraft (airframe & engines) during a recovery manoeuvre. He must always have in mind the capability of the aircraft, so as to be able to always fly ahead of the aircraft. This is the only way for him to react in time to any emergency warning.

For the pilot, the overall performance of the aircraft is materialised with the altitude versus distance profile the aircraft is able to fly in a recovery manoeuvre. This profile is essentially a function of two paramount parameters:
• The engine thrust spool-up characteristic, which is similar on all FADEC controlled high by-pass ratio engines, since ALL engine manufacturers have implemented an anti-surge protection.
• The aircraft’s response to the pilot’s inputs on the side-stick or on the yoke: this response depends significantly on the pilot’s flying technique, on how aggressively he acts.

The aircraft’s response will therefore be very tight linked to whether the aircraft is protected or not:
• If the aircraft is protected the pilot may apply full back stick immediately whenever an emergency is detected.

Achievable Performance

In case of an emergency on approach (CFIT, windshear...) what matters to the pilot is the overall performance he is able to get from the aircraft (airframe & engines) during a recovery manoeuvre. He must always have in mind the capability of the aircraft, so as to be able to always fly ahead of the aircraft. This is the only way for him to react in time to any emergency warning.

For the pilot, the overall performance of the aircraft is materialised with the altitude versus distance profile the aircraft is able to fly in a recovery manoeuvre. This profile is essentially a function of two paramount parameters:
• The engine thrust spool-up characteristic, which is similar on all FADEC controlled high by-pass ratio engines, since ALL engine manufacturers have implemented an anti-surge protection.
• The aircraft’s response to the pilot’s inputs on the side-stick or on the yoke: this response depends significantly on the pilot’s flying technique, on how aggressively he acts.

The aircraft’s response will therefore be very tight linked to whether the aircraft is protected or not:
• If the aircraft is protected the pilot may apply full back stick immediately whenever an emergency is detected.
In-flight demonstration

This demonstration is achieved in two steps:

- An analytical step which demonstrates successive phases of the protection, and resulting aircraft/engine behaviour.
- A deductive step where a typical recovery manoeuvre shows the flight trajectories to the pilots.

The analytical step (Figure 4):

- Slowly decelerate (approximately 0.5 knots/sec.), with ATHR off, in flap extended configuration (e.g. CONF3), level flight, stick free.
- Reaching VLS minus 5 knots approximately: Check “Speed - Speed” aural message.
- Reaching Alpha Prot speed: Note the significant change in aircraft behaviour. The aircraft sinks down at Alpha Prot speed; the auto-trim stops; in level flight the stick feels “heavy”.
- Acting on the side-stick to maintain level flight: speed decreases: Alpha Floor is reached. TOGA is automatically set by ATHR, the aircraft climbs at Alpha Prot speed, if stick is free.
- Pulling full back side-stick: the Alpha Prot speed is immediately traded into additional rate of climb till Alpha Max speed is reached, and Alpha Max maintained.

The deductive step

Two exercises will demonstrate the capabilities of the aircraft in recovery manoeuvres, and parameters essential to the pilots will materialise:

- Go around from high vertical speed (V/S) approach (Figure 5).
- Escape manoeuvre (Figure 6).

ALERTNESS TRAINING

The training for escape from emergency situations such as windshear and CFIT has actually two aspects:

- Train the pilot to be alert to the elements which may create an emergency situation.
- Train for the escape manoeuvre.

Training the escape manoeuvre

A GPWS alert comes up with about 15 seconds before potential impact, depending on the terrain configuration. Therefore, the pilot’s reaction must be quick and efficient. Thus, he must be able to achieve the escape manoeuvre easily and naturally.

- On a protected aircraft: no training is required to achieve the escape manoeuvre; indeed, the procedure is straightforward, is instinctive and does not require exceptional flying skills. And, it systematically leads to the best achievable aircraft performance.
- On a non protected aircraft, a thorough training is required in order to reach a certain level of flying skill. The flying technique is not easy to acquire. Furthermore, it is very dependent upon the situation! Therefore, a lot of time is required to try to make this manoeuvre “natural” for the pilot and a lot of men-
The effort to improve flight safety must be a co-ordinated one, from aircraft manufacturers to airline management, including Air Traffic Control and other agencies. However, the pilot is the last link in the chain. The pilot has to take the right decision, and the pilot has to take the right action at the right moment, in an emergency situation, so as to save lives. Therefore, all efforts have to converge, to assist pilots in their decision-making processes, to ensure that they achieve the safest and most efficient manoeuvre, in an emergency.

Training is obviously one of these essential efforts; and it is most clear that the training to handle emergency situations on protected aircraft is a rational one, because the protection of fly-by-wire allows concentration on the most important aspect of the accident prevention, which is pilot alertness. On a protected aircraft, valuable training time is not necessary and is not lost in teaching and learning how to fly the escape manoeuvre itself.

In order to train the pilot alertness, many aspects have to be reviewed:

- proper departure/arrival procedures,
- proper and concise take-off and approach briefings,
- proper review of major obstacles and safety altitudes,
- proper appreciation of lateral and vertical situation of the aircraft,
- radio communication phraseology, altimeter setting, task sharing.

Last but not least, in case of emergency, the pilots’ reaction must be automatic and immediate, with little room for argument (unless in clear, cloudless weather for GPWS warning). This is also part of the training for pilot’s alertness. It will be achieved through several realistic scenarios flown in the simulators, spread throughout the training courses.

For that purpose the simulator must have the capability to create an “electronic mountains” from the instructor panel, at a selected point ahead of the aircraft’s instantaneous position along its predicted trajectory. However, this facility shall be used in an environment where it will create an alert realistically. Four examples of realistic scenarios are proposed hereunder; these will create a surprise for the pilots without degrading the crew confidence in the GPWS warning. Note: The same principle applies for windshear scenarios.

CONCLUSION

The effort to improve flight safety must be a co-ordinated one, from aircraft manufacturers to airline management, including Air Traffic Control and other agencies. However, the pilot is the last link in the chain. The pilot has to take the right decision, and the pilot has to take the right action at the right moment, in an emergency situation, so as to save lives. Therefore, all efforts have to converge, to assist pilots in their decision-making processes, to ensure that they achieve the safest and most efficient manoeuvre, in an emergency.

