Escape slides & slide rafts
A330/A340 Family
A380 - A solution for airports
Approach and Landing Accident Reduction
Preventing ignition sources inside fuel tanks
Anemometric leak detection
Approach & landing - Part 2
Customer Services
2ND AIRBUS FLIGHT OPERATIONS MONITORING & SAFETY DEVELOPMENT CONFERENCE
22-24 September, 2003  Rome, Italy

As part of its commitment to increase safety, Airbus held its second conference in Rome. 70 representatives attended from 48 operators.

Airbus will continue to organise this proactive safety dialogue in the future together with other safety initiatives.

18TH HUMAN FACTORS SYMPOSIUM
28-30 October, 2003  New York, USA

In cooperation with JetBlue Airways, this event attracted 130 participants.

Topics of the programme have been, amongst others, the implementation of a safety culture right from the beginning of an aircraft operation, the safety evaluation methods and tools, the ways and means to prepare the digital future in the cockpit.

A300/A300-600/A310 TECHNICAL SYMPOSIUM
17-21 November, 2003  Seville, Spain

This year the A300 Family Symposium gathered 250 representatives from 51 airlines and 16 vendor representatives. The programme covered aspects of ageing aircraft, major in-service issues, improved responsiveness, aircraft upgrades and freighter versions. Demonstrations on fuel leak detection and repair as well as AOLS were performed daily throughout the conference.

Awards for Excellence in Operation were given to Japan Air Systems and Kuwait Airways. Exceptionally an award for Recognition of outstanding performance were given to European Air Transport, Korean Airlines and TAP Air Portugal. Pakistan International Airlines, Qatar Airways and TAP received a recognition for the highest aircraft utilisation.

19TH HUMAN FACTORS SYMPOSIUM
May 2004  Location not yet decided

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

The first, of two scheduled for 2004, will take place in May. A provisional agenda will soon be sent to all operators.

A330/A340 FAMILY SYMPOSIUM
14-18 June, 2004  Athens, Greece

Airbus is pleased to announce the date and location of the next A330/A340 Technical Symposium. The working sessions will begin on Monday morning and will continue through to Friday midday. These sessions will as usual comprise presentations based on actual service issues affecting the A330/A340 programme as well as subjects of more general interest.

A provisional agenda will soon be sent to all operators.
Escape slides and slide rafts  A330/A340 Family
Scheduled maintenance operational test

Each door on a passenger aircraft is fitted with an escape slide for emergency evacuation of passengers and crew. Most of the slides may also be used as life rafts in the event the aircraft lands on water. For simplicity in this article, slides includes slide rafts. Slides can be compared to parachutes: they are packed to work once. Following use, it is necessary to repack them to be ready for the next deployment. And, before each deployment, there is no absolute certainty that they will work. Since they are not used often it is necessary to have a means of gathering information on their reliability and particularly to identify potential deployment failures: the only way is to perform scheduled deployments of slides.

When and where slides are tested

Today, deployment tests are performed at different stages in the life of the slide.

At the manufacturing facility
During the manufacturing process by the supplier, Goodrich, all slides are tested before delivery to Airbus. This acceptance test consists of deploying all units from a mock-up of the aircraft door. After inflation the slide is checked in order to correct any anomalies such as bonding and leaks between pieces of material. In the event of deployment failure, the slide is reconditioned and tested again. Each deployment is video recorded and the tape is archived by Goodrich.

Sampling on new aircraft during Airbus A330/A340 final assembly
Since 2002 a sampling programme was organized during A330/A340 final assembly in order to test in real conditions, from the aircraft, the newly installed slide. Before delivery of a new aircraft to the customer, one door is selected at random and the corresponding slide is deployed. All the tests are video recorded from three different angles (inside the aircraft, outside in front of the door and on the side). This permits identity of potential issues, which are not linked to operational or in-service conditions.

When fitted on in-service aircraft (maintenance requirement)
The Airbus Maintenance Planning Document (MPD) requires that operators perform a scheduled operational test on the slide fitted on their A330/A340 Family. The minimum requirement is to perform one deployment per fleet (A330/A340), per door position (1, 2, 3 and 4 left or right) every 36 months. However, depending on national regulations, some authorities request their local operators to perform more deployment tests than Airbus requires.

Airbus requests each operator to report all deployment tests (successful or unsuccessful) through SIL 25-061. Also, every 36 months, each slide has to be overhauled in a qualified shop approved by Goodrich, and listed in their Component Maintenance Manual (CMM).

Testing the slide

The tests have to be done on the aircraft by opening the relevant door in armed mode to allow the deployment of the slide. The Aircraft Maintenance Manual (AMM) operational test task and SIL 25-124 describes the procedure to follow and the corresponding safety precautions.

It is important to follow the rules in performing this test in order to ensure that slide deployment will occur in the best conditions (close to an emergency situation).

