JULY 2004

FLIGHT
AIRWORTHINESS
SUPPORT
TECHNOLOGY

FAST 34

AIRBUS TECHNICAL DIGEST

FAST 34

AIRBUS

edito

Denis Dempster,
Agnès Massol-Lacombe
and Kenneth Johnson

Dear FAST reader,

This issue of FAST marks the end of an era - it is the last FAST which will be produced under the guidance of our editor Denis Dempster. Denis, who is retiring in the summer, has been FAST editor almost since the beginning, taking over from the third issue. His first issue of FAST was in 1984, when Airbus had only the A300 and A310 aircraft in service. Since then, the A320 and A330/A340 aircraft families have gone into service, with a resulting increase of articles covering their advanced technology. Denis has seen FAST through the expansion of the Airbus family and the ups and downs of our industry. He has unfailingly produced excellent, informative and well received articles, which is confirmed by the results of the survey enclosed in FAST 33. These results give very high scores for the level of content, readability, attractiveness and quality of FAST. Denis brought exceptional abilities, patience and humour to FAST and he will be sorely missed, but after 49 years in the industry, his retirement is well earned, so my colleagues and I here in Airbus would like to thank him for his exceptional work and wish him well in his retirement. I feel confident that you, the readers of his work over the past 20 years, will feel the same and therefore we will wish him well on your behalf.

We are fortunate that Agnès Massol-Lacombe, who is the art director of FAST and has worked on it since the beginning, will carry on with us to provide continuity in the future with our new editor. Agnès provides the artistic organisation, which makes FAST the attractive magazine it is, confirmed by the survey mentioned above.

Our new FAST editor is Kenneth Johnson. Kenneth has wide and long experience of the commercial aircraft industry from propjet airliners, through Concorde to the fly-by-wire airliners of today. He has over 20 years experience with Airbus aircraft, having been involved with all of them from the A300 to the A340, both in France and Germany. His experience covers various technical and industry areas including structural, cabin, electrical and avionic systems and he has spent the last 17 years here in Toulouse involved in the production of technical, communication and marketing documents for Airbus Customer Services. He, Denis and Agnès have worked together in the production of this FAST to ensure a smooth handover and Kenneth will take over as FAST editor for future issues.

I and my colleagues welcome Kenneth to the Airbus Customer Services Communications team and wish him well in his new task.

Yours sincerely,

Bruno Piquet,
FAST Publisher

FAST

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

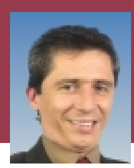
Aging aircraft electrical systems investigation

Airbus recommendations to enhance the design & maintenance of aircraft electrical wiring systems

Aircraft systems, including electrical wiring systems, are becoming more and more complex and electrical wires and their associated components are becoming increasingly important with respect to aircraft systems that are necessary for safe flight. There has been, and continues to be, events associated with wire failures, and aging wiring has become a key issue that transcends individual federal agencies.

As a logical follow-on to a 1997 recommendation by the White House Commission on Aviation Safety and Security, chaired by Vice President Gore, the US Federal Aviation Administration and industry representatives are working together to determine whether existing design and maintenance practices may be improved to ensure the continued airworthiness of older aircraft.

This is being done under the *"Aging Transport System Rule making Advisory Committee"* (ATSRAC) activities.



Dominique Chevant
Aircraft Aging Systems Manager
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AGING AIRCRAFT ELECTRICAL SYSTEMS INVESTIGATION

BACKGROUND

The investigation into a fatal accident on 17 July 1996 resulted in a heightened awareness of the importance of maintaining the integrity of aircraft and, in February 1997, the US White House Commission on Aviation Safety and Security (WHCSS) recommended to the Federal Aviation Administration (FAA) to work in cooperation with airlines and manufacturers to expand the FAA's Aging Airplane Programme to include non-structural components.

In July 1998, the FAA issued the Aging Transport Non-Structural Systems Plan to address the WHCSS recommendation. The Aging Systems Plan focussed specifically on wiring systems.

To help fulfil the actions specified in this Aging Systems Plan, the FAA set-up an Aging Transport Systems Rulemaking Advisory Committee (ATSRAC), which is composed of key members of the aviation industry, to give recommendations on aircraft safety issues and propose enhancements to current procedures.

ATSRAC PHASE 1

ATSRAC focused its efforts on jet transport category aircraft whose type certificates were at least 20 years old and in 1998 was given five major tasks. They included collecting data on aging electrical wiring systems through aircraft inspections, reviewing aircraft manufacturer's fleet service history, reviewing operator's maintenance criteria, standard practices for electrical wiring and repair training programmes.

To accomplish these tasks ATSRAC chose to establish five separate working groups composed of ATSRAC members and industry representatives, to provide technical support in conducting analyses and developing recommendations.

TASK 1
SAMPLING INSPECTION OF THE FLEET

The first working group conducted an in-depth survey of the condition of the electrical wiring in an aging aircraft fleet. This sampling program included a non-intrusive inspection of the electrical wiring on 81 in-service aircraft (eight aircraft types selected: B727, B737, B747, DC-8, DC-9, DC-10, A300 and L1011) and an intrusive evaluation of the electrical wiring removed from six decommissioned aircraft, with additional laboratory analysis of wiring samples.

A total of 3,372 notable items were found during the survey, most of them were related to maintenance activity, passage of personnel, lack of housekeeping and/or inadequate protection. Fluid or chemical contamination, significant dust, lint and metal shavings were seen on most aircraft.

None of the observed items were determined to be issues affecting aircraft or personnel safety and no immediate airworthiness issues were noted. However, for reasons of repeat occurrences in the same general area, 182 items were thought to be "Significant". Additional engineering analysis was conducted to propose solutions as necessary via either maintenance enhanced inspection guidelines and processes and/or Service Bulletins (SBs).

The result of this analysis with regard to five fixes for the A300, and the availability status for each, is provided in table 1.

The evaluation of the survey results and findings indicated that in many cases, the current design, maintenance and modification procedures could identify existing or potential electrical wiring problems. However, the survey confirmed that these inspection procedures could not always prevent an actual or potential wiring

Wire failures are known to be contributory factors in some aircraft incidents and wire related failures can be attributed to multiple factors. These include, but are not limited to: localised heat damage, breached wire insulation, embrittlement, chafing, arcing, reduced insulation resistance, defective or broken connectors. Nevertheless, problems associated with systems on aging aircraft are not completely related to the degradation of wire over time. Wire system degradation could also result from inadequate design, installation, maintenance and modification practices.

Table 1- A300 inspection and modification status

Significant item	Status	References
1. Clamp slippage on rod	- Inspection Service Bulletin (ISB) issued 21-Feb-03 with compliance recommended to assess clamp inst. on rods at Frame 77 & to repair as necessary as per ESPM (Electrical Standard Practices Manual) procedure - ESPM 20 Repair section provides enhanced technical process for improved gripping of the clamping attachment when found loose.	ISB 24-0094 dated 21-Feb-03 ESPM 20-52-13
2. Bundle sagging	- Enhanced inspection guidelines as per Task 3 report will be introduced in MPD section Introduction. - ESPM 20 Repair section provides enhanced inspection criteria for bundle sagging and technical process for repair as necessary	MPD-Intro ESPM 20-52-13
3. Conduit clamping at conduit end	- Enhanced inspection guidelines as per Task 3 report will be introduced in MPD section Introduction. - ESPM 20 Repair section provides grommet clamps alternative to metal clamps at the end of convoluted conduits.	MPD-Intro ESPM 20-52-13
4. Bundle at panel 811VU	- Modification Service Bulletin (MSB) (Mod. 12432/D21880) issued 15-Jan-03 with compliance recommended, to introduce additional bundle protection and attachment. - Illustrated Parts Catalog (IPC) will reflect the latest installation configuration as per MOD/SB embodiment & reporting process for IPC revision.	MSB 24-0096 dated 15-Jan-03 (IPC 31-16-12)
5. Bracket unstuck at panel 800VU	- Mod SB (Mod 12431/D21879) issued 15-Jan-03 with compliance recommended, to introduce riveted brackets. - Illustrated Parts Catalog (IPC) reflects the latest installation configuration as per MOD/SB embodiment & reporting process for IPC revision.	MSB 24-0097 dated 15-Jan-03 (IPC 31-16-11)

Table 2 - Service Bulletins upgraded from "Recommended" to "Mandatory"

SB reference	Issue date	Title	References of A310 and A300-600 SB
24-0053 Rev 7	14-Apr-81 31-Jul-02	Electrical power - Pylon - Inspection of feeder cables	24-2021 Rev 7: 31-Jul-02 24-6011 Rev 6: 31-Jul-02
24-0079 Rev 3	15-Mar-93 25-Feb-03	Improve tightening of APU starter feeder terminal blocks	24-2045 Rev 6: 25-Feb-03 24-6034 Rev 4: 25-Feb-03
24-0083 Rev 4	25-Feb-94 31-Jul-02	Inspect and repair wiring looms in wing/pylon inter face area	24-2052 Rev 5: 31-Jul-02 24-6039 Rev 8: 31-Jul-02

Service Bulletins upgraded from "Desirable" or "Optional" to "Recommended"

SB reference	Issue date	Title	References of A310 and A300-600 SB
24-0085 Rev 5	12-Dec-94 06-Mar-01	Improve strength of the electrical bundles at flap screw jack	24-6043 Rev 4 issued 06-Mar-01
25-0119 Rev 6	22-Dec-78 13-Nov-00	Improvement of wire bundle protection in FWD cargo compartment	N/A
27-0100 Rev 4	26-Jun-78 13-Nov-00	Rerouting of wire assembly 813 VB between FR 84 V - strut and variable lever arm unit	N/A
28-0057 Rev 2	21-Jun-78 08-Jan-01	Installation of thermo shrinkable tube for protection of fuel pump feeders	N/A
53-0046 Rev 2	29-Jun-78 13-Nov-00	Improve wiring installation between FR 25 and FR 31 in the cargo compartment	N/A

problem from occurring. Specific recommendations included enhancement of scheduled maintenance programmes, improved training programmes, and enhanced procedures for wiring protection, cleaning and routing.

TASK 2
REVIEW OF FLEET SERVICE HISTORY

This second task was to review existing service data, such as manufacturer's Service Bulletins, manufacturer's Service Information Letters, All-Operators Telexes, Operator Information Telexes, and the fleet history relating to aircraft electrical wiring.

Each aircraft manufacturer reviewed thousands of documents to determine the need for specific recommendation, or upgrade of compliance. As far as Airbus aircraft are concerned, three A300 SBs were proposed for compliance change, from "Recommended" to "Mandatory" (see Table 2).

In addition five A300 SBs were issued with a "recommended" compliance instead of "Desirable" or "Optional". When applicable, the A300 recommendations were validated on A310/A300-600 aircraft (see Table 2).

TASK 3
IMPROVEMENT OF MAINTENANCE CRITERIA

Using knowledge gained from Task 1, the third working group addressed maintenance practices and the effectiveness of maintenance programmes. Recommendations were developed to enhance general practices concerning in-service handling of electrical wiring. These included guidance on the minimisation of contamination during repairs/servicing and an enhancement of inspection criteria, particularly with respect to improving the effectiveness of General Visual Inspections (GVIs).

In order to ensure that wiring systems are adequately addressed during development of a maintenance programme, the team developed an Enhanced Zonal Analysis Procedure (EZAP) that complements existing procedures used to develop Zonal Inspection Programmes. The logic process assesses each aircraft zone that contains wiring and, through a series of questions, determines the need for tasks to minimize the presence of combustible material (cleaning tasks), and the need for either stand alone GVI's or dedicated Detailed Inspections of specific wiring installations in addition to GVI's performed as part of zonal inspections.

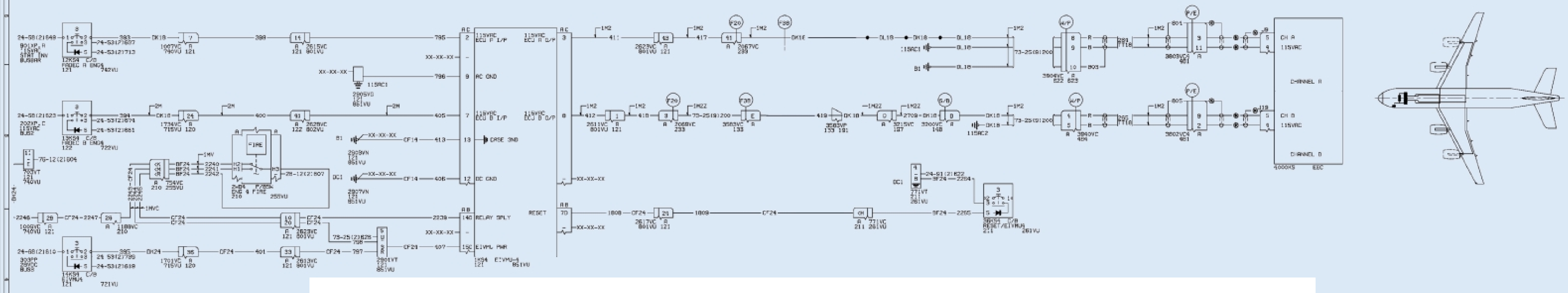
TASK 4
STANDARD PRACTICES FOR ELECTRICAL WIRING

The task of this working group was to review any documentation related to wiring standard practices, which is used to inspect or repair aircraft wiring, and to identify areas for possible improvement.