Training is obviously one of these essential efforts; and it is most clear that the training to handle emergency situations on protected aircraft is a rational one, because the protection of fly-by-wire allows concentration on the most important aspect of the accident prevention, which is pilot alertness. On a protected aircraft, valuable training time is not necessary and is not lost in teaching and learning how to fly the escape manoeuvre itself.
VOIDING ELEVATOR VIBRATION
A319, A320, A321

In-flight vibrations on the A320 Family, an intensive flight test campaign was launched by Airbus Industrie to determine the different sources of elevator vibrations. They are described in the Trouble Shooting Manual (TSM) Chapter 05-50-00, and each possible cause is associated with corresponding trouble shooting procedures. The TSM also provides a recording sheet to help operators establish the cause of vibration.

The main source is the elevator system, which accounts for more than 70% of all vibrations. Further to the flight test campaign, it was revealed that the phenomenon was in fact a Limit Cycle Oscillation (LCO) which is a sustained vibration at a fixed frequency with limited amplitude and having no impact on flight safety.

This article describes how to avoid elevator vibration through the incorporation of a modification on the spherical bearing of the elevator servo control and a new elevator setting.

Added to potential aerodynamic excitation, two concomitant conditions causing the LCO were discovered: servo control bearing backlash and low actuator load.

SOLUTIONS

Two solutions were developed to eliminate these two causes: reduce backlash and increase hinge moment.

TO REDUCE BACKLASH

Several cases of excessive play within the spherical bearings of the elevator servo control, due to premature wear of the Teflon liners, were discovered during inspections following reports of in-flight airframe vibrations.

This condition has now been eliminated thanks to higher performance NMB bearings, introduced on the elevator servo-controls through the LUCAS Service Bulletin 31075-27-17 and Airbus Service Bulletin A320-27-1111. This modification incorporates an additive in the existing liner, and chromium and super finishing of the inner ball to reduce the wear rate and friction coefficient. Also the maximum acceptable value for backlash, measured at the elevator trailing edge has been reduced from 10mm to 7mm, as described in the AMM.

TO INCREASE HINGE MOMENT

The Airbus Service Bulletin A320-27-1114 describes the resetting of the elevator neutral position to 0.5 degree (aircraft) nose up. Accomplishment of this modification ensures that the elevators are aerodynamically loaded in an appropriate manner in order to eliminate vibration, even during flight in turbulent conditions.

These changes have no effect on aircraft performance and there is no change in the handling characteristics of the aircraft, nor is there any penalty in fuel consumption. This modification has been developed to fit easily into the maintenance program.

To perform the revised elevator rigging, a new elevator rigging tool, developed by Airbus Industrie, enables the new neutral position to be determined. It is highly recommended that this new tool be used, as it allows more accurate rigging through a simplified procedure. Nevertheless, the elevators can also be set using the previous tool which was developed originally to set the elevators to a 0 degree position.

Therefore the Aircraft Maintenance Manual (AMM) procedure now describes how to set the elevators to the 0.5 degree using the original tool or the new tool.

ADVANTAGES

As a preventive measure, these modifications will:

• improve the fleet reliability due to the new elevator servo spherical bearings and revised elevator rigging,
• improve passenger and crew comfort by removing the causes of vibration,
• reduce maintenance costs.

CONCLUSION

The extensive work performed by the Airframe Vibration Task Force led to conclusions for eliminating airframe vibration which have since been proven in service. The effectiveness of these modifications has been clearly demonstrated through the positive feedback from the Operators. Therefore as a preventive measure, the incorporation of the Service Bulletins are highly recommended by Airbus Industrie.

REFERENCES

• TSM Task 05-50-00, “In-flight airframe vibration”
• AMM Task 27-34-00-200-001 “Check of the elevator servo controls and hinge bearings for too much play, and condition”
• Video Tape “A320 Family elevator rigging”

The Part Numbers are: New Elevator Rigging Tool, 98D27309006000 / Previous Elevator Rigging Tool, 98D27309002000

To order the new Elevator Rigging Tool, please contact: AIRBUS INDUSTRIE, Materiel Support Center
Tel: +49 (40) 50 76 0 - Fax: +49 (40) 50 31 68

For further information or to receive a copy of the video tape please contact:
Airbus Industrie Customer Services A55E,352 - Flight Control Systems - Sonia Bouchardie
1, rond-point Maurice Bellonte - 31707 BLAGNAC Cedex FRANCE Tel: +33 (0) 5 61 93 22 33 Fax: +33 (0) 5 61 93 44 25

Elevator rigging tool (developed by Airbus Industrie)
In everyday life, the words common, reliable and punctual often conjure up an image of something dull, lacklustre, and non-spectacular. In the commercial or engineering world these terms can mean the difference between profit and loss or success and failure. The aircraft industry is no exception to this. In the aircraft manufacturing business, the benefits of being common are apparent not only through flight deck commonality (1) with cross crew qualification (CCQ) and common system architecture and maintenance philosophy, but also in the savings which can be made through common spare parts.

More reliable equipment naturally means that less spare parts are required. The punctuality in the repair of spare parts will determine how many spares are required to ensure the operation of the aircraft while a part is away for repair. All these factors, when optimised, yield considerable cost savings which this article examines with respect to aircraft spare parts.

Common, reliable and punctual – the path to lower spares costs

The 10th Performance and Operations Conference
28 September - 2 October 1998 in San Francisco

An excellent opportunity for Airbus Operators, Flight Operations directors and managers, chief pilots, training pilots, operations engineers... and Airbus Industrie Training, Flight Operations and Flight Test staff to share their experience.

Looking ahead, Documentation Procedures, Operations and environment and new technologies are part of the programme.

Separate sessions are also planned for fly-by-wire aircraft, conventional aircraft and performance issues.

A330/A340 Technical Symposium
11 - 15 May 1998 in Kuala Lumpur

Three hundred representatives from 33 Airlines, 40 Vendors, Airbus Industrie and Partners attended the third A330/A340 Technical Symposium which took place 11-15 May in Kuala Lumpur. The symposium was hosted by Gerard Mirria, Deputy VP Engineering and Technical Support, and John Grother, Programme Manager for Long Range Aircraft.

During the four day event all major technical items affecting the A330/A340 in service fleet were reviewed with the operators as well as some areas of more general interest.

In accordance with tradition the event was preceded by a social evening at which awards were given to some operators in recognition of exceptional operation of their aircraft.

Cathay Pacific took two awards on their A340 fleet, winning both the dispatch reliability and highest daily utilization awards.

A special recognition was also given to Philippines Airlines for the simultaneous entry into service of three Airbus types (A320, A330 and A340) last year.

The other winners (left to right) and their hosts:

- Helmut Fligl, LTU, Team Leader A330
- Mike Bock, LTU, Head of Engineering & Planning
- Chris Gibbs, Cathay Pacific, General Manager Engineering
- Arnold Badilla, Philippines Airlines, Senior Airframe & Systems Engineer

The symposium concluded with the awards ceremony.