Slide deployment sequence

- Door handle lever is lifted with door in armed mode.
- Door booster is activated.
- Gas under pressure goes into the door damper.
- Door starts to open quickly and move forward.
- Release-pin lanyard is under tension, and then the two release pins are pulled.
- The slide packboard drops on to the door sill and the rail adapters are extracted from the rails.
- The packboard is detached from the door.
- Door moves to the side and allows the packboard to drop outside the aircraft.
- The packboard starts to rotate and then the parachute pin is pulled.
- Soft cover lacing opens (packboard rotated about 90 degrees).
- Packboard continues to rotate to a total of 270 degrees so that the top outboard corner of the packboard (rail adapters) is pointing towards the fuselage.
- The packboard and the cylinder is then extracted from the pack.
- The aspirators detach from the packboard and the cylinder is then extracted from the fuselage.
- The firing lanyard being under tension, the firing pin is pulled out of the regulator valve and the inflation is initiated.
- Pressurised gas (3290 psi of mixed nitrogen and CO2) passes from the cylinder through the aspirators to the inflatable part of the slide and opens the aspirators’ flapper valve with the help of a venturi.
- The aspirators’ flapper valve draws in external air.
- The mix of gas under pressure and external air starts to inflate the slide.
- Inflation is finished when the slide raft has reached the requested pressure controlled by a pressure relief valve (PRV).
The complete deployment sequence, from the door opening until the full inflation of the slide, should not exceed 16 seconds. Actual slide inflation from the packboard being released until deployment is complete takes less than six seconds.

The Goodrich method is to extract the complete packboard from the aircraft, let it drop against the fuselage and then commence inflation. During the deployment and inflation, the packboard, which is built from hard composite material, may come into contact with the fuselage skin. Dents on the fuselage (or belly fairing for door 3) may result from this contact. It is therefore necessary to protect the aircraft during test slide deployments.

Initially the only recommendation was to use a “protective mat” for the fuselage during slide deployment, without giving a material specification. Most of the time just before deployment test, mechanics had to find something in the hangar to tape to the aircraft skin. Usually plastic sheet, a piece of carpet, cardboard or bubble wrap were the most easily available materials and were quickly taped to the fuselage below the doorsill.

**IN SERVICE EXPERIENCE**

Several reports have been received from the field showing that the use of such materials has allowed damage to the fuselage and in some cases prevented normal deployment of the slide raft:

- damage to the fuselage and particularly to the belly fairing was due to a protection that was too light (Figure 1) or not located where contact would occur,
- deployment failures were mainly due to the slide pack being caught in protective material (particularly bubble wrap), which decreased the drop inertia and stopped the deployment before inflation (Figure 2).

**RECOMMENDATIONS**

Further to these reports, Airbus reviewed in detail how to protect the aircraft skin during a deployment test. The first step was to determine the fuselage area to be protected at each door position. The second step was to define a material able to protect the fuselage structure without disturbing the deployment sequence.

**WHICH AREA TO PROTECT**

During the deployment sequence, the packboard may hit the fuselage and cause damage. This happens when the packboard is rotated a total of 270 degrees, and its top outboard corners (rail adapters) point towards the fuselage (figure 3). The degree of contact depends on the dropping inertia. At the door 3 position, due to the contour and composite material of the belly fairing located below it, a heavy dent may result.

After review of the different conditions it has been decided to have a specific protection fitted during the test, just below the doorsill and covering the maximum area of packboard movement:

- for passenger exit (Type A door equipped with slide raft) the protection dimension should be 3m deep x 4m wide (figure 4).
- for emergency exit (Type 1 door equipped with slide) the protection dimension should be 3m deep x 2m wide (figure 5).

**PROTECTIVE MATERIAL**

Having determined the area to be protected, the type of protection chosen is also important to ensure adequate protection without disturbing the deployment sequence. The protective material should simulate the aircraft skin. After review of existing materials and some tests on the final assembly line during a sample deployment, it has been decided to use two different materials, bonded together, to provide the required protection.
Being a system designed to be used in emergencies, slide deployment is fast and quite violent, as the slide has to be ready to evacuate passengers from the aircraft very quickly after the door opens. Because of this deploying a slide or slide raft for test requires some precaution in order to prevent any fuselage damage or interference in the sequence. Making a video of the tests in order to be able to investigate possible failures is recommended. Airbus would be grateful for feedback on all deployments, successful or otherwise, as described in SIL 25-061.

Conclusion

This protection is made of two separate layers (Figure 6):

- The outer layer is fibreglass-reinforced polyester laminate Material No. 05-109 (refer to AMM 20.31.00), which has a minimum thickness of 1.2mm (0.06in). This layer has a hard smooth surface, which cannot catch parts of the packboard, as it falls during deployment. The surface is also impact resistant and spreads the load evenly.

- The inner layer is polyethylene foam Material No. 05-082 (refer to AMM 20.31.00), which has a minimum thickness of 10mm (0.39in). It absorbs the load.

HOW TO BUILD AND FIT THE PROTECTION ON THE AIRCRAFT SKIN

Refer to figures 4 and 5 for the dimensions and position of the protection required for each type of door. Three different sizes of protection can cover all A330/A340 door types: (one for all Type A doors 1, 2 and 4; one for Type A door 3; one for Type 1 door 3). However, the protection for door 3 Type A can also be used for Type 1 if both door types are present in the fleet. Then cut both outer and inner layers to the appropriate dimensions. Attach the self-adhesive foam sheets to the polyester laminate sheets.

Use an adjustable access platform to help position and attach the protective cover: Make sure the protection is correctly attached with tape to the aircraft structure. This prevents the suction of loose protection material into the aspirator during the deployment test. Loose protection material can cause damage to the aspirator, with the risk that the deployment test will not be satisfactory.

Use adhesive tape (Material No. 05-069) or ADETEC 5150 to attach the protection sheets to the fuselage below the doorsill. Make sure that there are no gaps between the edges of the sheets and that the self-adhesive foam sheet goes against the fuselage.