The main working group recommendations were to all aircraft manufacturers to adopt a common document format including the same standard practices for care and maintenance of wiring systems.

TASK 5
INSPECTION AND REPAIR TRAINING

The fifth task consisted of reviewing airline and repair station training programmes for inspection and repair of non-structural systems, to ensure that they adequately covered aging wiring system components. The working group confirmed that training programmes should be enhanced in the area of wiring maintenance practices and deliver a standardised training curriculum containing a series of recommended, detailed lesson plans covering additional training for aging systems. The content would be adjusted for any model of aircraft and student skill level.



ATSRAC PHASE 2

The results and recommendations from the above initial tasking indicated that problems associated with wiring systems on aging aircraft were not completely related to the degradation over time of wiring systems. The review of these systems also found inadequate installation and maintenance practices could lead to what is commonly referred to an “aging system” problem. Therefore the scope of ATSRAC is not limited solely to age-related issues, but also involves improving the continued airworthiness of aircraft systems, and in particular wiring systems.

The FAA accepted the ATSRAC recommendations from the first five tasks and subsequently assigned four additional tasks to ATSRAC in January 2001. These new tasks were intended to facilitate implementation of earlier recommendations. As a result, four new working groups were established.

TASK 6

ADDRESS THE NEED FOR NEW WIRE SYSTEM CERTIFICATION REQUIREMENTS

Specifically, Task 6 was formed to address wire related certification issues. The working group was therefore tasked to review all previous recommendations in the Code of Federal Airworthiness Regulations (FAR) 14 Part 25, in Joint Airworthiness Regulations (JAR) Part 25 and ATSRAC, to identify all requirements related to wiring systems, and to combine these current regulations into one section.

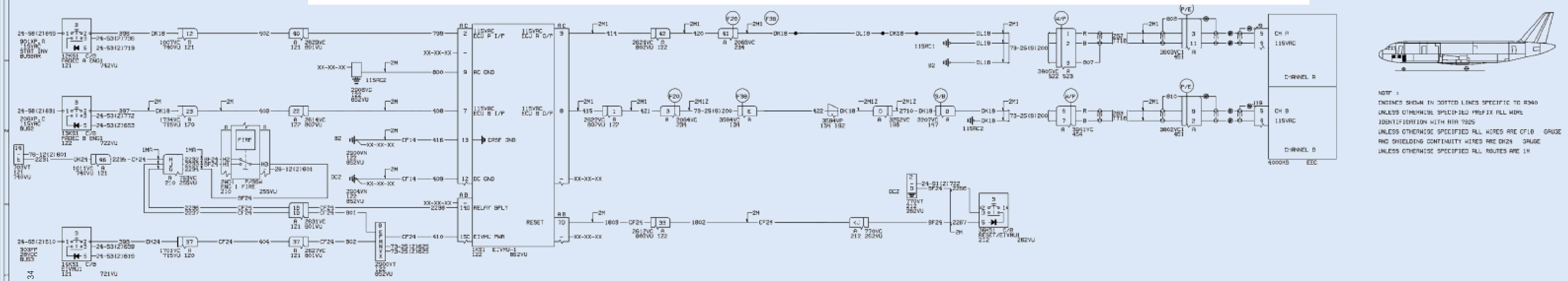
The product for this working group was the creation of a new FAR/JAR Part 25 Subpart H that contains all existing Part 25 requirements, including the creation of new requirements for wire system safety assessment, wire separation and wire identification. An Advisory Circular was developed to support these new/proposed regulations.

TASK 7

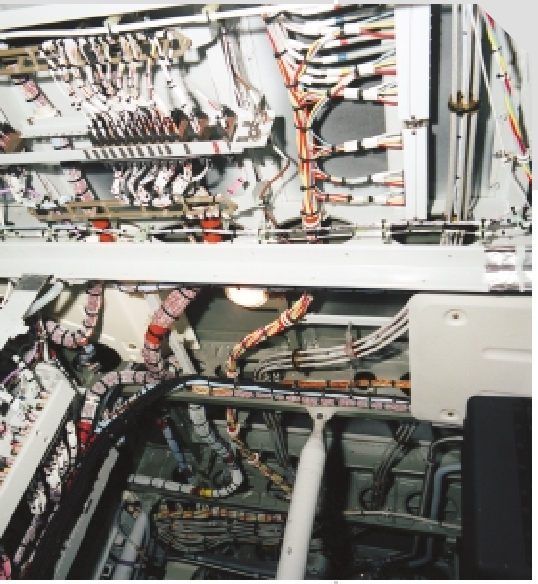
ADDRESS THE NEED FOR AN ELECTRICAL STANDARD WIRING PRACTICES MANUAL

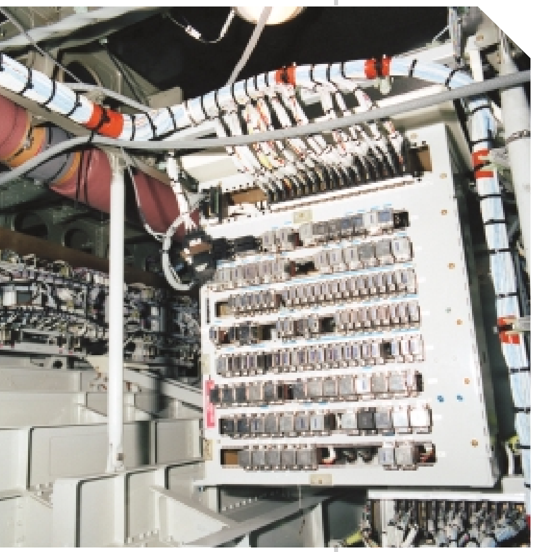
At the conclusion of the Task 4 report, the working group stated that the current presentation and arrangement of Standard Wiring Practices make it difficult to locate and extract pertinent data necessary for electrical repairs. The team therefore defined a standard format and minimum content of the Electrical Standard Wiring Practices Manual (ESWPM) so that aircraft maintenance technicians can easily use manuals from different manufacturers.

In addition, the working group proposed that paper-based legacy documents be upgraded to reflect format and content. Nevertheless, documents created and used in electronic form, and because of the searchable nature of the electronic document, need not implement a standardized format. The structure of these electronically-based documents is in fact transparent to the user.



AGING AIRCRAFT ELECTRICAL SYSTEMS INVESTIGATION





TASK 8
ENHANCED TRAINING PROGRAMME FOR ELECTRICAL WIRING SYSTEMS

Previous tasking to ATSRAC resulted in recommendations regarding the need for development of an enhanced training programme addressing wiring systems. In continuity with these previous recommendations, a wiring maintenance training programme was developed including wire system practices and documentation, inspection, applicable repair schemes, wiring modifications and wiring repairs. This training is customised for different target groups and could be used for initial and refresher training.

TASK 9
IMPLEMENT AN ENHANCED MAINTENANCE PROGRAMME FOR WIRING SYSTEMS

This working group was tasked to propose regulatory text and supporting advisory material to reflect the recommendations provided in the earlier Task 3 report.

In its original concept, the Enhanced Zonal Analysis Procedure (EZAP) envisioned an analysis of all wiring installed in zones in which combustible materials may be present. The logic would identify where additional repetitive tasks in these zones would minimise accumulation of these materials and/or would improve the likelihood that wiring system degradation, including age related issues, will be identified and corrected in a timely manner.

Analysing all wiring retrofitted into the aircraft under Supplemental Type Certificate (STC) modifications, was deemed not cost beneficial when combined with the recommended training for technicians. Mandatory implementation of both EZAP and Electrical Wiring Training is therefore still under discussion within the FAA and is part now of a new ATSRAC task. However, it is likely that aircraft manufacturers will have to develop EZAP within 24 months after the rule goes into effect. Then, operators are likely to be required to incorporate the EZAP tasks into their maintenance programmes within one year after EZAP development.

FAA ACTION PLAN

The ATSRAC efforts are part of an overarching plan developed by the FAA. This Enhanced Airworthiness Programme for Aircraft Systems (EAPAS) outlines the recommendations of the ATSRAC but is also intended to focus on all aircraft systems, including mechanical systems, which will undergo detailed evaluation after wiring systems. The current focus of this programme resolves around aging wiring systems and provides strategies for how the FAA and industry will work to improve the airworthiness of wire systems through near-term and long-term actions, with the intent to disseminate the products thorough the industry.

The EAPAS also includes an extensive Aging Electrical System Research Programme. This programme is intended to conduct research into aging wiring systems to determine mechanisms that drive the aging process, develop tools to better inspect and maintain wiring, and develop technologies that mitigate the hazards associated with wiring failure.

The FAA is now considering the ATSRAC recommendations on the second set of tasks forwarded in November 2002. The FAA recognized the benefits that ATSRAC provided through previous tasking and therefore requested that committee's assistance throughout the EAPAS rulemaking process. Therefore, the FAA requested ATSRAC in April 2003 to manage additional tasks and ATSRAC formed two new working groups

to provide technical support to develop recommendations on these tasks:

- Assemble technical and economic information and alternatives to the previous recommended actions, identify the minimum set of training to support EZAP and provide recommendations on the extension of EZAP applicability to STC installations.
- Review and develop implementation plans for viable tools and methods resulting from ongoing FAA research programme.

Completion of the above tasks is expected by January 2005. Nevertheless, the overall FAA Aging Aircraft programme encompasses numerous rulemaking programmes (Fuel Tank Safety Operational Rules, Aging Systems, Aging Structure, Widespread Fatigue Damage, Corrosion Prevention Control Programme), which may result in several rulemakings that require performance of non-scheduled maintenance checks. The FAA therefore set up a "Tiger Team" to review implementation methods and compliance times with the objectives to develop an integrated plan to align all rulemaking programmes and to prioritize rules if necessary. The "Tiger Team" results are not yet available but publication of the Notice of Proposed Rulemaking and Advisory Circulars is not expected before mid 2005.

AIRBUS ACTION

Airbus has supported ATSRAC since 1998 through active participation within the ATSRAC committees and various working groups and has already initiated the following actions:

ELECTRICAL STANDARD PRACTICES MANUAL
To anticipate ATSRAC Tasks 4 and 7 recommendations, Airbus decided to develop a new electrical standard wiring practices manual to take over from the AMM Chapter 20. A generic Electrical Standard Practices Manual (ESPM) was launched in April 2001. This new manual encompasses the old Chapter 20 and new chapters like standard inspection tasks, cleaning tasks, electrical component repair and replacement procedures, etc, to make easier the application of wiring inspection. This manual was lately updated to improve recommendations regarding wiring installation and protection and to add guidelines on wiring separation.

ELECTRICAL WIRING INTERCONNECTION SYSTEMS COURSE
Airbus Training Division has developed a wiring training course based on the ATSRAC Task 5 and 8 recommendations. This training called "Electrical Wiring Interconnection Systems" course is to help operators better understand and maintain their aircraft electrical installation. This course is customised to cover all Airbus aircraft and incorporates practical and hands-on sessions to teach technicians how to adequately evaluate the wiring system and effectively use the applicable aircraft wiring practices documentation.

AIRBUS EZAP POLICY AND PROCEDURES
Airbus has initiated the process of developing EZAP for all their aircraft types. Airbus is currently testing application of the EZAP on a sample of aircraft including A300/A310, A320 and A330/A340 families. The Airbus EZAP policy and procedures have been presented to and accepted by all Industry Steering Committees and with the exception of the A300, will be applied to all Airbus types through the Maintenance Review Board (MRB) process. Depending on the aircraft type, final validation of EZAP procedures are scheduled from mid 2004 till mid 2005.

For the A300, new and modified tasks that are recommended to be

added to operator's programs will be promulgated by an SB expected mid 2005. All new recommendations will be included in the MPD revision following publication of the SB (for A300) and revised MRB Reports (for all other types).

ELECTRICAL INSTALLATION MATURITY REVIEW

In addition to the above actions, and to anticipate ATSRAC future requirements, Airbus decided in 2000 to launch an electrical installation survey programme on early A320s, called Electrical Installation Maturity Review (EIMR).

In fact, Airbus initiated its own Aging Aircraft Electrical Installation Survey programme in 1992 with the A300 (See “Aging – The Electrical Connection”, FAST n°14 Feb 93 and FAST n°18 Jun 95). As well as for the A300, the A320 EIMR programme consists of wiring inspections of a sample of in-service aircraft to ascertain the condition of the complete wiring installation, and to collect and use data with the intent to:

- confirm the wiring installation design principle and improve if necessary the present electrical design,
- confirm the material selection,
- confirm the predicted performance of the complete electrical wiring installation and to update if necessary the inspection and repair processes.

All inspections confirmed the robustness of both A300 and A320 family electrical installation but also provided valuable information in respect to technology with regards to certain electrical components, wiring installation and operators’ maintenance practices. They also confirmed the need for increased awareness among electrical maintenance personnel of the importance of wiring installation (and specifically wiring segregation on fly-by-wire aircraft) and to improve ESPM for wiring installation and separation guidelines.