Cathay Pacific took two awards on their A340 fleet, winning both the dispatch reliability and highest daily utilization awards.

A special recognition was also given to Philippines Airlines for the simultaneous entry into service of three Airbus types (A320, A330 and A340) last year.

The other winners (left to right) and their hosts:

- Helmut Fligl, LTU, Team Leader A330
- Mike Bock, LTU, Head of Engineering & Planning
- Chris Gibbs, Cathay Pacific, General Manager Engineering
- Arnold Badilla, Philippines Airlines, Senior Airframe & Systems Engineer

The symposium concluded with the awards ceremony.

Philippines Airlines also won the introduction of aerodynamic and structural design changes for the A340.

A special recognition was also given to Philippines Airlines for the simultaneous entry into service of three Airbus types (A320, A330 and A340) last year.

The other winners (left to right) and their hosts:

- Helmut Fligl, LTU, Team Leader A330
- Mike Bock, LTU, Head of Engineering & Planning
- Chris Gibbs, Cathay Pacific, General Manager Engineering
- Arnold Badilla, Philippines Airlines, Senior Airframe & Systems Engineer

The symposium concluded with the awards ceremony.

A330/A340 TECHNICAL SYMPOSIUM
11 - 15 May 1998 in Kuala Lumpur

The 10th Performance and Operations Conference
28 September - 2 October 1998 in San Francisco

A special recognition was also given to Philippines Airlines for the simultaneous entry into service of three Airbus types (A320, A330 and A340) last year.

The other winners (left to right) and their hosts:

- Helmut Fligl, LTU, Team Leader A330
- Mike Bock, LTU, Head of Engineering & Planning
- Chris Gibbs, Cathay Pacific, General Manager Engineering
- Arnold Badilla, Philippines Airlines, Senior Airframe & Systems Engineer

The symposium concluded with the awards ceremony.

A330/A340 TECHNICAL SYMPOSIUM
11 - 15 May 1998 in Kuala Lumpur

The 10th Performance and Operations Conference
28 September - 2 October 1998 in San Francisco

A special recognition was also given to Philippines Airlines for the simultaneous entry into service of three Airbus types (A320, A330 and A340) last year.

The other winners (left to right) and their hosts:

- Helmut Fligl, LTU, Team Leader A330
- Mike Bock, LTU, Head of Engineering & Planning
- Chris Gibbs, Cathay Pacific, General Manager Engineering
- Arnold Badilla, Philippines Airlines, Senior Airframe & Systems Engineer

The symposium concluded with the awards ceremony.
Looking at a typical airline’s Direct Operating Costs (DOC) which may vary depending on individual airlines and regions, spares costs are an important part (figure 1). Typically, consumed airframe spares represent 29% of direct maintenance costs (airframe, and engine consumed parts and labour), whilst airframe spares acquisition account for 12.5% of total acquisition costs. Therefore, a common set of spares will bring cost savings, which this article will highlight.

When considering spares commonality it is useful to first consider the initial investment required at entry-into-service of a new aircraft. Airbus Industrie provides spares recommendations for operations, which enables them to select with a certain degree of confidence the optimum spares holding that they will need for their aircraft operation (see FAST no. 21 May 1997, pages 25-29). The major share (figure 2), over 90% of the spares investment by value, consists of vendor Line Replaceable Units (LRUs). These parts are rotatable and repairable spares which are considered re-usable over the lifetime of the aircraft.

Of approximately 500 LRUs recommended, the top fifty spare LRUs, in terms of recommended investment, account for approximately 70% of that investment, the top hundred for 80% and the top two hundred for 95%. Given the distribution of the investment, an effort to concentrate on the commonality of a few spare parts can result in large cost savings. If an airline chooses to fit the same equipment across its fleet, e.g. wheels and brakes, navigation equipment or communication equipment, up to 95% investment commonality can be achieved within an Airbus family. This implies considerable savings when adding say an A319 or A321 to an existing fleet of A320s in order to provide flexibility. Commonality therefore enables economies of scale to be realised as the fleet grows.

The Airbus idea of family planning involves maximum parts commonality and system maintenance commonality. Naturally, the greatest commonality exists within family groups:
- A300-A310,
- A319-A320-A321 and
- A330-A340

Commonality between the A320 family and A300/A340 family is concentrated in the cockpit and systems. The evolution of Airbus aircraft commonality means that aircraft in the same family, rolling off the production lines to day, share the highest commonality of spare parts. In the case of the A320 family this is due to the introduction of common standards along with the introduction of the A321 and A319, as shown in figure 3.

We will examine the achievable savings through commonality by comparing the addition of A319s and a non-common type to an existing fleet of 10 A320s. The commonality dividend i.e. the savings made specifically through the effect of commonality can be seen in figure 4. This illustrates the effect of adding the first A319 to a 10 strong A320 fleet with the full benefits of commonality, compared to adding one non-A320 family aircraft. The impact of commonality is clear. The cost of the fleet of 10 A320s is $11.63m and the cost of adding an A319 to the A320 fleet is $0.27m, compared to a cost of $2.35m of adding a non-common type. The commonality dividend is therefore 88.5% of the cost of the spares for the additional aircraft. The overall investment for 11 aircraft in a combined Airbus fleet is 85% that of the investment required for the non-common fleets.

As the number of added A319 aircraft increases, the commonality dividend expressed as a percentage...
Along with the initial provisioning and "in-service" savings achievable through commonality there are the spares savings that Airbus Industrie has sought to make through continuous improvement and integration of aircraft systems.

As we have already seen, LRU's are the most expensive material category within an initial provisioning recommendation. Of the ATA chapters, chapter 22 "Auto Flight" generates the highest spares investment for an Airbus aircraft representing 14% of the total investment (Figure 8). For the A320, ATA chapter 22 consists of only five LRU part numbers reflecting the continuous integration of functions into single boxes. It is therefore an appropriate area to focus upon: within this ATA chapter a significant improvement has taken place in integrating the computers performing the Automated Flight System (AFS) function. As can be seen in Figure 9, the number of units required to fulfill the Automated Flight System function has been reduced simplifying maintenance and spares holding costs.

1. Generally, the reliability (MTBUR) of the individual LRUs has remained fairly constant.
2. Individual LRU prices have increased.