Follow all safety instruction provided in AMM 25-62-00-501.

Protective material

Outer layer with hard and smooth face
Minimum thickness: 1.2mm (0.06in.)

Inner layer of foam to absorb the load
Minimum thickness: 10mm (0.39in.)
Most major airports are facing significant passenger growth, growing congestion, and limited potential for expansion. Given the unique nature of the A380’s size with greater span, height, seating capacity and weights, a team dedicated to the A380 airport compatibility aspects was set up in 1994, 12 years before the planned entry into service. Dialogue with major world airports is now well-established and many are using the A380 as the reference aircraft for master planning. The availability of the A380 Airplane Characteristics for Airport Planning manual, on the Airbus web site since February 2002 has significantly supported this process. In parallel, work with regulatory authorities and on environmental aspects is ongoing. Many aspects of the A380 design have been driven by airport compatibility considerations, thus minimising the amount of adaptation and, hence investment, required by airports to accommodate the aircraft.

Most major airports are planning for operations of large aircraft, mainly because they are facing significant passenger growth, growing congestion, and limited potential for expansion. These airports, therefore, see the A380 as a boost for business: it will enable them to increase revenue for relatively little expenditure within the limits of their existing infrastructure. Dialogue and combined working groups are key elements in defining the A380 and airport master plans.
Airbus is working closely with 60 airports (Figure 1) that are likely to see the A380 before 2010 as indicated by existing and potential customers. Of these airports, many are A380 compatible today and those that do require infrastructure changes have planned and in some cases started work on the relevant upgrades. In addition surveys have been carried out and contacts established with further airports based on carrier interest and Airbus forecasts for future A380 routes.

AIRPORT COMPATIBILITY

Many recommendations that Airbus received during its extensive consultations with airports and regulatory authorities have directly shaped the design of the A380. The main characteristics that have been optimised for better airport integration are summarised in Figure 2. The landing gear width and 20-wheel design will allow the aircraft to use 23m wide taxiways and have a comparable pavement loading to existing aircraft. Furthermore the A380 will be certificated for unrestricted operations on 45m wide runways.

In the context of terminal operations, the door locations and cabin layout allow comparable turn around times to the 747-400 with 35% more passengers boarded. Ground servicing points are located in similar positions to other widebody aircraft allowing the use of existing ground servicing equipment. As well as the physical characteristics, the field performance of the aircraft has been optimised to allow the A380 to operate from any airport that the 747 does today.

There are a number of factors that relate to the wingspan, weight and capacity of the aircraft that airports will have to take into consideration however. With a wingspan of 79.8m (262ft) and fin height of 24m (79.6ft) the main area that airports will need to address are runway and taxiway separation distances. These vary from one airport to another with many newer airports already being fully A380 compliant. Although the pavement loading of the A380 is comparable to existing aircraft, the weight-bearing limit of tunnels and bridges will need to be verified to ensure they are capable of supporting the 562t Maximum Ramp Weight of the aircraft. Parking stands will need to be upgraded to cater for the greater wingspan, alternatively the size of aircraft on the stands either side of an A380 could be limited. With a seating capacity approximately 35% higher than the 747-400, terminal facilities directly related to aircraft capacity such as gate holding rooms, may require modification. The amount of modification required at airports will vary considerably dependant on the compatibility of existing infrastructure.

Figure 1 - Likely first A380 airports

Figure 2 - Designed for airport integration

<table>
<thead>
<tr>
<th>Recommendations</th>
<th>A380 Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum obstacle free zone (OFZ)</td>
<td></td>
</tr>
<tr>
<td>- less than 20m (24.4m) height</td>
<td></td>
</tr>
<tr>
<td>Run of 45m (154ft) wide runway, 23m (78.6ft) taxiways</td>
<td></td>
</tr>
<tr>
<td>- close to group V / code E</td>
<td></td>
</tr>
<tr>
<td>Reduced taxiway/object separation</td>
<td></td>
</tr>
<tr>
<td>(Wing tip height to be considered)</td>
<td></td>
</tr>
<tr>
<td>Pavement loading - comparable to existing aircraft</td>
<td></td>
</tr>
<tr>
<td>Ground manoeuvres comparable to existing aircraft</td>
<td></td>
</tr>
<tr>
<td>Minimize need for new ground support equipment</td>
<td></td>
</tr>
<tr>
<td>Location of servicing points comparable with existing aircraft</td>
<td></td>
</tr>
<tr>
<td>30 minutes turn around-time</td>
<td></td>
</tr>
<tr>
<td>Low noise and emissions</td>
<td></td>
</tr>
<tr>
<td>Jet blast comparable to existing jets</td>
<td></td>
</tr>
<tr>
<td>Meet latest ICAO standards with margins</td>
<td></td>
</tr>
</tbody>
</table>
Many airports are already congested today, accommodating future growth with the existing aircraft mix would require additional infrastructure to provide the extra stands and slots. This would require the construction of new runways, taxiways, parking areas, terminals and gates with costs in the region of several billion dollars. As aircraft capacity has hardly changed for three decades there is an urgent need to prepare for the future. The A380 carries 35% more passengers than a 747, thus allowing airports to accommodate growth within their current infrastructure, therefore mitigating the need for such massive infrastructure investment. Adaptation of airports to accommodate larger aircraft is cheaper, simpler and more space efficient than the duplication of runways and gates. For those airports that are land constrained and/or movement limited by local environmental legislation, large aircraft are the only solution to cater for growth. The costs related to the integration of the A380 are incremental and relate only to airside, apron and terminal upgrades ($100 million - Airports Council International – North America average). They are dependent on a variety of factors including the level and layout of existing infrastructure, frequency of A380 operation and adoption of operational recommendations. This level of investment is small in comparison to total airport expenditure and much less than that required for new airports, which are also subject to very long planning and construction periods.