Both studies also highlighted the need to do this type of review on other Airbus aircraft types. Inspection of the A310 and A300-600 aircraft has been recently initiated and other Airbus aircraft types will follow in sequence.

Conclusion

The FAA has launched an important programme on aircraft systems aging to enhance the current aircraft systems airworthiness programmes and ATSRAC was requested to develop, co-ordinate and follow-up the implementation of the enhancements related to the design and maintenance of aircraft electrical systems and associated documentation and training.

Airbus is fully participating and supporting the FAA advisory committee tasks and follow-up efforts. In addition, aircraft manufacturers are coordinating to ensure a continuing consistent programme support and communication to their customers.

AIRBUS

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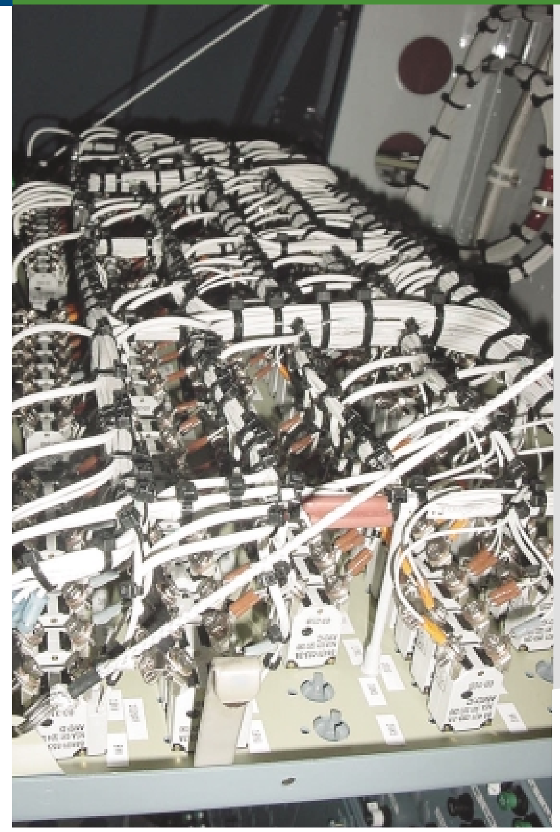


Electrical protection devices

It is widely recognized in the electrical industry that wiring has to be protected against overheating. Aircraft electrical circuits are no exception, as this article explains.

In spite of the precautions taken in the selection of aircraft electrical cables and their installation, unforeseen overheating may occur. Overheating may also be due to an abnormal electrical load on a piece of equipment. This could then result in the total or partial de-activation of the electrical installation owing to a short circuit, so electrical installations must be protected against this hazard. To this end, electrical circuit protection devices achieve this function.

This article presents three families of electrical protection devices:

- Thermal Circuit Breakers (CB), widely used to date,
- Arc Fault Circuit Breakers (AFCB), under development,
- Solid State Power Controller (SSPC), introduced with A380.

Jean-Luc Barré
Aircraft Electrical Installation and Standard Items
Customer Services Engineering

Patrick Scudier
Aircraft Electrical Installation and Standard Items
Customer Services Engineering

One pole CB

Not monitored Monitored

Three pole CB

THERMAL CIRCUIT BREAKER

A thermal CB will cause the circuit to open when a predetermined current is detected. The circuit opening is achieved by a thermal sensing element (e.g. bi-metal) whose characteristics are dependent on the current.

These CBs are selected according to their:

- tripping time with respect to the current intensity,
- compensation with respect to the ambient temperature.

These characteristics are specific to each CB and are given in the Airbus Standards Manual.

The CBs can be of three poles (115VAC three-phase) or single pole (28VDC or 115VAC single-phase). In addition to the main contacts (used in a power circuit), circuit breakers may have auxiliary contacts that are used to make a permanent check of the main contact position.

CB MONITORING

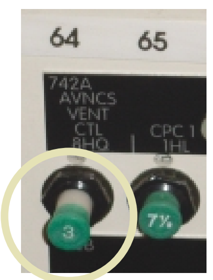
On A330/A340 Family aircraft the CBs are located in the avionics compartment underneath the cockpit and in the bulk cargo compartment. This is why monitoring means are required to enable the crew to check CB status. The CBMU (Circuit Breaker Monitoring Unit) linked to each circuit breaker auxiliary contact allows monitoring of individual circuit breakers. The principal functions of the CBMU are:

- acquisition of the circuit breaker position,
- monitoring of the circuit breaker,
- circuit breaker identification and transmission to the ECAM (Electronic Centralised Aircraft Monitor) to build CB page display,
- proper functioning of the built-in-test-equipment (BITE).

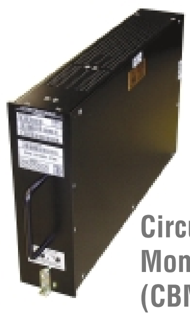
In the event a circuit breaker trips (disconnects), a warning signal is generated on the ECAM and EWD (Engine/Warning Display). The crew can then call up the circuit breaker tripped list on the SD (System Display).

For other aircraft types (A300/A310 and A320 family aircraft) most of the CBs are located in the cockpit. However, monitoring of some CBs is performed via various methods of CB status acquisition depending on aircraft type.

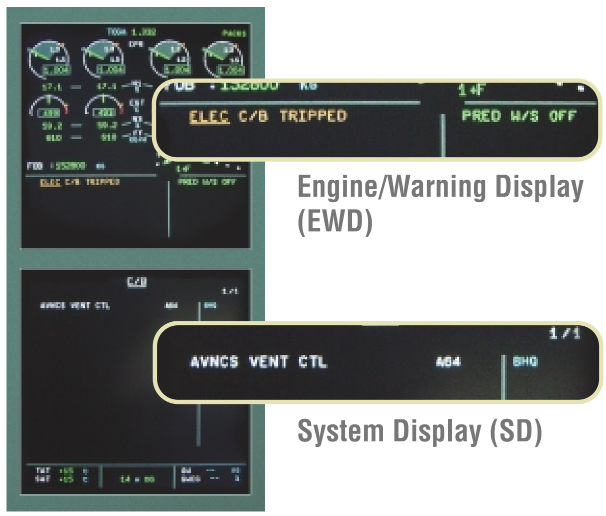
Circuit breaker monitoring on A330/A340 Family aircraft



Tripped circuit breaker



Circuit Breaker Monitoring Unit (CBMU)



Engine/Warning Display (EWD)

System Display (SD)

Overheated 50Amp CB

50AMP CBs ON A300/A310 FAMILY AIRCRAFT

Ref. Documents:
AOT 24-08, OIT 999.0077/99, SIL 24-045, TFU 92.00.00.006

On Airbus A300/A310 family operators have reported 50Amp CBs tripping or being overheated. Investigations revealed the following causes:

- possible high load in certain configurations,
- temperatures up to 180°C at circuit breaker terminal strips causing burn marks on the casing,
- variation of circuit breaker tripping characteristics due to malfunction of the temperature compensation function,
- insufficient tightening of attachment screws causing circuit breaker temperature increase.

A high number of the overheats experienced on 50Amp CBs were found to be due to insufficient tightening of attachment screws leading to loose connections. The wire terminals should be tightened to the correct torque value given in the AMM (Aircraft Maintenance Manual) chapter 20-21-12 or ESPM (Electrical Standard Practices Manual) chapter 20-46-10.

The high number of reports of 50Amp CBs tripping has resulted in a number of corrective improvements and inspections such as:

- decrease of electrical load of some AC (alternating current) Bus bars (Mods 8648 & 11134),
- installation of a larger wire gauge on some CBs (Mod 11332),
- inspection of the most heavily loaded 50Amp CBs,
- replacement of the existing 50Amp CBs by improved ones.

The latest standard is part number NSA931323-501 Amendment B.

TRIPPED CB REENGAGEMENT

Ref. Document: OIT/FOT 999.0172/99

The likely cause for CB tripping is an abnormality in the electrical load or in the associated wiring. Consequently, reengagement of a tripped CB may aggravate any

Corrective improvements & inspections for 50Amp CBs

Mod 8648	SB 24-2041 for A310, issued October 1991 SB 24-6030 for A300-600, issued September 1991
Mod 11134	SB 24-2067 for A310, issued March 1995 SB 24-6058 for A300-600, issued March 1995
Mod 11332	SB 24-2072 for A310, issued November 1995 SB 24-6004 for A300-600, issued November 1995
Inspection of 50Amp CBs	ISB 24-0092 for A300, issued Jan 2000 ISB 24-2081 for A310, issued Jan 2000 ISB 24-6071 for A300-600, issued Jan 2000

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One topic of the FAA Aging Electrical Systems Research Program (refer to the “Aging aircraft electrical systems” article page 2 to 10) focused on aging circuit breakers. In November 2002 the FAA issued a report ref. DOT/FFF/AR-01/118 that provides technical data for a series of tests on circuit breakers removed from several retired large transport aircraft.

The results of the study indicated that circuit breakers installed in aircraft with extended service life will continue to protect the electrical wire provided there is a more controlled evaluation of circuit breaker aging. The report makes several recommendations aimed at improving the reliability of circuit breakers, and reducing maintenance related problems, including:

- periodic cycling of circuit breakers,
- inspection of circuit breaker panels for loose or broken hardware, incorrect wire attachment, overheating and electrical arcing.

The FAA is now considering these recommendations and is expected to provide guidance material that recommends the above.

It is also Airbus’ intent to issue a Service Information Letter that recommends operators to perform an initial manual cycling of all thermal circuit breakers on and off under no power within an initial 24 month period and thereafter at intervals not to exceed 36 months.

The Airbus Enhanced Zonal Analysis Procedure will also consider circuit breaker panels to permit visual inspection of circuit breakers.

ELECTRICAL DEVICES PROTECTION

electrical damage by propagating it, with possible risk of affecting other equipment. It may even result in a temperature increase and smoke emission in the area concerned.

Airbus recommendations with regard to the reengagement of a tripped CB in flight and on the ground are as follows:

- In flight, Airbus does not authorise a pilot to reengage a CB which tripped by itself, unless the Captain, using his/her emergency authority, judges it necessary for safe continuation of the flight. In this emergency case, only one reengagement should be attempted.
- On the ground, the pilot may reengage the CB provided the action is coordinated with the maintenance team and the cause of the CB tripping is identified.

These recommendations are also detailed in the applicable chapters of the FCOM (Flight Crew Operating Manual) and TSM (Trouble Shooting Manual).

ARC FAULT CIRCUIT BREAKERS

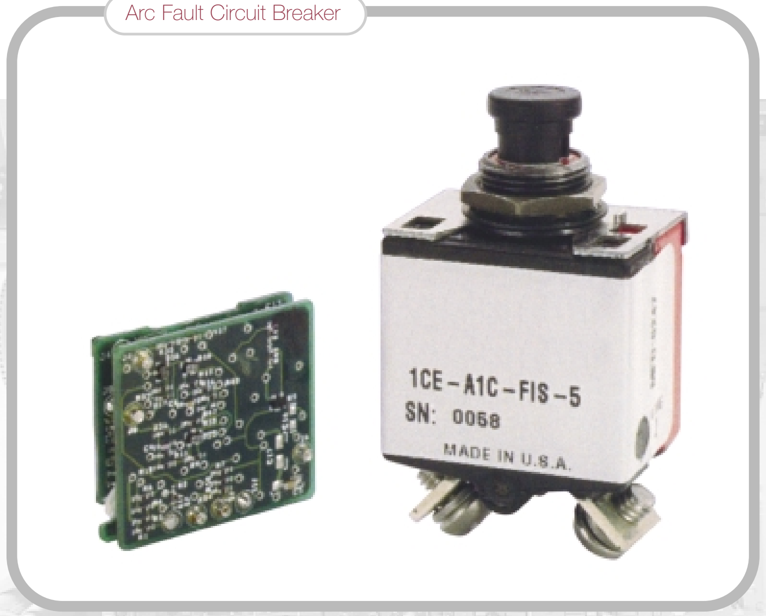
Research into new technologies to improve wiring safety is a key issue for individual federal agencies and industry. To this end, the Federal Aviation Agency (FAA) has launched an extensive Aging Electrical System Research Program (refer to the "Aging aircraft electrical systems" article page 2 to 10). This programme is intended to conduct research into aging wiring systems to determine mechanisms that drive the aging process, develop tools to better inspect and maintain wiring, and develop technologies that mitigate the hazards associated with wiring failure.

As part of this programme, the FAA, in partnership with the Office of Naval Research, initiated a study of arc-fault circuit interruption technology, which promises to overcome some of the issues caused by wiring degradation.

PRINCIPLE

The Arc Fault Circuit Breakers provide additional protection against arcing conditions in addition to the thermal overload protection provided by thermal CBs. Arc Fault Circuit Interruption (AFCI) technology monitors the electrical circuit for arcing events that are indicative of potential wiring issues that could result in a short circuit. In essence, the device keeps a count of each momentary insulation breakdown and breaks the circuit when the count of these exceeds a predefined number. The heating caused by these intermittent contacts may be below the normal rating of a thermal CB.