The savings attained as a result of combining these factors must be calculated by considering the Automated Flight System as one system. It is therefore necessary to calculate the reliability of the system as a whole. This was done by using the following calculation where \( N_u \) = number of units (see formula below).

\[
\sum (\frac{N_u}{MTBUR_A} + \frac{N_u}{MTBUR_B} + \frac{N_u}{MTBUR_C} + \ldots) \]

Applying this formula the impact of FBW integration is readily apparent. Although the individual LRU MTBURs have remained relatively steady, the commonality dividend and the averaging effects are evident when we consider the total investment rather than just the savings themselves. Figure 6 illustrates not only these points but also that the investment required for a 'combined' fleet differs little from the investment required for a fleet consisting of only A320s.

In this article we have considered only the single aisle family using data for the A320, A319 and a non-common aircraft of similar size. Similar commonality savings are evident with the A321 and the long-range A340/A330 family as can be seen in the similarity between Figures 6 and 7.

The commonality dividend and the averaging effects are evident when we consider the total investment rather than just the savings themselves. Figure 6 illustrates not only these points but also that the investment required for a ‘combined’ fleet differs little from the investment required for a fleet consisting of only A320s.

In this article we have considered only the single aisle family using data for the A320, A319 and a non-common aircraft of similar size. Similar commonality savings are evident with the A321 and the long-range A340/A330 family as can be seen in the similarity between Figures 6 and 7.
Airbus Industrie is able to demonstrate that its aircraft families share large commonality in aircraft spares, enabling operators to reduce their operating costs. This has been achieved through aircraft design with maintenance in mind. Further, the fly-by-wire technology has lent itself to improving commonality by integrating the Automated Flight System Computers into a reduced number of LRUs, which share high commonality and reliability within the family groups. So, when it comes to aircraft spare parts, Airbus Industrie is glad to be called common, reliable and punctual.

However with eleven years of technological improvements the Auto Flight system MTBUR has increased quite dramatically from the non-FBW aircraft to the latest technology FBW aircraft, the A320 and A340. The savings for a recommended spares investment in dollar terms as a result of the integration of AFS functions are considerable. The investment required for the AFS equipment for ten A340 or A320 being roughly half of that required for ten non FBW type aircraft. The advances made in component integration offsets the increase in price of the individual LRUs (Figure 10).

The cost effectiveness of the integration of the AFS can be measured by dividing the recommended spares investment figures by the AFS reliability i.e. Cost/AFS MTBUR. The results can be seen in the Figure 11.

The AFS fitted to the A320 is four times, and the A340 seven times, more cost effective than the pre-FBW aircraft and as fleet size increases this effect becomes more pronounced.

The repair processing time

Airbus Industrie has taken the initiative with its proprietary parts repair turnaround time.

Airbus Industrie now guarantees a maximum of 15 calendar days repair time for its proprietary parts. This is backed up by a forward exchange at no additional cost should the repair time exceed this guarantee. The operator in this case is then only invoiced for the repair charges and not the exchange fee. This significantly reduces the level of inventory which needs to be stored to cover those “just-in-case” situations and moves away from the current industry ‘standard’ of guaranteeing average repair times.

CONCLUSION

Airbus Industrie is able to demonstrate that its aircraft families share large commonality in aircraft spares, enabling operators to reduce their operating costs. This has been achieved through aircraft design with maintenance in mind. Further, the fly-by-wire technology has lent itself to improving commonality by integrating the Automated Flight System Computers into a reduced number of LRUs, which share high commonality and reliability within the family groups. So, when it comes to aircraft spare parts, Airbus Industrie is glad to be called common, reliable and punctual.
The basic windshield rain protection system on Airbus aircraft consists of two electrically operated windshield wipers, one on the Captain’s side and one on the First Officer’s side (Figure 1). The wipers can be operated independently and at low or high speed, depending on the level of the precipitation (Figure 2). An optional intermittent function is also available.

All Airbus aircraft are certified for operation without further windshield rain protection system.

All Airbus aircraft are also equipped with a so-called rain repellent system. This system allows spraying of a fluid onto the windshield outer surface when heavy rain is encountered (see Figure 3 on the following page). The fluid can be sprayed independently on the Captain’s side and on the First Officer’s side. It temporarily modifies the surface tension on the windshield and, combined with the effect of the air flow caused by aircraft movement, prevents water droplets from adhering to the windshield outer surface.

The ‘Rainboe’ rain repellent fluid originally used on Airbus aircraft and on all other jetliners equipped with a similar system contains CFC 113. This substance is a type of freon (Chloro-fluorocarbon). It is officially listed as an Ozone depleting substance by the Montreal Protocol which bans its production, import and export since 1st January 1996.

Since this date and in order to comply with the international agreements for the protection of the Ozone layer (Vienna Convention and Montreal Protocol), the ‘Rainboe’ fluid bottle is no longer installed on delivered aircraft. Airbus Industrie has nevertheless taken the option to leave the rain repellent system installed on the aircraft (electrically deactivated) whilst actively working with chemical manufacturers on the development of a new rain repellent fluid free of CFC.

Service Bulletins for all aircraft types were issued in January 1996 in order to allow ‘Rainboe’ fluid bottle removal and system deactivation on aircraft in service (refer to Table below for the applicable Service Bulletins and Modifications references).

---

**Applicable Service Bulletins and Modifications references**

**‘RAINBOE’ RAIN REPELLENT FLUID DEACTIVATION**

<table>
<thead>
<tr>
<th>MOD</th>
<th>MOD</th>
<th>MOD</th>
<th>A310</th>
<th>A319/A320/A321</th>
<th>A330</th>
<th>A340</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB</td>
<td>A300</td>
<td>A300-600</td>
<td>11480</td>
<td>14480</td>
<td>1310</td>
<td>125419</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>11480</td>
<td>14480</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>11480</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| CFC FREE (LBFS) RAIN REPELLENT FLUID INSTALLATION**

<table>
<thead>
<tr>
<th>MOD</th>
<th>MOD</th>
<th>MOD</th>
<th>A300</th>
<th>A300-600</th>
<th>A310</th>
<th>A319/A320/A321</th>
<th>A330</th>
<th>A340</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB</td>
<td>A300</td>
<td>A300-600</td>
<td>11974</td>
<td>11974</td>
<td>11974</td>
<td>26963</td>
<td>48597</td>
<td>48597</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**PPG ‘SURFACE SEAL’ COATING INSTALLATION**

AIRBUS Service Information Letter 30-024 - Issued in July 1997

(1) SB issued in January 1996 (2) SB will be issued by end of 1998 (3) SB issued in July 1998

---
HYDROPHOBIC COATINGS
- AN ALTERNATIVE -
For those operators wishing to leave the rain repellent system deactivated, Airbus Industrie has also formally approved the use of the PPG Industries "Surface Seal" windshield hydrophobic coating on all Airbus aircraft types. The coating, which can be used without restriction on all types of windshields available on Airbus aircraft, consists of a treatment applied on the windshield outer surface in a liquid form. It dries out to provide rain repellent characteristics similar to those of the fluid.