**REGULATORY ASPECTS**

The costs of adapting an airport to handle the A380 can be minimized by applying current accepted airport operational recommendations rather than design recommendations (Figure 3), which are applicable to new airports and new areas of existing airports. The A380 Airport Compatibility Group (AACG) was the first group dedicated to airport operational recommendations and they now work jointly with the FAA and ICAO on A380 operations. The AACG Common Agreement Document was completed at the end of 2002. Four European civil aviation authorities have signed a letter, stating that the AACG document constitutes a sound basis for any adaptation of their respective regulations, to facilitate the introduction of the A380 for safe and harmonized operations into existing airports. A CD-ROM containing the complete AACG documentation was officially released to ICAO on January 31st, 2003.

Dissemination of AACG work to ICAO, FAA, A380’s airlines and airports, international and working groups dealing with new large aircraft operations was conducted through presentations at ICAO Europe (October 2002), ICAO Montreal (November 2003) and FAA (November 2002).

Following the dissemination of the AACG work Airbus is currently assisting in the definition of operational recommendations in conjunction with both ICAO (circular on new large aircraft operations, including A380 specifies discussed at Airport Design Study Group meetings in July and October 2003 - planned to be issued by year end) and the FAA (modification of standards requested by major US airports - expected FAA answers by early 2004).

**GROUND OPERATIONS**

The main driver for ground operations of the A380 was to be as compatible as possible to existing wide-body aircraft in all key areas, these include manoeuvrability on ramp and taxiway systems and terminal operations. To facilitate this aim, Airbus has and continues to work closely with airlines, airports, ground handling companies, ground servicing equipment (GSE) manufacturers to ensure the all aspects of ground operations will be ready for the A380 when it enters service.

**MANOEUVRABILITY**

Recent modifications to corners of taxiways to suit the greater turning circles of the A340-600 and 777-300 will allow the A380 to manoeuvre without restriction (Figure 4). Although the track of the A380 landing gear is slightly wider than those aircraft its wheelbase is shorter. This means that the effective clearance between the main wheels of the A380 and the edge of the taxiway is greater. Visibility from the cockpit also directly influences the accuracy of ground manoeuvring and in this respect the A380’s mid-deck cockpit position offers a better field of vision than the 747. It also makes the transition from other Airbus wide-body types to the A380 easier for pilots.
between Doors 1 left and right on the main deck. This allows the same two bridge arrangement to be used as the 747 but results in separate and simultaneous boarding flows onto the upper and main decks (Figure 7). This considerably improves passenger boarding and de-boarding times, a critical component in the turn around time of a large aircraft.

In those cases where airlines or airports wish to offer an increased level of passenger service or faster turn-around times, specialised equipment such as upper deck boarding bridges and upper deck catering vehicles are required. In those applications which necessitate new equipment with direct upper deck access capability, Airbus has taken a proactive approach in facilitating the communication between the airlines, airports and GSE manufacturers. This primarily includes the organisation of working groups and open forums where manufacturers can present their design concepts and receive feedback from airlines and ground handling companies. As well as the organisation of these meetings, Airbus provides A380 technical data and has set up e-rooms which greatly aid the interchange of information between working group members.

Instigated in February 2001, the upper deck catering vehicle working group is the longest running of these forums. Several manufacturers have shown detailed design solutions for such a vehicle whose main requirement is to service the 8m high upper deck directly. As part of its commitment to ensuring the availability and safe operation of such vehicles by A380 entry into service, Airbus has recently completed a full scale partial mock-up of the A380 in Toulouse (Figure 8) which will be used for operational testing. These tests will initially use existing 5m main deck capable catering vehicles to validate positioning concepts and the interaction with other GSE. When prototype upper deck catering vehicles are available, the mock-up will be offered for full scale operational testing and possibly familiarisation training.

**TERMINAL OPERATIONS**

Essentially from the main deck to ground level the A380 offers the same accessibility as existing wide-body aircraft. Ground servicing locations have been agreed with airlines to ensure compatibility with existing ground servicing vehicles (Figure 5 & 6). The size of the A380 cabin will drive specific ground servicing requirements, in particular for the amount of electrical power and preconditioned air. Additional ports for ground electrical power and a higher flow rate for the preconditioned air cater for the increased demand, which existing servicing equipment can provide.

The cabin architecture of the A380 allows turn-around times similar to the 747-400. This has largely been achieved by the optimal positioning of the A380’s wide dual lane stairs in the cross aisle.
PAVEMENT LOADING

Full scale pavement testing to optimize and validate A380 landing gear design was started in 1998 at Toulouse Blagnac airport (Figure 9) with two phases (flexible and rigid pavement tests). New test-validated methodologies are under development, using a software called ALIZE to supplement and eventually replace the current Aircraft/Pavement Classification Number (ACN/PCN) method which although widely used has limited theoretical basis. The development process will see ALIZE calibrated against results from full-scale static and fatigue tests using real aircraft on both flexible and rigid pavements. A380 landing gear configurations as well as those for some competing aircraft were reproduced using a landing gear configuration test vehicle. The results obtained from the test vehicle were also validated against production aircraft.