Arc Fault Circuit Breaker



Arc Fault Circuit Breaker (AFCB) technology has been already introduced into housing and industrial markets over the past 10 years. Adapting the technology for use in aircraft will improve safety by reducing arcing occurrences and their consequences, and will reduce costs by limiting damage to both electrical wiring and the surrounding area.

AIRBUS ACTION

Due to the specifics of circuit breakers installed on Airbus aircraft (in terms of specifications and overall dimensions), Airbus decided in 2000 to launch its own AFCB programme, similar to that of the FAA.

The first feasibility phase of such a programme defined single pole and three pole AFCBs that, in addition to the functions provided by traditional circuit breakers, have the ability to detect complex current-time waveforms that are characteristic of wiring anomalies/arcing in an aircraft environment. Other challenges were to develop products likely to replace current circuit breakers at competitive prices within the 1-50Amp range, and to solve the main issues of reliability and overall dimensions.

Only AFCB implementation on a 115VAC aircraft electrical network was considered in the first phase of the programme. A prototype test programme has been defined with suppliers and AFCB prototypes have been tested on an electrical laboratory test bench, then during an aircraft test flight. The next step is now to conduct an evaluation of the AFCB end-component maturity on aircraft during a six month period to be completed by the end of 2004.

After having demonstrated good maturity, an industrial product qualification will proceed and Airbus may then determine which systems the AFCB will be used on.

SOLID STATE POWER CONTROLLER

The electrical power distribution system in the A380 introduces a big jump forward for the protection function by using the Solid State Power Controller (SSPC).

The SSPC module is a conjunction of electronic and semiconductor devices in the same electronic card. Unlike the conventional thermal CB or AFCB that are considered electrical standard items, the SSPC

Protection and commutation devices

Electromechanical technology

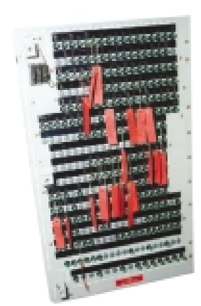
SSPC technology

Additional benefits of SSPC technology

- Programmable wire gauge
- Long-life and high reliability
- Contactless and fast switching
- High resistance
- No electromechanical noise

Examples of man/machine interface

With classical electromechanical technology

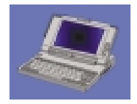


CB panel used in emergency electrical power distribution system

With SSPC

On-board Information Terminal

On-board Maintenance Terminal



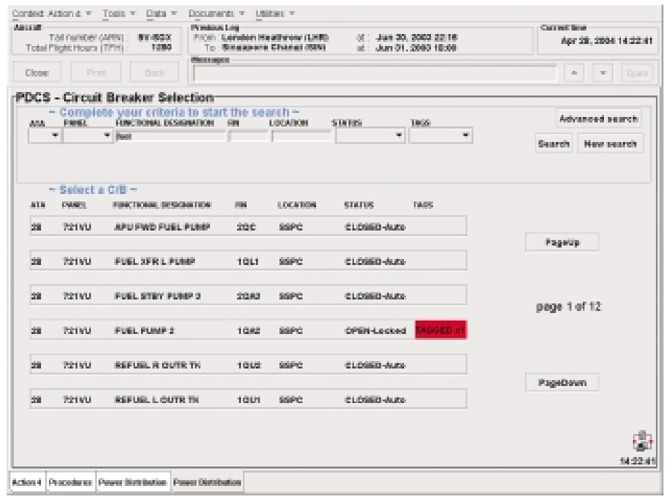
Portable Maintenance Access Terminal

Power Distribution Maintenance Interface

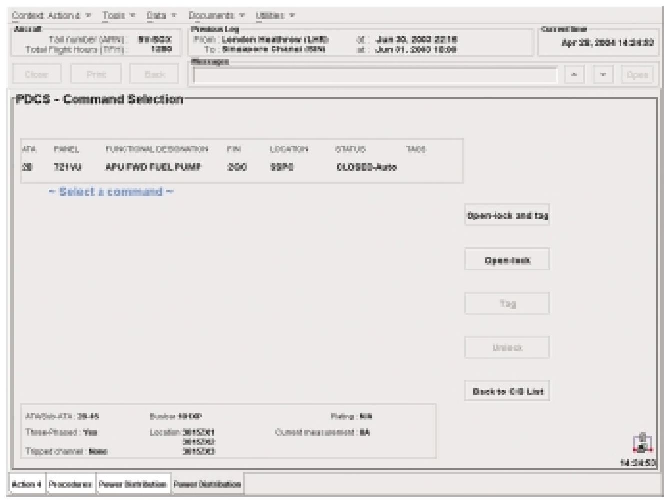
Example of SSPC maintenance status

4 examples of screen pages displaying the maintenance status of the SSPC

1. Search by CBs in fuel system



2. Select a CB



Module is part of the electrical power centre, and is considered as equipment.

The SSPC Module works primarily as a protection device for the aircraft wiring against overload, and as a system power supply switch for technical operation and load management.

The SSPC has the same function as a circuit breaker, but by using a comparison of a triggering curve rather than the traditional mechanical tripping function.

So, basically, the SSPC technology combines the functions of the circuit breaker and relay in classical electromechanical technology.

With this new technology, the trip threshold of the device protection is programmable. It also allows switching ON/OFF of the loads, and controls and monitors the switch status.

SSPC cards are customisable for the cabin loads. For each SSPC channel, two current ratings are available: 3A to 5A and 7.5A to 15A with in-between software programming capability.

Due to the large number of circuits to protect, it would have been necessary to have a huge panel and space available if classical electromechanical technology were used. This new technology allows reduction of the man-machine interface whilst saving weight.

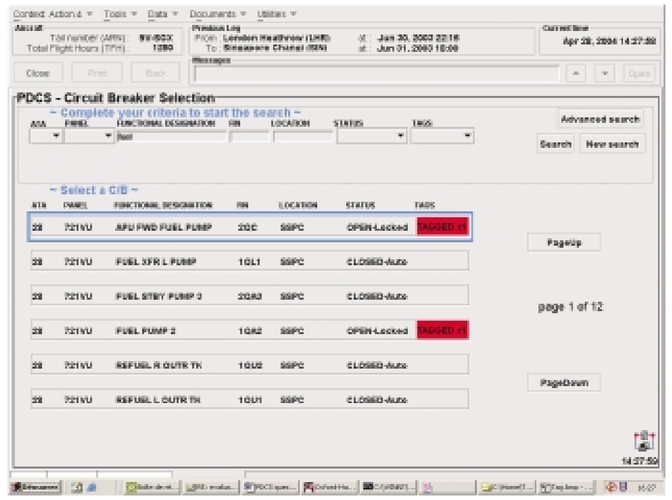
POWER DISTRIBUTION MAINTENANCE INTERFACE (PDMI)

The new SSPC technology allows a newer maintenance man-machine interface. One of the functions of the Power Distribution Maintenance Interface (PDMI) is to allow the engineer to control the SSPC as a conventional circuit breaker. They may be tripped and tagged to permit maintenance, or to isolate a system for dispatch under MEL criteria. So, PDMI can be considered as a virtual Circuit Breaker Panel.

Some PDMI Functions are:

- provide manual override ON/OFF control of each SSPC channel,
- secure the open state of SSPC channels (flag or lock-out),
- provide manual reengagement to tripped channels,
- review configuration status and load assignment,
- display Built-In-Test Status,
- summary of tripped channels and manually opened channels
- sort by ATA chapter,
- sort by Power Bus and/or MMEL,
- maintenance status (e.g. name of operator, maintenance duration, reason for lock-out).

3. Tag the CB



4. Warning message when CB has been tagged

Conclusion

CONTACT DETAILS

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The electrical devices protection such as thermal CB, AFCB, or SSPC have the same main basic function: ensure protection of aircraft electrical installations. Whatever the technology used, tripped electrical devices protection should only be reengaged once, if at all, as described above and in the appropriate manuals such as the AMM and TSM.

A relatively new technology – Arc Fault Circuit Interruption (AFCI) technology – has been developed to improve the overall level of aircraft wiring protection. This new technology that is predictive in nature, will reduce arcing occurrences and possible collateral damage.

At the time of writing the FAA had not mandated installation of AFCBs and even though the FAA strongly supports activities to define Arc Fault Detection CBs, it is expected that replacement of conventional circuit breakers by AFCBs will be up to the airlines.

The sheer size of the A380 and the significantly greater electrical installation has meant that conventional circuit protection devices would take up far too much space and be excessively heavy. This has led to the development of the Solid State Power Controller, which provides the necessary protection, a user-friendly man-machine interface, and several possibilities of customisation.

HOW TO TACKLE BLEED AIR LEAKS

How to tackle bleed air leaks

Improving durability of seals on hot air ducts

Leaks from bleed air ducts cause approximately one third of ATA36 operational interruptions.
A high proportion of these leaks can be attributed to previous generation seals. These seals are fitted at numerous locations in the bleed (ATA36), anti-ice (ATA30) and air conditioning (ATA21) systems. Consequently, the need for a reliable seal is of the utmost importance to the efficient operation of an aircraft.

At the beginning of Airbus operations, bleed air ducts were equipped with a pair of seals with part numbers (PN) NSA8054-08 and PN NSA8054-09, being used together. This type of seal was, at that time, the only one available on the market.

Later, as the technology evolved, different seals were proposed. Each were to the latest technology, but never providing the durability desired. The latest in the series was ABS 0737.

To cater for this situation Airbus introduced a periodic seal replacement in the MPD (Maintenance Planning Document) to avoid operational interruptions. In parallel a call for tender was launched with various seal manufacturers. The primary goal was to find a new seal able to withstand the new qualification process called “accelerated aging test”. This test being a combination of endurance, temperature and pressure conditions more demanding than those used previously and adapted to the latest materials.

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QUALIFICATION TESTING

Two types of qualification testing, (dynamic and static) were imposed:

DYNAMIC TESTING

- Total of 240,000 movement cycles at 24 cycles/minute.
- Combination of ±10 mm (0.4 inch) linear and ±3° angular displacement to simulate wing bending.
- 200,000 cycles at 215°C (420°F) and 40,000 cycles at 260°C (500°F) representing aircraft operation (see illustration below).
- One pressure cycle for every two movement cycles, ambient to 4.2bar (61psi) (see illustration above).

STATIC TESTING

- Proof pressure 6.2bar (90psi) at 215°C (420°F) for 1 minute.
- Burst pressure 13.2bar (190psi) at 215°C (420°F) for 1 minute.

QUALIFICATION RESULT

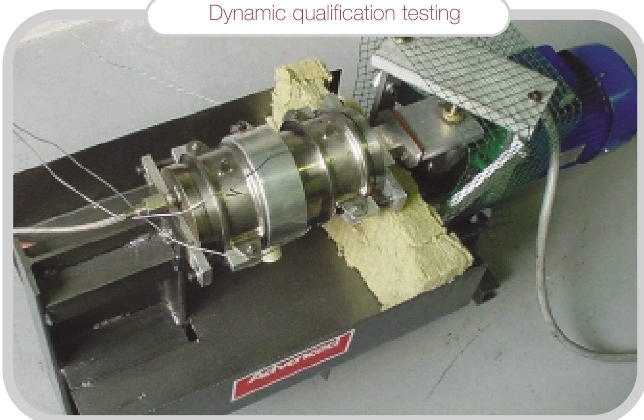
At the end of this qualification testing, only one seal satisfied the qualification criteria *(seal A on the illustration Qualification test bench on page 21)*. That seal being identified as PN ABS1040 is manufactured by Advanced Products.

QUALIFICATION CRITERIA

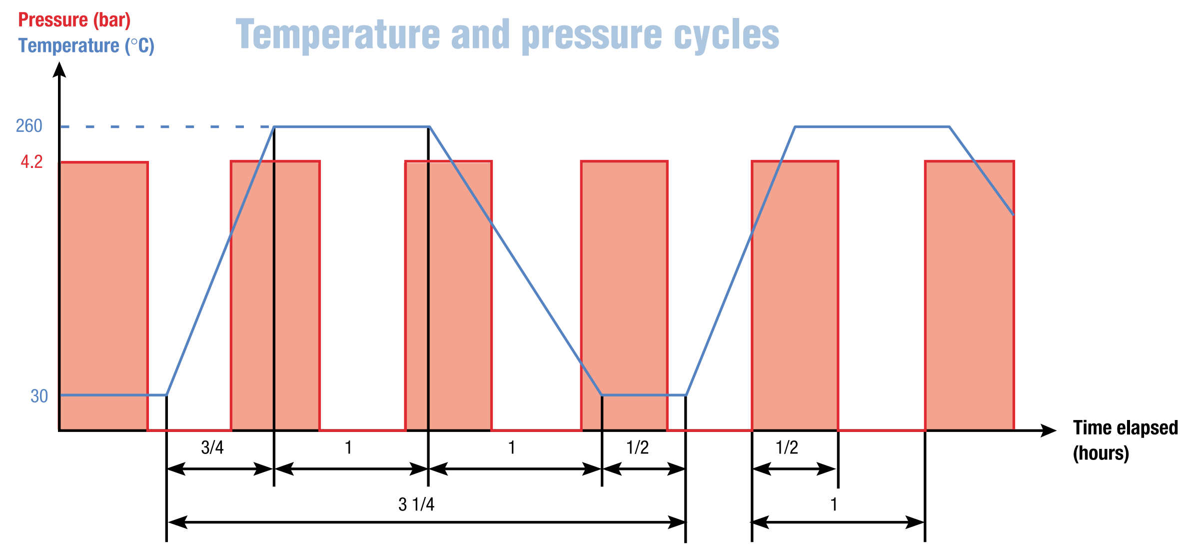
- Static leak rate at 4.2bar (61psi) in cold and hot state well below maximum allowed.
- No extrusion tendencies.
- Minimal wear.
- No cracks, extrusion or deformation after proof and burst test.