The coating does not contain CFC and is therefore not subjected to the requirements of the Montreal protocol. The treatment has a limited service life and needs to be reapplied on a regular basis.

Airbus Service Information Letter 30-024, issued in July 1997, provides procurement and material information related to the coating, as well as recommendations for application and servicing. The content of this SIL is being incorporated in the Aircraft Maintenance Manual, Maintenance Planning document, Consumable Materials List and Tool and Equipment Manual in accordance with the normal revision planning set for each document and aircraft type.

Airbus Industrie is closely monitoring the development of other windshield hydrophobic coatings, which will also be incorporated in the SIL and in the aircraft documentation if their performance on Airbus aircraft is found to be satisfactory.

NEW RAIN REPELLENT FLUID FREE OF CFC
A new rain repellent fluid has been successfully developed. The product complies with all the existing regulations for fluid application and is compatible with all existing windshield rain repellent systems on Airbus aircraft.

Laboratory testing has confirmed its compliance with the existing easy of use and performance requirements. The rain repellent fluid bottle is supplied by Le Bozec Filtration and Systems (LBFS). Refer to the Table on the preceding page for the applicable Service Bulletins and Mod references.

Airbus Industrie is now preparing the introduction of the new fluid in production. Service Bulletins will allow reactivation of the rain repellent systems and installation of the fluid bottle on aircraft in service. The fluid bottle is supplied by Le Bozec Filtration and Systems (LBFS). Refer to the Table on the preceding page for the applicable Service Bulletins and Mod references.

CONCLUSION
The commitments of Airbus Industrie on the subject of windshield rain protection were twofold:

- To comply with the requirements of the Montreal Protocol on Ozone depleting substances.
- To provide Airbus operators with an alternative form of windshield rain protection, in addition to the basic wiper system.

These commitments are today achieved with the removal of the 'Rainboe' fluid from the Airbus aircraft and with the availability of two alternative forms of windshield rain protection for use on all Airbus aircraft types:

- A new rain repellent fluid,
- A windshield hydrophobic coating.

The needs of Airbus operators regarding windshield rain protection vary a lot, depending on local weather conditions, habits, operational and maintenance procedures. Airbus Industrie strongly believes that the choice of fluid or coating now available provides the best response to these different needs.

Airbus Industrie Service Information Letter 30-024 issued in July 1997, provides the necessary information for application and servicing of the new fluid.

Airbus Industrie Service Information Letter 30-024 issued in July 1997, provides the necessary information for application and servicing of the new fluid.

Airbus Industrie Service Information Letter 30-024 issued in July 1997, provides the necessary information for application and servicing of the new fluid.
Technical Publications which reflect the configuration of your aircraft

Airbus Industrie endeavours to supply all Airbus Operators with Technical Publications that accurately reflect the configuration of their aircraft. However, in order to do this, the Operators must supply Airbus Industrie with the relevant data on Service Bulletins (SB) selected for, and implemented on the aircraft in a timely manner, since the Operators are the sole source of such information.

During aircraft final assembly, for each piece of equipment installed in the aircraft, the relevant data is directly incorporated into the Technical Publications. In this case, the Airbus Industrie internal process is smooth, as the source of the data is controlled by Airbus Industrie production system.

Once the aircraft has been in service, the aircraft is regularly inspected, repaired and upgraded by the incorporation of SBs. The Technical Publications should evolve with the aircraft, reflecting the changes that the aircraft undergoes throughout its service life. To enable this to happen, Operators should systematically report SB selection and accomplishment to Airbus Industrie. These changes can only be reflected in the customised manuals and when Airbus Industrie is informed of them. In the event an aircraft is sold or transferred from one operator to another, Technical Publications which accurately reflect the state of the aircraft can significantly ease the sale or transfer.

1st step: SB selection

Upon receipt of an Airbus Industrie SB, the Operator decides whether the change is to be accepted and implemented on the fleet. The last page of each SB (Figure 1) can be used to inform Airbus Industrie of this decision: SB selected for embodiment or SB rejected. Airbus Industrie also accepts a simple fax, letter or other document from the Operator.

When Airbus Industrie has been informed of the Operator’s decision, the records are updated and a target date for the updating of the manuals is supplied to the Operator. Once the SB has been selected, data is incorporated in the affected customised maintenance manuals:

- Aircraft Maintenance Manual (AMM),
- Aircraft Wiring Manual (AWM),
- Aircraft Wiring List (AWL),
- Illustrated Parts Catalog (IPC).

Note: All affected non-customised manuals are systematically revised with SB data after SB release (no Operator input is required).

The original information i.e. PRE SB data, remains valid but, in addition, the POST SB data is included and dual configuration is shown, i.e. PRE and POST service bulletin configuration.

Figure 1
SB acceptance/rejection sheet

Service bulletin acceptance/rejection sheet

A340

This SB can only be incorporated in your customised documentation within the agreed time schedule as far as this sheet is returned to us on purchase date and signed by a duly authorized empowered officer or representative.
Figure 2A shows the PRE solution and also the PRE and POST SB solution in the AMM with the addition of subtask 26-21-00-860-057-A (highlighted) in the close-up paragraph.

As long as aircraft 0401 to 0405 are PRE SB A340-24-4015, the PRE SB subtask 26-21-00-860-057 applies.

When aircraft are retrofitted, the maintenance personnel can then find the POST SB subtask 26-21-00-860-057-A.

Figure 2B shows the introduction of new part number 5908974-17 (highlighted) in Figure 1-1B of the IPC 24-22-34-1 for aircraft 0401 to 0405. Pending retrofit on the aircraft, the Operator’s maintenance personnel can consult the PRE SB data while POST SB data is also available (highlighted). Note: If the SB is rejected, only the PRE SB data is reflected.

In addition and upon specific request, a Temporary Revision (TR) (Figure 4) can be issued when the new pages of the manual are needed on an urgent basis.

When the SB is reported as having been accomplished on the whole fleet, the PRE SB data is removed from the customised maintenance manuals: AMM, TSM, ASM, AWM, AWL and IPC.

As long as one aircraft remains to be retrofitted, both PRE and POST SB configurations are valid and will be reflected in the manuals.