In both of the tests four 30m x 3m segments of pavement were prepared, each separated by 5m of neutral pavement (Figure 10). Each segment represented a pavement laid on a different quality of natural foundation called subgrade and measured on the CBR (California Bearing Ratio) scale. The three weaker subgrades CBR10, 6 and 4 were covered first with a layer of humidified reconstituted crushed gravel then a layer of asphalted gravel and finally with a layer of either asphalt for the flexible surface or concrete for the rigid surface. Dozens of strain gauges were placed in the surface to measure the effect of different weights of aircraft on the pavement.

The landing gear configuration test vehicle was built to simulate different full scale landing gear layouts and different weights of aircraft (Figure 11). A340 wheels and tyres were used with tyre pressure being varied to simulate the tyres of different aircraft types. A load per wheel of up to 32 tonnes was made possible by the addition of ballast to the vehicle. Both Airbus and other aircraft were used to validate the results obtained from the vehicle tests.

Airbus can now simulate any landing gear configuration with the associated aircraft weight and load transferred through each wheel. The strain gauges on the eight pavement and subgrade samples show the actual load on the surface. Results obtained from the pavement tests have been in line with the outputs from the ALIZE model and validate the comparable pavement loading of the A380 to existing aircraft.
The A380 offers immediately an elegant solution to cope with the forecast ongoing growth in airport traffic. With its larger capacity it offers the most efficient use of terminal stands and runway slots thereby mitigating the requirement for complex and costly infrastructure development. Through a process of consultation from a very early stage, many aspects of the A380 have been optimised for airport compatibility resulting in an aircraft that can be integrated into existing airports with a minimum of change and hence investment. Airbus continues to work with all parties concerned to ensure that airports will be ready for the A380 when it enters into service in 2006.

From an environmental perspective the application of new technology and intensive research has enabled the A380 to combine the intrinsic advantages of its larger capacity with much lower noise compared to existing large aircraft.
Aviation safety, measured in terms of number of hull losses per departure, has reached a mature, but stable, level. Any further enhancement of this achievement requires a systematic approach where the aircraft, the operations and the operating environment are considered globally.

The on-going industry effort to reduce approach-and-landing accidents is an illustration of global teamwork involving the aircraft manufacturers, the airlines, the state regulatory authorities and all other actors of the aviation system (e.g., flight academies, service providers).
The Approach and Landing Accident Reduction (ALAR) effort certainly is the largest flight safety initiative ever initiated by the aviation industry. The ALAR project was launched by the Flight Safety Foundation in 1996 as a new phase of the Controlled Flight Into Terrain (CFIT) accident reduction programme started in 1992.

The Flight Safety Foundation is an international membership organization dedicated to the continuous improvement of aviation safety. Safety initiatives launched by the Flight Safety Foundation draw on the support of the worldwide aviation industry, thus ensuring the wide acceptance and dissemination of the resulting conclusions and recommendations.

Airbus has been an active contributor to the CFIT accident reduction project and makes a continuing major contribution to the on-going ALAR effort.

SIZING ELEMENTS

Approach-and-landing accidents (defined as accidents occurring during the initial approach, final approach and landing) represent approximately 55% of total hull losses and 50% of fatalities.

The flight segment from the outer marker to the completion of the landing roll represents only 4% of the flight time but 45% of hull losses.

This statistical data has not shown any down trend over the past 40 years.

Five types of events account for 75% of approach-and-landing incidents and accidents: • CFIT (including landing short of runway), • loss of control in flight, • runway overrun, • runway excursion, • unstabilized approach.

DATA-DRIVEN APPROACH TO CONCLUSIONS AND RECOMMENDATIONS

The Flight Safety Foundation ALAR task force collected and analysed data related to a significant set of approach-and-landing accidents, including those resulting in controlled-flight-into-terrain (CFIT). The task force developed conclusions and recommendations for practices that would improve safety in approach-and-landing accidents, in the following domains:

- air traffic control - training and procedures,
- airport facilities,
- aircraft equipment,
- aircraft operations and training.

All conclusions and recommendations were data-driven and supported by factual evidence of their relevance to the reduction of approach-and-landing incidents and accidents.

CONCLUSIONS AND RECOMMENDATIONS FOR FLIGHT OPERATIONS AND TRAINING

The conclusions of the Flight Safety Foundation ALAR task force identify the following flight operations and training issues as frequent causal factors in approach-and-landing accidents, including those involving CFIT:

- standard operating procedures,
- decision-making in time-critical situations,
- decision to initiate a go-around when warranted,
- rushed and unstabilized approaches,
- pilot/controller understanding of each other’s operational environment,
- pilot/controller communications,
- awareness of approach hazards (visual illusions, adverse wind conditions or operations on contaminated runway),
- terrain awareness.

Each conclusion is complemented by a set of recommendations that has been translated in a corresponding set of Flight Operations Briefing Notes.

In addition to flight operations and training recommendations, the ALAR task force encourages the operators to consider the immediate benefit of:

- existing technology and equipment such as Terrain Awareness Warning Systems of Global Positioning Systems,
- flight operations monitoring systems,
- aviation information sharing programmes.

IMPLEMENTATION

The conclusions and recommendations of the ALAR task force have been translated into industry actions to ensure their effective implementation. These actions have been endorsed by the ICAO, the US FAA, the European JAA and the CAAC (Civil Aviation Authority of China), to name the main regulatory authorities supporting this effort.