Static qualification testing

Dynamic qualification testing

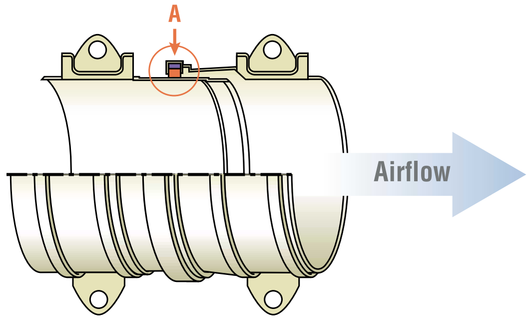


Temperature and pressure cycles

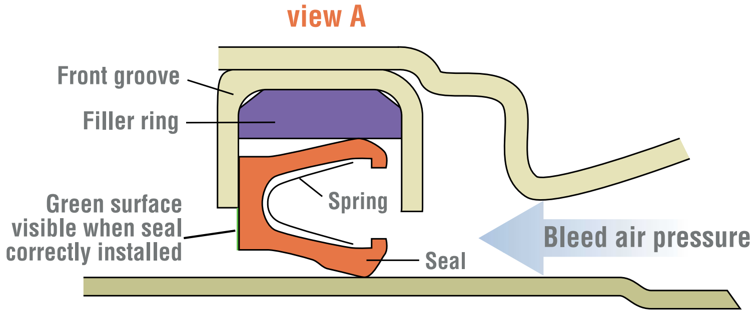


HOW TO TACKLE BLEED AIR LEAKS

Seal installation on duct



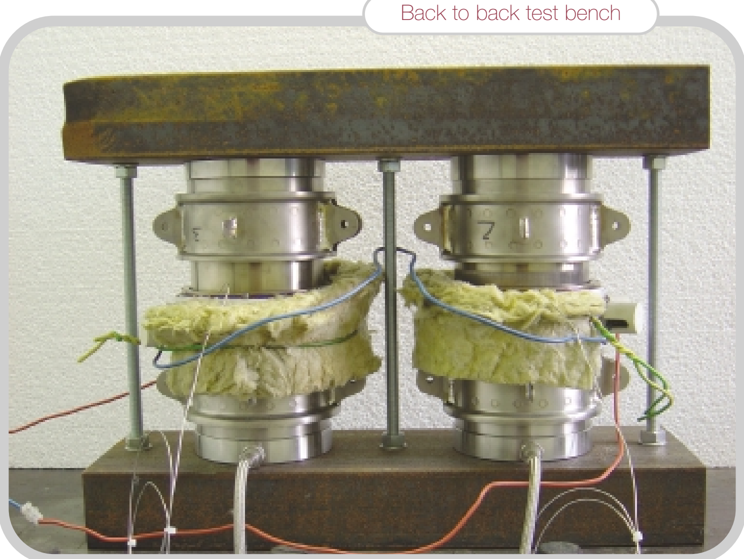
Seal installation (with expander)



The PN ABS1040 seal is made of PTFE (polytetrafluorethylene), in two parts:

- the seal is equipped with a spring to keep it expanded,
- a filler ring to reduce the volume of the recess.

Back to back test bench



PERFORMANCE COMPARISON

Following the qualification test, another test programme was performed to compare the performance of the ABS1040 seals to the ABS0737 seals ("back to back testing"). For that purpose, a specific "back to back" test bench was developed in order to be able to compare the performance of the two types of seal in real time and in similar conditions.

Seals were installed on production ducts during the pressure and temperature cycles.

Following the test, the ABS0737 seal showed significant deterioration and erosion while the ABS1040 seal remained in excellent condition

ABS0737

ABS1040

Test performances show:

- the ABS1040 seals provide significant reduction in bleed air leakage compared to the ABS0737 seals.
- the ABS1040 seals continue to provide excellent long-term performance while the ABS0737 seals degrade over time resulting in steadily deteriorating performance.

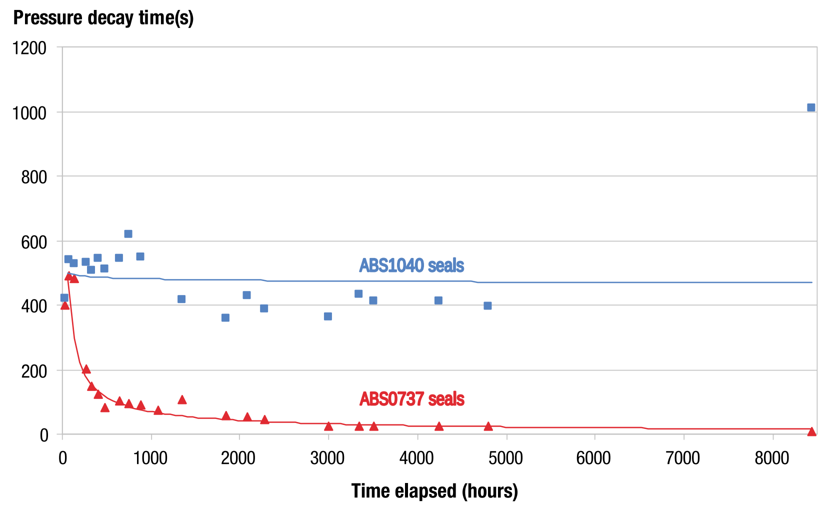
IN-SERVICE EVALUATION

Also, before making this new seal available for general airline use, it was decided to perform an in-service evaluation to confirm that the tests reflected the real life environment. This evaluation was performed with five different airlines operating in different environmental conditions (Cathay Pacific, Air Macau, Lufthansa, MyTravel and Austrian Airlines) and on two aircraft types (two A330/A340 Family and four A320 Family).

This evaluation has accumulated more than 26,000 flight hours and 12,500 flight cycles without any seal failure or detection of any bleed air leaks, demonstrating the good behavior of seal ABS1040 during aircraft operation

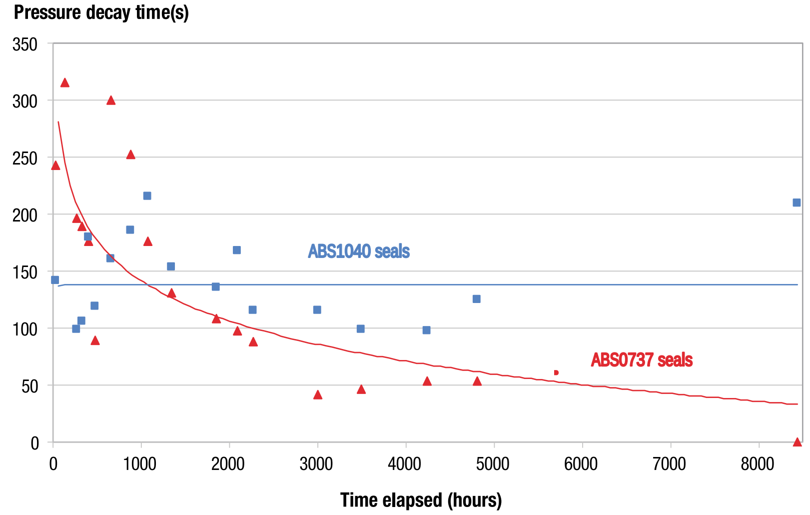
Comparative Test Results – Hot condition (260°C)

4.2 --> 4.1bar (61-->59,5psi) Air volume = ± 2.35 dm^3 (ie 2.35litres or 0.08cu.ft)



Comparative Test Results – Cold condition (30°C)

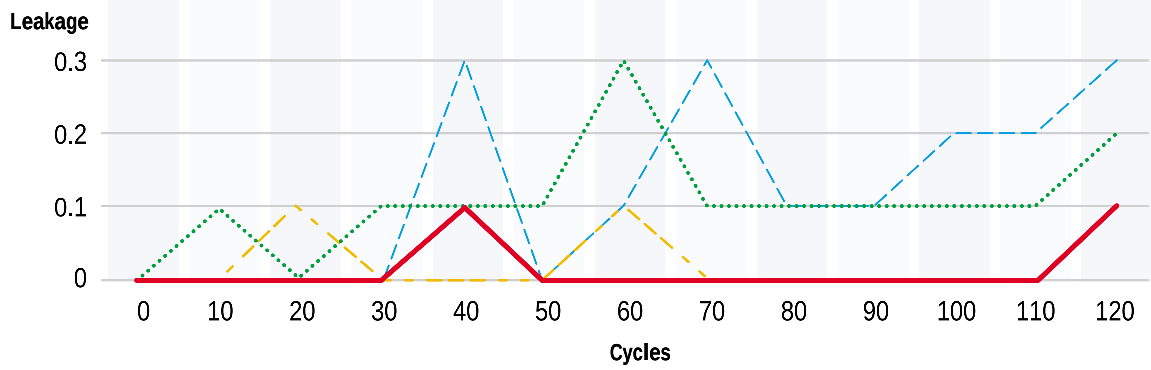
4.1 --> 3.5 bar (59,5-->51psi) Air volume = ± 2.35 dm^3

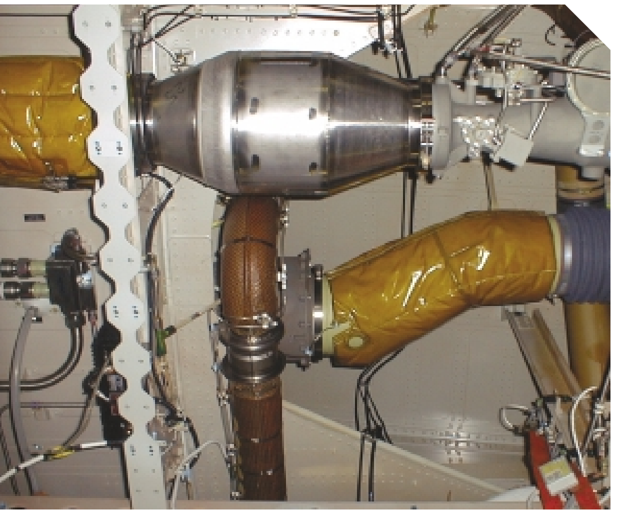


Qualification test benches

Leakage per cycle (grams/second)

Seal A	0	0	0	0	0.1	0	0	0	0	0	0	0	0.1
Seal B	0	0	0	0	0.3	0	0.1	0.3	0.1	0.1	0.2	0.2	0.3
Seal C	0	0	0.1	0	0	0	0.1	0	0	0	0	0	0.1
Seal D	0	0.1	0	0.1	0.1	0.1	0.3	0.1	0.1	0.1	0.1	0.1	0.2





RESULTS

From the investigation, it is clear that seal ABS1040 will bring about a much-wanted decrease in bleed air leaks.

A Detection Leak Localisation System (DLLS) has been installed on the A340-500, -600 series. It is dedicated to maintenance and simplifies troubleshooting so reducing the amount of time the aircraft is delayed on the ground. A combination of the DLLS and new seals should have a significant impact and a direct benefit on the Operational Interruption rate.

A direct consequence of the reduction in Operational Interruptions is the positive effect it will have on the Direct Maintenance Costs of an aircraft. A reduction in this area is of major importance to airlines and always sought after. This will be brought about as a result of the introduction of ABS1040 seals and by the reduction in the number of times the aircraft is grounded due to bleed leaks.

	Airbus SB	Modification	Embodiment rank
A320 Family	A320-36-1043	32027	MSN 1830
A330	A330-36-3027	49771	MSN 494
A340	A340-36-4024	49771	MSN 528
A340-500/600	A340-36-5001	50229	MSN 468

Conclusion

It is clearly evident that Bleed Air Leaks caused by inadequate sealing have been a continuous cause of concern over a number of years. Despite some improvements in technology standards, seals still failed to meet the desired level of performance. However, upon the highly successful completion of the "accelerated aging test", having the results of the "back to back test" with the previous bleed seal standard, and the in-service evaluation, it was agreed to select the ABS1040 seal for in-service and production aircraft.

The new bleed seal incorporates significant design improvements due to both the material change and the new shape. The seal is made from Teflon, superseding the traditional silicon and the innovative new shape incorporates a two-part design feature. As explained in this article, the Teflon material and the revamped design perform adequately to satisfy the requirements set by the investigation process. Airbus now uses the ABS1040 seals on new production aircraft bleed air systems.