Figure 3 shows a completed card. Here also a simple fax, letter or other document from the Operator is accepted.

For each aircraft the SB accomplishment is recorded and a target date for the updating of the manuals is supplied to the Operator. When affected, the operational manuals are revised:

- Flight Crew Operating Manual (FCOM),
- Quick Reference Handbook (QRH),
- Aircraft Flight Manual (AFM),
- Master Minimum Equipment List (MMEL).

The operational manuals are configured on an aircraft-by-aircraft basis and every SB accomplishment is reflected. In addition, any relevant Operations Engineering Bulletin (OEB) can be removed.

In addition and upon specific request, a Temporary Revision (TR) (Figure 4) can be issued when the new pages of the manual are needed on an urgent basis.

When the SB is reported as having been accomplished on the whole fleet, the PRE SB data is removed from the customised maintenance manuals: AMM, TSM, ASM, AWM, AWL and IPC.

As long as one aircraft remains to be retrofitted, both PRE and POST SB configurations are valid and will be reflected in the manuals.

2nd step:
SB accomplishment

As soon as an SB is installed on a given aircraft, all that is required of the Operator is to notify Airbus Industrie. The pre-printed card that is supplied together with the kit can be used to inform Airbus Industrie of SB accomplishment.

Figure 3 shows a completed card. Here also a simple fax, letter or other document from the Operator is accepted.

For each aircraft the SB accomplishment is recorded and a target date for the updating of the manuals is supplied to the Operator.

When affected, the operational manuals are revised:

- Flight Crew Operating Manual (FCOM),
- Quick Reference Handbook (QRH),
- Aircraft Flight Manual (AFM),
- Master Minimum Equipment List (MMEL).

The operational manuals are configured on an aircraft-by-aircraft basis and every SB accomplishment is reflected. In addition, any relevant Operations Engineering Bulletin (OEB) can be removed.

In addition and upon specific request, a Temporary Revision (TR) (Figure 4) can be issued when the new pages of the manual are needed on an urgent basis.

When the SB is reported as having been accomplished on the whole fleet, the PRE SB data is removed from the customised maintenance manuals: AMM, TSM, ASM, AWM, AWL and IPC.

As long as one aircraft remains to be retrofitted, both PRE and POST SB configurations are valid and will be reflected in the manuals.
Figure 6 shows the introduction page of a typical SB list, including the Operator’s Engineering Order (EO). The left column gives the SB incorporation code: ‘S’ means split (or dual) configuration (PRE and POST) while ‘C’ indicates the complete (final) configuration (POST).

This process ensures that the manuals accurately reflect the technical status of the fleet with respect to SB application. The volume of the manuals is also significantly reduced after fleet-wide SB reporting, as obsolete PRE SB data is removed from the manuals leaving the relevant POST SB information. This also results in more user-friendly manuals and can help avoid any confusion when ordering spares and carrying out maintenance tasks.

An overall view of SB application/incorporation is available in the SB list of each maintenance manual.

Figure 6 shows the introduction page of a typical SB list, including the Operator’s Engineering Order (EO). The left column gives the SB incorporation code: ‘S’ means split (or dual) configuration (PRE and POST) while ‘C’ indicates the complete (final) configuration (POST).

On the Operator’s request, it is possible to show the Operator’s internal EO number that is associated with the SB.
SERVICE BULLETIN
CONFIGURATION REVIEW

An SB configuration review has been launched and sent to all Airbus Industrie Operators with specific emphasis on the SBs which are classified as mandatory (linked to an Airworthiness Directive).

This exercise enables the Operators to review their SB data and to make sure that proper information is supplied to Airbus Industrie. As a result, the technical level and content of all maintenance and operational documentation should reflect the technical status of the Operators’ fleets.

Two SB status lists were sent to all Airbus Industrie Operators:
- The first list containing all SBs which are effective for the Operator’s fleet.
- The second list containing only mandatory SBs.

Figure 7 shows one status list. This list is available in printed form and on diskette. They reflect the current SB embodiment status based on the data received from the Operators. In the case of leased or second-hand aircraft, they also include SB status reported from previous Operators.

Each Operator is requested to provide Airbus Industrie with the configuration of their aircraft after cross checking against the real aircraft status. Then Airbus Industrie will update their database. Continuous updating will also be performed from the regular reports which should be received from each Operator.

Methods of SB reporting will improve as time goes on, and reduce the Operators’ workload. On-line access to the Technical Publications database will become available with SPOC (Single Point of Contact). Another reporting process using bar codes could also be introduced. A project is under evaluation to record bar codes on the SB kits, Line Replaceable Units (LRUs), and Airbus Industrie proprietary parts. This system of recording could not only trace the repair of any specific piece of equipment but it could also make it possible to easily and safely monitor the changes carried out on each aircraft.

CONCLUSION

In the early days of civil aviation, Environmental protection actually meant Protection from the Environment. Windshields were carefully profiled to give the maximum protection, and rain dispersion was provided by a quick wipe of the pilot’s hand. All that was needed was a good scarf and/or hat, and a pair of goggles, for the passengers as well as the pilot.

Mind you, having a stiff upper lip probably made the elements easier to bear.
## Resident Customer Support Representation

### USA / Canada

Thierry van der Heyden, Vice President Customer Services  
Telephone: +1.703.834.3484 / Telefax: +1.703.834.3464

### China

Emmanuel Peraud, Director Customer Services  
Telephone: +86.10.6456.7720 / Telefax: +86.10.6456.76942 / 3 / 4

### Rest of the World

Mohamed El-Boraï, Vice President Customer Support Services Division  
Telephone: +33 (0) 5 61 93 35 04 / Telefax: +33 (0) 5 61 93 41 01

### General Administration

Jean-Paul Gayral, Resident Customer Representation Administration Director  
Telephone: +33 (0) 5 61 93 38 79 / Telefax: +33 (0) 5 61 93 49 64