In 2000 the Flight Safety Foundation started a worldwide awareness campaign that will ensure the availability of this information to everyone who participates in approach-and-landing operations, so that they can all play a part in improving safety within their sphere of influence.

This global effort, to which Airbus is contributing, has raised the awareness of the aviation community in the following world regions:

- Central America and Caribbean area,
- South America,
- Iceland,
- Africa,
- Southeast Asia,
- Australia,
- People’s Republic of China,
- Russia / CIS
- Europe.

The cooperation and contribution of all players in the global aviation system are of paramount importance to enhance partnership, cooperation and communication between:

- operators (commercial, cargo and corporate),
- manufacturers,
- national and international airlines and pilots associations,
- air traffic control/services,
- state regulatory authorities,
- state navigation agencies,
- services providers,
- training organizations.

This is essential to achieve a wide dissemination of the ALAR Education and Training Aid (ALAR Tool Kit), including:

- CFIT and ALAR awareness videos,
- Briefing Notes,
- Safety Alert Bulletins,
- Awareness Tool (checklist),
- Risk Reduction Guide.

They are also vital to facilitate an easy and fast implementation of all conclusions and recommendations.

ALAR BRIEFING NOTES

Airbus provided major leadership in the development of the Flight Safety Foundation ALAR Briefing Notes.

The ALAR Briefing Notes provide an overview of the operational standards, factors and prevention strategies related to the various aspects involved in approach-and-landing accidents.
Airbus published the ALAR Briefing Notes in the brochure “Getting to grips with Approach and Landing Accident Reduction” (Issue 1, October 2000). Flight Safety Foundation published the Briefing Notes in “Flight Safety Digest” (Vol. 19, Nos 8 to 11, August to November 2000) and in “ALAR Tool Kit” (CD-ROM).

Overall, approximately 35000 copies of the ALAR Briefing Notes have been disseminated worldwide, under paper or CD-ROM format.

The scope of the ALAR Briefing Notes actually extends well beyond approach-and-landing accidents, by addressing:

- wind shear awareness in all flight phases, including takeoff and landing,
- terrain awareness in all flight phases,
- descent-and-approach preparation,
- initial descent management, go-around and missed-approach.

This extended scope addresses the type of events and causal factors involved in approximately 70% of total hull losses.

ALAR Briefing Notes consist of 34 standalone documents grouped under 8 chapters, (see table right).

### ACCIDENT-PREVENTION STRATEGY

The ALAR Briefing Notes have been designed to allow an eye-opening and self-correcting accident-prevention strategy. To support this strategy, each Briefing Note:

- presents the subject in the CFIT and/or ALAR context, using statistical data,
- emphasises the applicable standards and best practices (e.g., standard operating procedures [SOPs], supplementary techniques, flying techniques and training guidelines),
- lists and discusses the operational and human factors that may cause flight crews to deviate from applicable standards (for eye-opening purposes),
- provides or suggests company accident-prevention strategies and/or personal lines-of-defense (for prevention purposes or for correction purposes),
- establishes a summary of operational and training key points,
- provides cross-reference to other Briefing Notes, whenever appropriate,
- refers to ICAO, US FAR and European JAR regulatory documents.

The proposed education and training strategy is valid at both company and personal level for:

- risk awareness (eye-opening aspect),
- exposure assessment,
- identification of risk-related prevention strategies (at company level) and lines-of-defense (at company and/or personal levels),
- supporting the analysis of flight data, line checks and line audits,
- implementing relevant prevention strategies and/or corrective actions.

### ALAR BRIEFING NOTES

<table>
<thead>
<tr>
<th>1 STANDARD OPERATING PROCEDURES (SOPs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 Operating Philosophy</td>
</tr>
<tr>
<td>1.2 Normal Use of Automation</td>
</tr>
<tr>
<td>1.3 Normal Use of Automation</td>
</tr>
<tr>
<td>1.4 Standard Calls</td>
</tr>
<tr>
<td>1.5 Normal Checklists</td>
</tr>
<tr>
<td>1.6 Approach and Go-around Briefings</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2 CREW CO-ORDINATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1 Human Factors in Approach- and-</td>
</tr>
<tr>
<td>Landing Accidents</td>
</tr>
<tr>
<td>2.2 CRM Issues in Approach- and-</td>
</tr>
<tr>
<td>Landing Accidents</td>
</tr>
<tr>
<td>2.3 Effective Pilot/Controller</td>
</tr>
<tr>
<td>Communications</td>
</tr>
<tr>
<td>2.4 Intra-Cockpit Communications –</td>
</tr>
<tr>
<td>Managing Interruptions and Distractions</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3 ALTIMETER AND ALTITUDE ISSUES</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1 Altimeter Setting – Use of Radio</td>
</tr>
<tr>
<td>Altimeter (see figure 1)</td>
</tr>
<tr>
<td>3.2 Altitude deviations</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4 DESCENT AND APPROACH MANAGEMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1 Descent and Approach Profile</td>
</tr>
<tr>
<td>Management</td>
</tr>
<tr>
<td>4.2 Energy Management during Approach</td>
</tr>
<tr>
<td>(see figure 2)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5 APPROACH HAZARDS AWARENESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1 Approach Hazards Awareness</td>
</tr>
<tr>
<td>General</td>
</tr>
<tr>
<td>5.2 Terrain Awareness</td>
</tr>
<tr>
<td>5.3 Visual Illusions Awareness</td>
</tr>
<tr>
<td>5.4 Windshear Awareness</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>6 READINESS AND COMMITMENT TO GO-AROUND</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1 Being Prepared to Go-around</td>
</tr>
<tr>
<td>6.2 Flying a Manual Go-around</td>
</tr>
<tr>
<td>6.3 Terrain Avoidance (Pull-up)</td>
</tr>
<tr>
<td>Manoeuvre</td>
</tr>
<tr>
<td>6.4 Bounce Recovery – Rejected Landing</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>7 APPROACH TECHNIQUES</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.1 Flying Stabilised Approaches</td>
</tr>
<tr>
<td>7.2 Flying Constant Angle-</td>
</tr>
<tr>
<td>Non-Precision Approaches (figure 3)</td>
</tr>
<tr>
<td>7.3 Acquisition of Visual References</td>
</tr>
<tr>
<td>7.4 Flying Visual Approaches</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>8 LANDING TECHNIQUES</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.1 Preventing Rampway Excursions and</td>
</tr>
<tr>
<td>Overruns</td>
</tr>
<tr>
<td>8.2 The Final Approach Speed</td>
</tr>
<tr>
<td>8.3 Factors Affecting Landing Distance</td>
</tr>
<tr>
<td>8.4 Optimum Use of Braking Devices</td>
</tr>
<tr>
<td>8.5 Landing on Wet or Contaminated</td>
</tr>
<tr>
<td>Runway</td>
</tr>
<tr>
<td>8.6 About Wind Information (What’s</td>
</tr>
<tr>
<td>your current Wind?)</td>
</tr>
<tr>
<td>8.7 Crosswind Landing</td>
</tr>
</tbody>
</table>