Furthermore, it should be noted that after installation of the ABS1040 seals (mod number in table above) the preventive seal replacement recommended in the Maintenance Planning Document (MPD) will be cancelled and only the leak check will remain. The periodicity of the leak check will be reviewed upon feedback of in-service experience.

The incorporation of this modification is highly recommended by Airbus since it is now well demonstrated that the ABS1040 seal will dramatically improve bleed air system performance, bring a significant reduction in maintenance costs, and improve aircraft dispatch reliability.

CONTACT DETAILS

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AIRBUS

Customised Spares Logistics

A new Airbus concept based on supply chain experiences

During the life cycle of an aircraft, time, location and requirement of spare parts are not usually plannable.

Therefore on-time delivery of spare parts requires integration and management of flexible supply chains between the vendor's activities and customer's requirements. The physical distribution of parts, qualified communication and sophisticated information technology (IT) based monitoring systems are all key elements involved in harmonising the spares related processes, resulting in cost savings and high transparency. Following these requirements Airbus Spares Support and Services in Hamburg, as the headquarters for world-wide spares supply for Airbus aircraft, has developed Customised Spares Logistics (CSL).

Helmut Diekhoff
Manager Customised Spares Logistics
Spares Support & Services

Andreas Teufel
Director Spares Marketing
Spares Support & Services

CUSTOMISED SPARES LOGISTICS

The “Customised Spares Logistics” concept is the result of the long-term experience in aviation logistics focused on customer requirements and the transport logistics capability of Airbus Spares Support and Services.

SUPPLY CHAIN DRIVING FORCES

Based on 30 years of experience in supply chain management and logistics, Airbus Spares is clearly aware of some weaknesses in the conventional supply chain. The eye opener was during an Airbus symposium when the customers complained of a delivery performance of 66% versus Airbus’ reported delivery performance of 98%.

It appears that 30% of the performance gets lost within the supply chain between the supplier and the customer’s final location. The following describes what occurs within the conventional supply chain:

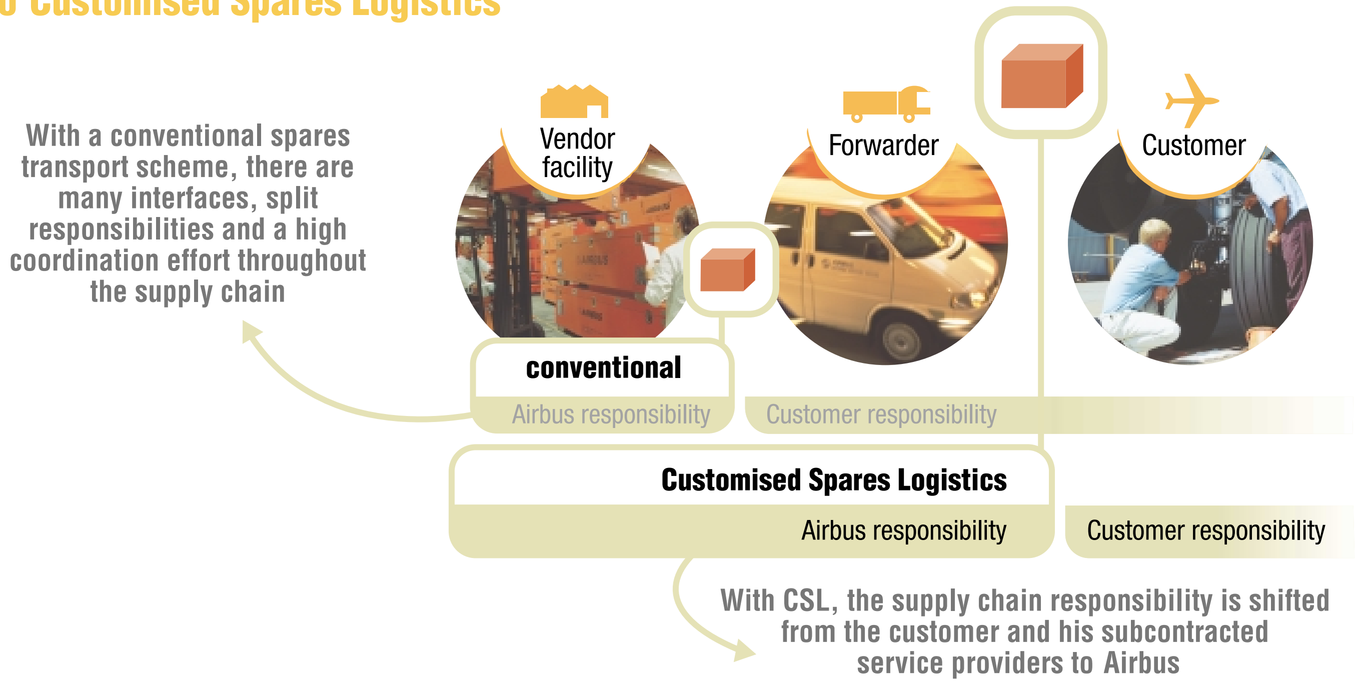
- Suppliers prepare the shipments for dispatch and hand them over to the customer appointed forwarders. With this hand-over, the shipment passes the so called “yellow line” of the suppliers warehouse or airport; this means the supplier is no longer responsible for the shipment.
- The forwarder who picks up the shipment, is conventionally subcontracted by the final customer and acts therefore on behalf of the customer. At this point the achieved delivery performance very much depends on the ability of this subcontracted forwarder to effectively transport the shipments to the customer.

Here the challenge starts. For economic and process-related reasons forwarders tend to consolidate shipments, route them through distribution hubs, subcontract second or third tier service providers and integrators, or are requested to consider service freight for shipping customer goods.

This fragmentation of the supply chain in respect to shipment responsibility and actual handling, causes the challenges to performance which customers experience. Each change in responsibility, each hand-over, each interface within the supply chain inherits a certain amount of risk causing shipment delay, transport inefficiency and loss of transparency.

The supplier at the start of the supply chain, as well as the customer at the other end, can lose track of the shipment and no longer be able to determine the current location of, or estimated arrival of, the shipment.

From conventional scheme to Customised Spares Logistics



This situation causes considerable uncertainty so an increased effort of tracking and tracing of shipments is required, particularly for priority customer requests such as AOG (Aircraft on Ground) orders.

Aircraft operators, aware of the supply chain and delivery risks, are forced to compensate with either increased manpower for tracking and tracing efforts, or increased and costly spares provisioning and inventory levels.

OBJECTIVE OF CUSTOMISED SPARES LOGISTICS

The objective of the Customised Spares Logistics scheme is to address the tracking and tracing problems described above and bring relief to customers by providing updated information about the shipment at any time, and supplied by one single source. The customer can then rest assured that the shipment will arrive on time with a guaranteed delivery performance of 98%.

The performance level is assured through continuous performance measurement by Airbus. Customised Spares Logistics is focussed on a balance of optimal cost and service, corresponding to the three strategic goals - safety, aircraft operational reliability and reduction of operating costs.

CHARACTERISTICS OF CSL

- Airbus as Single Point of Contact for the entire supply chain.
- Competitive freight rates due to Airbus and European Aeronautic Defense and Space Company (EADS) volume discounts.
- On-line Tracking and Tracing transparency.
- Customisation of the supply chain, covering all steps from pick up to customs clearance, considering service freight restrictions, special clauses and exceptions, and defining handover interfaces.
- Reduction of interfaces throughout the supply chain.

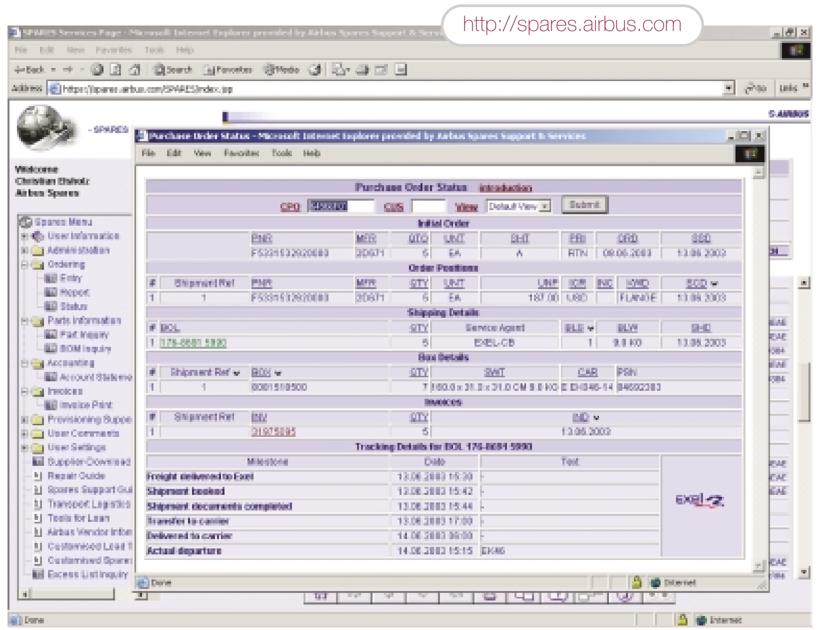
SERVICE SCOPE

Airbus manages dedicated approved forwarders, negotiating freight rates, steering the complete supply chain up to the point of demand. Priority shipments like AOG and WSP (Work Stoppage) are monitored on their way to the customer. Routine (RTN) shipments are consolidated to further reduce customers’ costs. Delivery is performed to the agreed location and within the agreed timeframe.

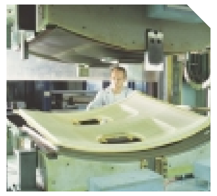
ADVANCED TRACKING AND TRACING ABILITIES

The management of transport is performed by Airbus and all shipments are actively monitored. Additionally the customer has the possibility to get advanced, milestone based, tracking data via the Internet based Airbus Spares Portal, *http://spares.airbus.com.*

By integrating the web-sites of forwarders and integrators, customers receive 24h on-line real-time tracking and tracing information through the Airbus Spares Portal. In addition, Airbus monitors each priority shipment until it arrives at the customer’s specified final destination, taking into account the special aerospace logistics requirements.

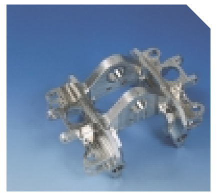


Spares Scope



Proprietary Spares

Modification and Repair Kits



Supplier Equipment

GSE and Tools

MATERIAL SCOPE

Customised Spares Logistics can be used for transportation of any spares purchased from Airbus. This includes Proprietary Parts, Ground Support Equipment, tools, and supplier parts. It also covers deliveries from Hamburg as well as drop-shipments.

LEAD TIME BASED PRICING CONCEPT

According to geographical zones defined by IATA (map below) a priority based lead time and pricing concept is applied for the Airbus Customised Spares Logistics concept. Table below shows the different lead times for shipments ex-Europe to the specified IATA zones.

To get a clear view of the yearly costs, individual business cases can be prepared according to the shipment structure of each customer. The customer will then receive an individual commercial proposal before entering into the agreement. All invoicing shall be consolidated and provided on monthly basis.

IMPLEMENTATION OF THE CSL PROCESS

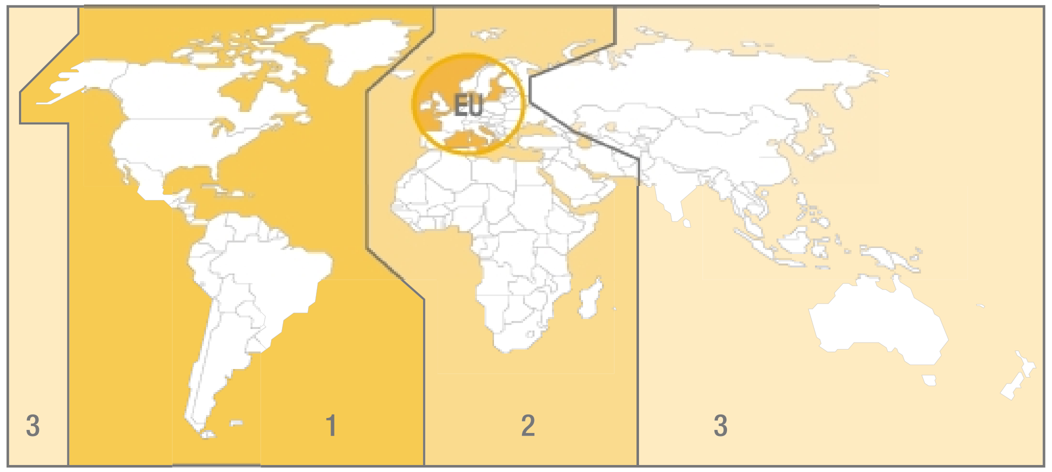
Initially the current supply chain for shipments from Airbus and suppliers to the final customer destination will be analysed. Next, a customised Standard Operation Procedure will be prepared together with a CSL proposal. This will ensure the performance will match the agreed lead times, ensure safe processes and cost-efficient spares transport. It includes general contractual items and all necessary operational details such as responsibilities, information required regarding customs issues etc. After an initial period of operation, usually between three to six months, all relevant business figures will be reviewed by Airbus together with the customer.