<table>
<thead>
<tr>
<th>Location</th>
<th>Country</th>
<th>Telephone 1</th>
<th>Telephone 2</th>
<th>Telephone 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abu Dhabi</td>
<td>United Arab Emirates</td>
<td>971 (2) 706 7702</td>
<td>971 (2) 757 0975</td>
<td></td>
</tr>
<tr>
<td>Amman</td>
<td>Jordan</td>
<td>962 (6) 445 1284</td>
<td>962 (6) 445 1195</td>
<td></td>
</tr>
<tr>
<td>Athens</td>
<td>Greece</td>
<td>30 (1) 981 8581</td>
<td>30 (1) 983 2479</td>
<td></td>
</tr>
<tr>
<td>Bangkok</td>
<td>Thailand</td>
<td>66 (2) 541 0070</td>
<td>66 (2) 501 1100</td>
<td></td>
</tr>
<tr>
<td>Beijing</td>
<td>People’s Republic of China</td>
<td>86 (10) 3347 2688</td>
<td>86 (10) 8547 0033</td>
<td></td>
</tr>
<tr>
<td>Beirut</td>
<td>Lebanon</td>
<td>961 (1) 901 300</td>
<td>961 (1) 901 200</td>
<td></td>
</tr>
<tr>
<td>Berlin</td>
<td>Germany</td>
<td>49 (30) 887 55 245</td>
<td>49 (30) 887 55 245</td>
<td></td>
</tr>
<tr>
<td>Bogota</td>
<td>Columbia</td>
<td>57 (1) 471 283896</td>
<td>57 (1) 471 283896</td>
<td></td>
</tr>
<tr>
<td>Bombay (Mumbai)</td>
<td>India</td>
<td>91 (22) 618 3273</td>
<td>91 (22) 611 3691</td>
<td></td>
</tr>
<tr>
<td>Brussels</td>
<td>Belgium</td>
<td>32 2723 4824/25 26</td>
<td>32 2723 8823</td>
<td></td>
</tr>
<tr>
<td>Buenos Aires</td>
<td>Argentina</td>
<td>54 (11) 420 3903</td>
<td>54 (11) 401 1008</td>
<td></td>
</tr>
<tr>
<td>Cairo</td>
<td>Egypt</td>
<td>20 (2) 418 3687</td>
<td>20 (2) 418 3707</td>
<td></td>
</tr>
<tr>
<td>Caracas</td>
<td>Venezuela</td>
<td>58 315 52 210</td>
<td>58 315 52 210</td>
<td></td>
</tr>
<tr>
<td>Colombo</td>
<td>People’s Republic of China</td>
<td>80 (29) 270 1001</td>
<td>80 (29) 301 391</td>
<td></td>
</tr>
<tr>
<td>Chicago</td>
<td>USA (Illinois)</td>
<td>1773 301 2602</td>
<td>1773 301 2405</td>
<td></td>
</tr>
<tr>
<td>Dakar</td>
<td>Senegal</td>
<td>221 801 615</td>
<td>221 801 148</td>
<td></td>
</tr>
<tr>
<td>Delhi</td>
<td>Bangladesh</td>
<td>99075 351 219</td>
<td>99075 351 219</td>
<td></td>
</tr>
<tr>
<td>Dubai</td>
<td>India</td>
<td>91 (11) 385 2035</td>
<td>91 (11) 385 2035</td>
<td></td>
</tr>
<tr>
<td>Derby</td>
<td>England</td>
<td>44 1332 852 898</td>
<td>44 1332 852 898</td>
<td></td>
</tr>
<tr>
<td>Detriot</td>
<td>USA (Michigan)</td>
<td>1 (313) 247 5090</td>
<td>1 (313) 247 5090</td>
<td></td>
</tr>
<tr>
<td>Dubai</td>
<td>United Arab Emirates</td>
<td>971 (2) 2381 58113/2</td>
<td>971 (2) 2381 58113/2</td>
<td></td>
</tr>
<tr>
<td>Dublin</td>
<td>Ireland</td>
<td>32 (1) 705 2324</td>
<td>32 (1) 705 3813</td>
<td></td>
</tr>
<tr>
<td>Dusseldorf</td>
<td>USA (Minnesota)</td>
<td>1 (218) 733 5077</td>
<td>1 (218) 733 5077</td>
<td></td>
</tr>
<tr>
<td>Frankfurt</td>
<td>Germany</td>
<td>49 (21) 941 8687</td>
<td>49 (21) 941 8687</td>
<td></td>
</tr>
<tr>
<td>Guangzhou</td>
<td>People’s Republic of China</td>
<td>86 (20) 8512 8513</td>
<td>86 (20) 8512 8513</td>
<td></td>
</tr>
<tr>
<td>Guayaquil</td>
<td>Ecuador</td>
<td>593 (9) 744 741</td>
<td>593 (9) 744 741</td>
<td></td>
</tr>
<tr>
<td>Hangzhou</td>
<td>People’s Republic of China</td>
<td>86 (21) 515 5076</td>
<td>86 (21) 515 5076</td>
<td></td>
</tr>
<tr>
<td>Hanoi</td>
<td>Vietnam</td>
<td>84 (46) 721 611</td>
<td>84 (46) 721 611</td>
<td></td>
</tr>
<tr>
<td>Ho Chi Minh City</td>
<td>Vietnam</td>
<td>84 (8) 64 25 602</td>
<td>84 (8) 64 25 602</td>
<td></td>
</tr>
<tr>
<td>Hong Kong</td>
<td>People’s Republic of China</td>
<td>852 2347 8449</td>
<td>852 2347 8449</td>
<td></td>
</tr>
<tr>
<td>Istanbul</td>
<td>Turkey</td>
<td>90 (21) 570 1312</td>
<td>90 (21) 570 1692</td>
<td></td>
</tr>
<tr>
<td>Jakarta</td>
<td>Indonesia</td>
<td>62 (21) 550 1923</td>
<td>62 (21) 550 1943</td>
<td></td>
</tr>
<tr>
<td>Johannesburg</td>
<td>South Africa</td>
<td>27 (11) 978 3193</td>
<td>27 (11) 978 3193</td>
<td></td>
</tr>
<tr>
<td>Karachi</td>
<td>Pakistan</td>
<td>92 (21) 457 0646</td>
<td>92 (21) 457 0646</td>
<td></td>
</tr>
<tr>
<td>Kingston</td>
<td>Jamaica</td>
<td>1 (268) 324 2097</td>
<td>1 (268) 324 2097</td>
<td></td>
</tr>
<tr>
<td>Kuala Lumpur</td>
<td>Malaysia</td>
<td>60 (3) 746 7352</td>
<td>60 (3) 746 7230</td>
<td></td>
</tr>
<tr>
<td>Kuwait</td>
<td>Kuwait</td>
<td>985 474 2193</td>
<td>985 474 2193</td>
<td></td>
</tr>
<tr>
<td>Kyrgyzstan</td>
<td>Kyrgyz</td>
<td>99 (9) 976 1384</td>
<td>99 (9) 976 1384</td>