Note: Should any deviation appear between the information provided in the ALAR Briefing Notes and that published in the applicable Aircraft Flight Manual (FMM), Flight Crew Operating Manual (FCOM), Quick Reference Handbook (QRH) and Flight Crew Training Manual (FCTM), the latter shall prevail at all times.
Flight safety enhancement has been, and will continue to be, the result of technological developments. However, 85% of accidents today are operational events that involve human performance at every stage of the safety chain.

Human performance can be, and must be, enhanced by the wide dissemination of safety-awareness information.

Safety awareness is a mindset, it is ... being mentally prepared.

CONTACT DETAILS

Michel Trémaud  
Senior Director  
Safety and Security  
Airbus Customer Services  
Tel: +33 (0)5 61 93 33 30  
Fax: +33 (0)5 61 93 29 68  
michel.tremaud@airbus.com

Jim Burin  
Director, Technical Programs  
Flight Safety Foundation  
Burin@flightsafety.org  
Jim_Burin@email.msn.com  
http://www.flightsafety.org

BEYOND THE ALAR EFFORT

The wide acceptance of the ALAR Briefing Notes by the pilot community and the positive feedback received from customers have prompted Airbus to initiate the development of new sets of Flight Operations Briefing Notes, in order to cover the entire flight profile and address the main threats and hazards to flight operations safety.

This effort will span the years 2003-2006 and will cover the following domains:

• takeoff and departure safety,
• climb and cruise safety,
• weather threats,
• environmental hazards,
• cabin safety and security,
• other operational hazards, as suggested by the lessons learnt from the operational and human factors analysis of in-service occurrences.

HOW TO USE AND IMPLEMENT THE ALAR BRIEFING NOTES

The ALAR Briefing Notes should be used by airlines to enhance the awareness of approach-and-landing accidents (including those resulting in CFIT) among flight crews and cabin crews.

MANAGEMENT PILOTS should review, customise (as required) and implement the ALAR recommendations, guidelines and awareness information, in the following domains:

■ Operational Standards: standard operating procedures (e.g., to incorporate ALAR-critical items), procedures and techniques’ supplementary techniques.

■ Training Standards: simulator training to develop new scenarios for line oriented flight training (LOFT) or special purpose operational training (SPOT), crew resource management (CRM) training to develop new topical subjects to support CRM discussions.

■ Safety Awareness Information: airline bulletins and airline safety magazine articles, classroom lectures (using ALAR Briefing Notes and associated presentations and videos), stand-alone reading.

LINE PILOTS should review and compare the CFIT/ALAR recommendations, guidelines and awareness information with their current practices and enhance their techniques and awareness level, as required.

OTHER ACTORS in the global aviation system such as: air traffic control services, navigation state agencies, operational authorities, service providers, flight academies… should use the provision of the ALAR Briefing Notes to evaluate their possible contribution to the reduction of CFIT and Approach-and-Landing accidents.
Following the B747 TWA centre wing tank explosion in 1996, the National Transportation Safety Board (NTSB) in the United States made recommendations to enhance the already good safety record of aircraft fuel systems worldwide. Subsequently the FAA and JAA introduced new requirements relative to the prevention of fuel tank explosions. This article describes the major activities undertaken by Airbus, in order to further improve safety margins.

The FAA has identified 6 cases of large aircraft fuel tank explosions since 1963:

- 1963 - B707, Elkton in Maryland. Empty wing tank explosion
- 1970 - DC-8, Toronto. External fuel fire caused tank explosion
- 1976 - B747-100, Spain. Iranian Air Force, empty wing tank explosion, lightning strike during descent
- 1990 - B737-300, Manila, Philippines, empty centre tank explosion during pushback from gate
- 1996 - B747, TWA 800, Long Island USA. Empty centre tank explosion during climb
- 2001- B737-400, Bangkok Thailand. Empty centre tank explosion a few minutes after refuelling
An exhaustive design review of the fuel systems installed on the various aircraft types has been launched in order to identify any situation that may in certain conditions lead to the presence of an ignition source inside or adjacent to a fuel tank, and initiate appropriate action.