CUSTOMER ADVANTAGES FROM CSL

Customers benefit from using CSL in various ways:

- They can rely on scheduled delivery times with the added convenience of on-line, real-time information on the current shipment status and location.
- They also experience a reduction in hidden costs, be it through savings for not having to invest time and capacity in tracking and tracing of shipments, or be it for not having to keep extra inventory to compensate for potential lack of spares due to shipment delays.
- Customers further profit from the economies of scale obtained by Airbus. These economies of scale lead to competitive freight rates. The rates are passed directly on to customers, leading to reduced transport costs.
- Since Airbus is responsible for the delivery of spares and tools right to customer's doorstep, there is one single contact for the entire supply chain, resulting in a continuous increase in supply chain efficiency.
- The whole service is backed-up by regular benchmark studies and continuous performance measurements to ensure optimised operations.

Lead Time and shipments in the world



Lead times	EU	Area 1	Area 2	Area 3	Within area
AOG	≤18h	≤ 24h	≤ 36h	≤ 36h	≤ 24h
WSP	≤ 24h	≤ 36h	≤ 48h	≤ 48h	≤ 36h
RTN	≤ 2 days	≤ 4 days	≤ 4 days	≤ 4 days	≤ 2 days

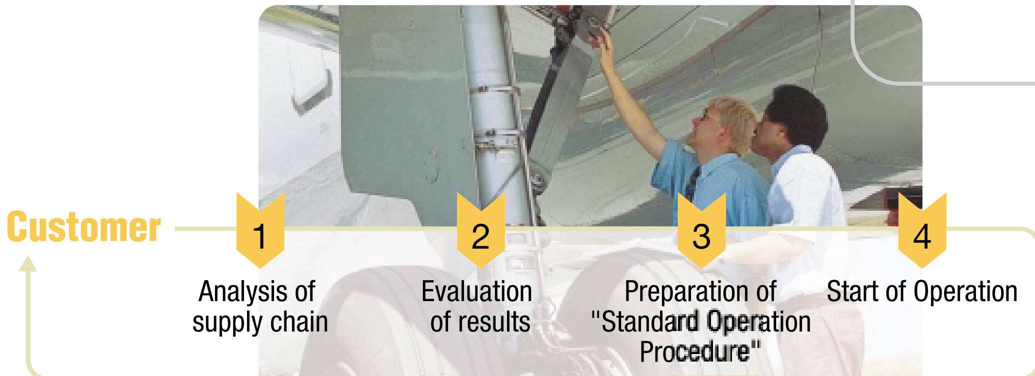
Service key figures

Total shipments delivered	more than 1500
Performance level	approx. 96.5%
Competitive freight rates, cost reduction	16.1%
Workload reduction	25%
Enhanced service level	from 65% to 91%
Average lead time AOG (ex- HAM)	less than 1 day
Average lead time AOG (ex- EU/US)	1.5 day

CUSTOMER QUOTE

"As far as we are concerned we only see advantages [of using Customised Spares Logistics]. Our freight costs are lower, leading to economic benefits. Additionally, Airbus manages the complete supply chain in cooperation with the forwarder, which includes the physical handling of the shipments as well as the electronic shipment tracking and coordination. Therefore we do not need to pay attention to the actual supply and dispatch of the required spare parts. As a consequence, we have been able to decrease our administrative costs. We only notify Airbus Spares Support and Services when we require particular spare parts - that's all we need to do!"

Martin Schmidt
Director Material & Logistics
Austrian Airlines Technik
(translated from LOGISTIK inside 17/2003)



Conclusion

Customised Spares Logistics (CSL) provides benefits for the entire supply chain. Not only do customers benefit, but also the suppliers and forwarders are able to achieve their promised delivery performance. The result is leaner supply chains, meaning higher efficiency and less wastage for the entire system.

That can only be of benefit to all!

AIRBUS

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AIRCRAFT SYSTEM MAINTENANCE AIDS AVAILABLE FROM AIRBUS

Aircraft System Maintenance Aids available from Airbus

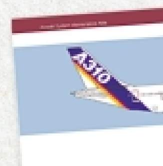
A300/A310 Family

AIRCRAFT TYPE	TITLE	ATA	ISSUE	REFERENCE
A300-600/A310	Autoflight System Operation / Troubleshooting Guidelines	22	APR 03	SEE43/952.2636/03
A300	Flap System Trouble Shooting Procedure	27	DEC 88	No reference
A300/A300-600	Flap System / Flap Jamming Trouble Shooting Guidelines	27	MAY 89	ST34/0001/89
A300-600	Slat / Flap System Trouble Shooting Guidelines	27	FEB 97	SEE41-952.0834/97
A300	Slat System Jam Trouble Shooting Guidelines	27	FEB 97	SEE41-952.0835/97
A300	Flap System Jam Trouble Shooting Guidelines	27	FEB 97	SEE41-952.0836/97
A310	Slat / Flap System Trouble Shooting Guidelines	27	MAR 98	SEE53-953.1907/98
A310	Spoiler Control Computers Trouble Shooting Guidelines	27	AUG 98	SEE53-953.4553/98
A310	Spoiler Control Computers Trouble Shooting Guidelines (for FEDEX only)	27	AUG 98	SEE53/953.6135/98
A300-600	Spoiler Control Computers Trouble Shooting Guidelines	27	AUG 98	SEE53-953.4556/98
A300-600	Spoiler Control Computers Trouble Shooting Guidelines (for FEDEX only)	27	AUG 98	SEE53-953.6134/98
A310-300/A300-600R	Trim Tank System Trouble Shooting Guidelines	28	NOV 90	ST22-948.1341/90
A300/A310/A300-600	Hydraulic System Maintenance Practices	29	MAR 99	SEE34-951.0684/99
A310/A300-600	Engine Bleed System Trouble Shooting Guidelines	36	APR 90	ST23/0002/90
A310/A300-600	Engine Bleed System Trouble Shooting Guidelines	36	JUL 02	SEE23-949.4691/95
A300B2/B4	Engine Bleed System Trouble Shooting Guidelines	36	JUN 02	SEE23-949.5177/96

A320 Family

AIRCRAFT TYPE	TITLE	ATA	ISSUE	REFERENCE
A319/A320/A321	Air Conditioning Trouble Shooting Guidelines	21	2002	SEE22/949.8283/97
A318/A319/A320/A321	Avionics Equipment Ventilation Trouble Shooting Guidelines	21	2002	SEE22/949.7305/99
A319/A320/A321	CIDS (Cabin Intercommunication Display System) Trouble Shooting Guidelines	23	JAN 99	SEE41/952.0797/99
A318/A319/A320/A321	IDG (Integrated Drive Generator) Servicing Procedure	24	JAN 01	SEE51/953.0616/01
A319	Slide / Slide Raft Arming / Disarming Procedures (for EASY JET only)	25	SEP 03	SEE21/949.7706/03
A318/A319/A320/A321	Slide / Slide Raft Arming / Disarming Procedures	25	OCT 03	SEE21/949.9098/03
A318/A319/A320/A321	Slat / Flap System Trouble Shooting Guidelines	27	JAN 90	ST34/993.396/89
A318/A319/A320/A321	Slat / Flap System Trouble Shooting Guidelines	27	FEB 97	SEE41/952.0831/97
A318/A319/A320/A321*	Slat / Flap System - System Evolution	27	MAY 97	SEE41/952.2528/97
A318/A319/A320/A321	Procedure for Re-greasing A320 Flap Actuators	27	FEB 98	No reference
A318/A319/A320/A321	A320 Family Flight Control System - Elevator Rigging	27	APR 03	GDCOS-S097/03 Issue 2004
A318/A319/A320/A321	Shark Fin Tool for Easy Flap Adjustment	27	JAN 00	SEE5959.0073/00
A318/A319/A320/A321	Hydraulic System Maintenance Practices	29	MAY 99	SEE34/951.1497/99
A320	AIDS Trouble Shooting Guidelines (for TELEDYNE DMU only)	31	JUN 89	ST33/0004/89
A318/A319/A320/A321	CFDS - Guidelines for Trouble Shooting using Centralized Fault Display System	31	FEB 96	SE54/953.1211/96
A319/A320/A321	Braking and Steering System Trouble Shooting Guidelines	32	FEB 03	SEE32/957.0519/03 Twin gear
A320	Braking and Steering System Trouble Shooting Guidelines (for IAC only)	32	DEC 97	SEE32/957.4606/97 Bogie gear
A319/A320/A321	Engine Bleed Air System Trouble Shooting Guidelines	36	JUN 02	SEE23/949.0229/95
A319/A320/A321	Vacuum Toilet System Trouble Shooting Guidelines	38	APR. 03	SEE21/949.3269/03
A318/A319/A320/A321	Passenger Door Operation & Maintenance	52	MAY 02	SEE5 956.0214/02

(*) In addition to this document, the "SLAT/FLAP SYSTEM – EVOLUTION" brochure is distributed to detail the component and part number evolution versus modification embodiment.



A330/A340 Family

AIRCRAFT TYPE	TITLE	ATA	ISSUE	REFERENCE
A330/A340 (all)	IDG (Integrated Drive Generator) Servicing Procedure	24	JAN 01	SEE51/953.0616/01
A330/A340 (all)	NBPT Simulation Tool (No Break Power Transfer)	24	2003	GDCOS-SL343/03
A330/A340-200 & -300	Cargo Loading System (CLS) Operation / Trouble Shooting Guidelines	25	2003	SEE24/949.4902/03
A330/A340-200 & -300	Cargo Hold Maintenance	25	SEP 00	AI/SR S064//00
A330/A340 (all)	Slat / Flap System Trouble Shooting Guidelines	27	FRB 97	SEE41/952.0832/97
A330/A340-200 & -300	Refuel System - Description & Trouble Shooting Guidelines	28	JUN 99	SEE31/951.1398/99
A330/A340 (all)	Hydraulic System Maintenance Practices	29	2002	SEE34/951.2403/02
A330 (PW/RR)	Engine Bleed Air System - Operation/Trouble Shooting Guidelines	36	APR 02	SEE/949.2963/00
A330 (GE)	Engine Bleed Air System - Operation/Trouble Shooting Guidelines	36	JUN 02	SEE/949.2966/00
A340-200 & -300	Engine Bleed Air System - Operation/Trouble Shooting Tips	36	JUN 99	SEE23/949.2725/99
A330/A340-200 & -300	Doors & Escape Slide Control System - Operation/Trouble Shooting Guidelines	52	JAN 04	SEE23/949.5096/96

All Aircraft Families

TITLE	ATA	ISSUE	REFERENCE
Leak Prevention on Hydraulic Tube Fitting	29	2004	GDCOS A002/04 (sets of 5)
Hydraulic Systems Maintenance Practices	29	APR 02	SEE34 951.3026/99
Fuel Tank Maintenance Practices (except A340-500 & -600)	57	2002	SEA22/943.1409/02

Delivery conditions for pocket size booklets/brochures/leaflets & posters (posters: by set of 5)

Free of charge (beyond these figures, the requested quantities will be delivered upon receipt of a purchase order)

Fleet size	1-3	4-10	11-20	21-30	31-40	41-50	> 50
Quantity supplied	10	20	30	40	45	50	50

This information is taken from SIL00-032 dated march 2004.
In the event of any conflict the text of the SIL applies

1 Videotape/1 CD is free of charge for each company. CDs are sold by set of 3 irrespective of fleet size.

- Brochure
- Video
- CD
- Poster

Free of charge quantities are provided in accordance with fleet size. Additional quantities are at prices reflected in the "Airbus Customer Services Catalog" (Session 2, paragraph 2.1.2 - "Maintenance and Engineering").
A purchase order form is provided in the Catalog.

Requests and associated purchase order are to be sent to the following address:

Fabienne Baron
AIRBUS S.A.S.
Engineering Services - SEE5 Department
1, rond-point Maurice-Bellonte
31707 BLAGNAC Cedex
France
Tel: +33 (0)5 61 93 47 40
Fax: +33 (0)5 61 93 44 25
fabienne.baron@airbus.com

A380 accommodation at airports

In May 2003, the International Civil Aviation Organization (ICAO) Council initiated a twofold Action Plan for the introduction of New Large Aircraft (NLA) into international civil aviation service.

The first step was to publish a Circular on NLA operations at existing airports to provide States with information concerning airports facilities and services, air traffic management and flight operations, which should be considered for accommodating NLA operations at existing airports. Secondly, a review will be undertaken of the current Annex 14, Aerodromes Volume I, code F provisions, including their underlying basis, considering the results of studies within and outside ICAO.

Most States which are willing to accommodate A380 operations at their airports, and noticeably States having potential alternate airports, may lack the background information and international working relationship which seems necessary for the application of the ICAO Circular on NLA operations. In line with the ICAO decision, an NLA Information Forum website (below) has been created, hosted by the European Civil Aviation Conference (ECAC). The aim of the website is to provide an easy, time-saving and informative access to all the documentation relevant to NLA. It will facilitate the exchange of information between States' administrations, international organisations, airports, airlines, research organisations and industry.

This website will be further developed and kept up to date on a continuous basis:

http://www.ecac-ceac.org/nla-forum.