<td></td>
</tr>
<tr>
<td>Lisbon</td>
<td>Portugal</td>
<td>39 (1) 404 7022</td>
<td>39 (1) 947 4444</td>
<td></td>
</tr>
<tr>
<td>London (CHI)</td>
<td>England</td>
<td>44 (181) 751 5431</td>
<td>44 (181) 751 5431</td>
<td></td>
</tr>
<tr>
<td>Luton</td>
<td>England</td>
<td>44 (1882) 36 8706</td>
<td>44 (1882) 36 8706</td>
<td></td>
</tr>
<tr>
<td>Madinah</td>
<td>Malaysia</td>
<td>609 436 4067</td>
<td>609 436 4067</td>
<td></td>
</tr>
<tr>
<td>Madrid</td>
<td>Spain</td>
<td>34 (11) 329 1444</td>
<td>34 (11) 329 1444</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>Maldives</td>
<td>960 317 042</td>
<td>960 317 042</td>
<td></td>
</tr>
<tr>
<td>Manchester</td>
<td>England</td>
<td>44 (161) 488 3155</td>
<td>44 (161) 488 3240</td>
<td></td>
</tr>
<tr>
<td>Manila</td>
<td>Philippines</td>
<td>65 (2) 251 3444</td>
<td>65 (2) 251 3444</td>
<td></td>
</tr>
<tr>
<td>LOCATION</td>
<td>COUNTRY</td>
<td>TELEPHONE</td>
<td>TELEFAX</td>
<td></td>
</tr>
<tr>
<td>--------------</td>
<td>------------------------</td>
<td>-------------------</td>
<td>------------------</td>
<td></td>
</tr>
<tr>
<td>MAURITIUS</td>
<td>Mauritius</td>
<td>230 637 8542</td>
<td>230 637 3882</td>
<td></td>
</tr>
<tr>
<td>MEDELIN</td>
<td>Columbia</td>
<td>57 (4) 5961027</td>
<td>57 (4) 5961024</td>
<td></td>
</tr>
<tr>
<td>MEMPHIS</td>
<td>USA (Tennessee)</td>
<td>1 (901) 224 3842</td>
<td>1 (901) 224 5018</td>
<td></td>
</tr>
<tr>
<td>NEW YORK</td>
<td>USA (New York)</td>
<td>1 (718) 656 0700</td>
<td>1 (718) 656 8636</td>
<td></td>
</tr>
<tr>
<td>NUREMBERG</td>
<td>Germany</td>
<td>49 (91) 365 68219</td>
<td>49 (91) 365 68218</td>
<td></td>
</tr>
<tr>
<td>PARIS (CDG)</td>
<td>France</td>
<td>33 (0) 1 49 78 02 88</td>
<td>33 (0) 49 78 01 85</td>
<td></td>
</tr>
<tr>
<td>PHOENIX</td>
<td>USA (Arizona)</td>
<td>1 (602) 705 745</td>
<td>1 (602) 705 7444</td>
<td></td>
</tr>
<tr>
<td>PITTSBURG</td>
<td>USA (Pennsylvania)</td>
<td>1 (724) 472 6420</td>
<td>1 (724) 472 1052</td>
<td></td>
</tr>
<tr>
<td>ROME</td>
<td>Italy</td>
<td>39 (6) 6501 0564</td>
<td>39 (6) 652 9077</td>
<td></td>
</tr>
<tr>
<td>SEOUL</td>
<td>South Korea</td>
<td>82 (2) 677 6777</td>
<td>82 (2) 677 1158</td>
<td></td>
</tr>
<tr>
<td>SINGAPORE</td>
<td>Singapore</td>
<td>65 (5) 655 027</td>
<td>65 (5) 652 380</td>
<td></td>
</tr>
<tr>
<td>TAIPEI</td>
<td>Taiwan</td>
<td>886 (2) 25 450 424</td>
<td>886 (2) 25 450 383</td>
<td></td>
</tr>
<tr>
<td>TASHKENT</td>
<td>Uzbekistan</td>
<td>7 (72) 653 5559</td>
<td>7 (72) 653 5559</td>
<td></td>
</tr>
<tr>
<td>TEHRAN</td>
<td>Iran</td>
<td>98 (21) 603 5647</td>
<td>98 (21) 603 5647</td>
<td></td>
</tr>
<tr>
<td>TOKYO (HND)</td>
<td>Japan</td>
<td>81 (3) 576 5081</td>
<td>81 (3) 576 5084</td>
<td></td>
</tr>
<tr>
<td>TORONTO</td>
<td>Canada</td>
<td>1 (416) 977 1674</td>
<td>1 (416) 977 1670</td>
<td></td>
</tr>
<tr>
<td>TULSA</td>
<td>USA (Oklahoma)</td>
<td>1 (918) 292 3227</td>
<td>1 (918) 292 2581</td>
<td></td>
</tr>
<tr>
<td>TUNIS</td>
<td>Tunisia</td>
<td>216 (1) 260 369</td>
<td>216 (1) 260 369</td>
<td></td>
</tr>
<tr>
<td>VANCOPUR</td>
<td>Canada</td>
<td>1 (604) 771 5555</td>
<td>1 (604) 771 5555</td>
<td></td>
</tr>
<tr>
<td>VIENNA</td>
<td>Austria</td>
<td>43 (1) 707 3688</td>
<td>43 (1) 707 3235</td>
<td></td>
</tr>
<tr>
<td>WINNIPEG</td>
<td>Canada</td>
<td>1 (204) 985 9908</td>
<td>1 (204) 985 2489</td>
<td></td>
</tr>
<tr>
<td>YAKUTSK</td>
<td>Russia</td>
<td>7 (4112) 420 169</td>
<td>7 (4112) 420 165</td>
<td></td>
</tr>
<tr>
<td>YEREVAN</td>
<td>Armenia</td>
<td>374 253 415</td>
<td>374 253 415</td>
<td></td>
</tr>
<tr>
<td>ZAGREB</td>
<td>Croatia</td>
<td>385 (1) 568 2336</td>
<td>385 (1) 568 2337</td>
<td></td>
</tr>
<tr>
<td>ZURICH</td>
<td>Switzerland</td>
<td>41 (1) 893 7247</td>
<td>41 (1) 893 7248</td>
<td></td>
</tr>
</tbody>
</table>
Airbus Resident Customer Support Managers are based at their operator’s premises. With over 25 nationalities represented, they can be relied upon to understand your country’s culture, ensuring they’ve a close relationship based on mutual trust. Many have an airline background, which means they’re at home with your operation and aircraft. In fact, whatever you require, you can be sure our Resident Customer Support Managers are all ears. Airbus Customer Services. Dedicated to meet your requirements.

http://www.airbus.com