Customer Services events

Just happened

SUPPLIER SUPPORT SYMPOSIUM
Toulouse, France, 2-3 March

The event brought together 160 representatives from engine manufacturers, major suppliers, BFE suppliers, small suppliers and distributors. It generated much interest amongst the supplier support community, who thanked Airbus for organising such an event to share with them details of Airbus recent developments, expectations from them and vision for the future.

A330/A340 TECHNICAL SYMPOSIUM
Athens, Greece, 14-18 June

Working sessions began on Monday morning and continued through Friday midday. The sessions, as usual, comprised presentations based on actual service issues affecting the A330/A340 programmes as well as subjects of more general interest. Awards for operational excellence were made to Lufthansa, Lan Chile, Korean Air lines and Srilankan Airlines.

3RD SPARES LOGISTICS CONFERENCE
Hamburg, Germany, 15-16 June

This event was the traditional gathering of Airbus customers, suppliers, forwarders and representatives of other industries to discuss expert views and concepts, plus share experience on supply chain logistics. Amongst a wide spectrum of logistical aspects, the event focused on the Airbus service of Customised Spares Logistics, CSL.

Coming soon

HUMAN FACTORS SYMPOSIUM
New Delhi, India, 14-16 September
Seoul, Korea, 23-25 November

Airbus will continue the dialogue with its operators at this forum, discussing human factors aspects with practical and operational perspectives.

AIRBUS SPARES & SUPPLIER SERVICES REGIONAL SYMPOSIUM
Puerto Vallarta, Mexico, 25-28 October

This event focuses on the latest developments related to spares support and services for all Airbus customers of the Americas. The conference follows the theme "Reducing cost through supply chain partnerships".

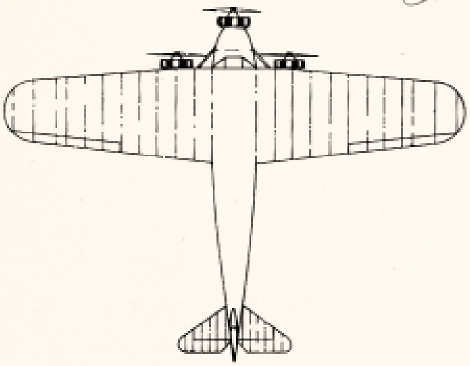
WARRANTY CONFERENCE
Toulouse, France, 30 November-2 December

This event will be the second concerning Airbus warranty processes. A significant number of suppliers are expected to participate to address open issues and positively exchange ideas for the benefit of all parties involved.

7TH TRAINING SYMPOSIUM
Bangkok, Thailand, 6-10 December

This event will continue with the two separate events specific to Maintenance Training and Flight Crew Training introduced with the 6th symposium, with which, generally speaking, attendees were highly satisfied and both events were perceived as beneficial and well organised.

100 years ago...



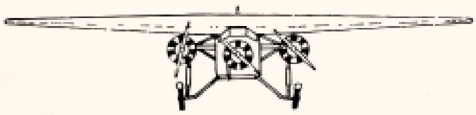
100 years ago, on 20 September 1904, the Wright brothers made the first human flight of more than one kilometre.

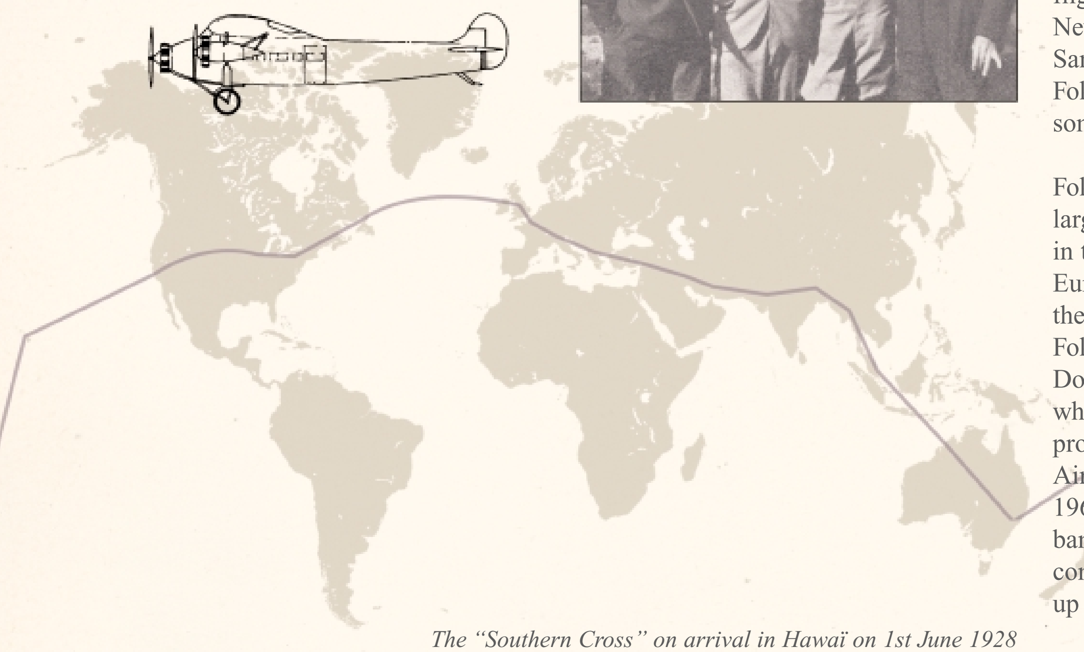
Only 25 years later *Maitland* and *Hegenberger* made the first successful flight from San Francisco to Hawaii in a Fokker F-VII trimotor. Their flight covered 3890km.

The following year, the Australian, *Charles Kingsford-Smith*, also in a Fokker F-VIIb with three Wright 230hp engines, made the first crossing of the Pacific Ocean from San Francisco to Brisbane and then on to Sydney. A flight of some 12,000km in three legs via Hawaii and Suva.

Captain Charles Kingsford-Smith with his fellow crew members.

From left to right, J.W. Warner, radio operator, First Officer Ulm and navigator H.W. Lyons.



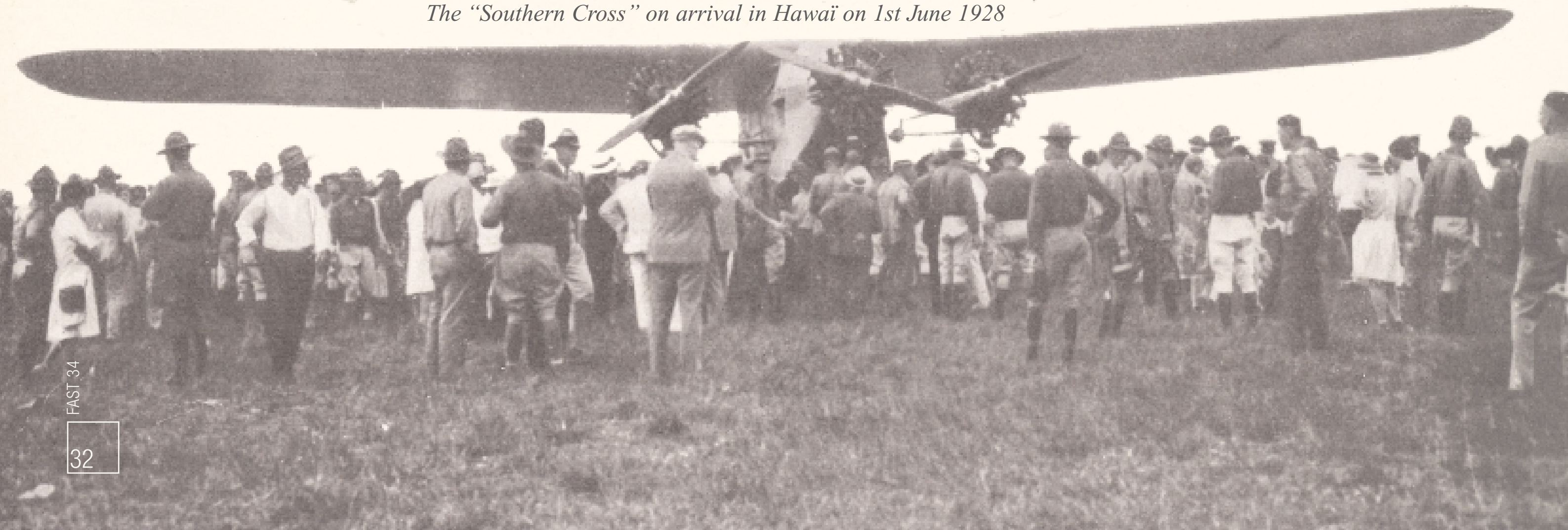


Three months later he made the first flight from Australia to New Zealand.

In the following two years, Kingsford-Smith continued to make the first round the world flight via India, London and New York arriving back at San Francisco in the same Fokker VIIb. A round trip of some 54,000km.

Fokker at this time was the largest aircraft manufacturer in the world with factories in Europe and the USA. However the success did not last. Fokker was overtaken by Douglas Aircraft Company who had more modern products. However Douglas Aircraft became insolvent in 1967. Fokker were declared bankrupt in 1996 and the company was finally wound up in May 2004.

The "Southern Cross" on arrival in Hawaï on 1st June 1928



Customer support

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TECHNICAL, SPARES, TRAINING

Airbus has its main Spares centre in Hamburg, and regional warehouses in Frankfurt, Washington D.C., Beijing and Singapore.

Airbus operates 24 hours a day every day.
AOG Technical and Spares calls
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Tel: +1 (703) 729 9000
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AOG Technical and Spares calls outside
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Fax: +49 (40) 50 76 3011/3012/3013

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AIRBUS TECHNICAL AOG CENTER (AIRTAC)
Tel: +33 (0)5 61 93 34 00
Fax: +33 (0)5 61 93 35 00
support.airtac@airbus.com

RCSM location	Country
Abu Dhabi	*United Arab Emirates*
Algiers	*Algeria*
Amman	*Jordan*
Amsterdam	*Netherlands*
Athens	*Greece*
Auckland	*New Zealand*
Bandar Seri Begawan	*Brunei*
Bangalore	*India*
Bangkok	*Thailand*
Beirut	*Lebanon*
Brussels	*Belgium*
Buenos Aires	*Argentina*
Cairo	*Egypt*
Casablanca	*Morocco*
Charlotte	*United States of America*
Chengdu	*China*
Colombo	*Sri Lanka*
Copenhagen	*Denmark*
Dalian	*China*
Damascus	*Syria*
Delhi	*India*
Denver	*United States of America*
Derby	*United Kingdom*
Detroit	*United States of America*
Dhaka	*Bangladesh*
Doha	*Qatar*
Dubai	*United Arab Emirates*
Dublin	*Ireland*
Duluth	*United States of America*
Dusseldorf	*Germany*
Frankfurt	*Germany*
Florence	*Italy*
Guangzhou	*China*
Hangzhou	*China*
Hanoi	*Vietnam*
Helsinki	*Finland*
Hong Kong	*S.A.R. China*
Indianapolis	*United States of America*
Istanbul	*Turkey*
Jakarta	*Indonesia*
Jinan	*China*
Johannesburg	*South Africa*
Karachi	*Pakistan*
Katowice	*Poland*
Kuala Lumpur	*Malaysia*
Kuwait city	*Kuwait*
Lanzhou	*China*
Larnaca	*Cyprus*
Lisbon	*Portugal*
London	*United Kingdom*
Louisville	*United States of America*
Los Angeles	*United States of America*
Luton	*United Kingdom*

RCSM location	Country
Macau	*S.A.R. China*
Madrid	*Spain*
Manchester	*United Kingdom*
Manila	*Philippines*
Mauritius	*Mauritius*
Memphis	*United States of America*
Mexico City	*Mexico*
Milan	*Italy*
Minneapolis	*United States of America*
Monastir	*Tunisia*
Montreal	*Canada*
Moscow	*Russia*
Mumbai	*India*
Nanchang	*China*
Nanjing	*China*
New Castle	*Australia*
New York	*United States of America*
Ningbo	*China*
Noumea	*New Caledonia*
Palma de Mallorca	*Spain*
Paris	*France*
Philadelphia	*United States of America*
Phoenix	*United States of America*
Pittsburgh	*United States of America*
Port of Spain	*Trinidad and Tobago*
Qingdao	*China*
Quito	*Ecuador*
Rome	*Italy*
San Francisco	*United States of America*
San Salvador	*El Salvador*
Santiago	*Chile*
Sao Paulo	*Brazil*
Seoul	*South Korea*
Shanghai	*China*
Sharjah	*United Arab Emirates*
Shenzhen	*China*
Shenyang	*China*
Singapore	*Singapore*
Sydney	*Australia*
Taipei	*Taiwan*
Tashkent	*Uzbekistan*
Tehran	*Iran*
Tokyo	*Japan*
Toronto	*Canada*
Tulsa	*United States of America*
Tunis	*Tunisia*
Valetta	*Malta*
Ventiane	*Laos*
Verona	*Italy*
Vienna	*Austria*
Washington	*United States of America*
Xi'an	*China*
Zurich	*Switzerland*