An inspection programme known as Aircraft Fuel System Safety Programme (AFSSP) was developed. Many representatives of the air transport industry, AEA (Air Transport Association of America), AEA (Association of European Airlines), AAPA (Association Asian Pacific Airlines), AIA (Aerospace Industries Association of America), AECMA (European Association of Aerospace Industries) and other groups participated.

The aim of this inspection programme was to:
• gather data on the condition of in-service fuel tanks,
• where necessary, identify follow-up activities to ensure the continued airworthiness of these tanks. These follow-up activities included updated maintenance programmes and / or corrective action Service Bulletins.

The conclusions of the design review, inspection programme and the subsequent engineering analysis, showed that the design of the fuel tank systems used on Airbus aircraft remains in general valid and functional throughout the aircraft life.

In addition to above activities Airbus participated in the FAA Aviation Rule Making Advisory Committee’s (ARAC) Fuel Tank Harmonisation Working Groups (FTHWG) 1 & 2.

The aim of the first FTHWG was to:
• review in-service history of fuel tank explosions to identify common contributory factors,
• assess various means of reducing or eliminating exposure to operation of transport airplane fuel tanks with explosive fuel air mixtures, or eliminating the resultant hazard if ignition does occur,
• assess the level of fuel tank exposure to flammable vapours.

It concluded that:
• heated centre wing tanks had a significantly higher incidence of fuel tank explosions than other types of fuel tank,
• heated centre wing tanks had a significantly higher exposure to flammable fuel vapours than unheated fuel tanks.

The aim of the second FTHWG was to provide a cost benefit study of fuel tank Nitrogen Inerting Systems. Nitrogen Inerting is a process where inert gas is introduced into the ullage (volume within fuel tank not occupied with liquid) of a fuel tank so the oxygen content of the ullage is reduced to a point where ignition and subsequent combustion is precluded. It concluded that Inerting systems were not yet economically viable with the Inerting requirements stipulated by the FAA (Oxygen concentration less than 9%) and the existing technology.

For Low flammability tanks known combinations of failures should be assessed. “Known” means those conditions that have occurred in-service and are likely to re-occur on other products of the same or similar type design.

The FAA also distinguishes between High Flammability and Low Flammability fuel tanks in the consideration of failure combinations. A tank is considered to be a High Flammability Tank if the fuel ullage remains flammable more than 7% of the fleet operational time for the aircraft type (the time from the start of preparing the aircraft until the deboarding of payload and passengers). If it is flammable less than 7% of the time, it is considered to be a Low Flammability tank.

In April 2001 the FAA issued Special Federal Aviation Regulation (SFAR) 88 applicable to aircraft registered in the USA. The JAA developed a similar policy, the JAA INT/POL 25/12, mandatory for all Airbus aircraft.

Both regulations relate to the prevention of ignition sources within fuel tanks of current type certificated aircraft. Both regulations require carrying out a one-time fuel system safety and design review. However, the assessment methodology differs.

JAA INTERIM POLICY 25/12

The JAA require current standards as per JAR 25.1309 methodology i.e. demonstrating that an ignition source could not result from each single failure, and from all combinations of failures not shown to be extremely improbable. The effects of manufacturing variability, ageing, wear, corrosion, and likely damage must be considered.

FAA SFAR 88

The FAA requires an additional assessment demonstrating that an ignition source could not result from each single failure in combination with each latent failure condition not shown to be extremely remote.

The FAA also requires the consideration of failure combinations. A tank is considered to be a High Flammability Tank if the fuel ullage remains flammable more than 7% of the fleet operational time for the aircraft type (the time from the start of preparing the aircraft until the deboarding of payload and passengers). If it is flammable less than 7% of the time, it is considered to be a Low Flammability tank.
The FAA also proposed Advisory Circular (AC) 25.981-1B. This AC sets a new and more stringent design standard for the industry and considerably reduces the design limits for in-tank energy and current. The previous energy limit of 200 micro Joules is reduced to 20 micro Joules for normal operations (excluding threats from environmental effect, e.g. lightning for which 200 micro Joules existing limit still applies). A new current limit is also set to 30 milliAmps for normal operations (no previous existing limits).

**FAA SFAR 88 SPOT AMENDMENT FLAMMABILITY EXPOSURE RISK**

Following research by the FAA Technical Centre, the FAA established that the oxygen concentration required to prevent fuel tank ignition on military aircraft in combat zones (9%) was excessively conservative when applied to commercial aircraft. The FAA identified that, at sea level, an oxygen concentration of 12% is an acceptable level of protection against fuel tank ignition for commercial aircraft.

The FAA also assessed that the technology for nitrogen inerting to reduce the oxygen concentration to less than 12% is practical and cost effective.

The FAA issued a Spot Amendment to the SFAR 88 in August 2002. This amendment introduced an alternative means of compliance (AMOC) affecting the assessment required for High Flammability tanks. The AMOC allows fuel tank inerting to be used to lower the flammability of High Flammability tanks such that the assessment required is equivalent to Low Flammability fuel tanks.

**AIRBUS COMPLIANCE TO AIRWORTHINESS AUTHORITIES REQUIREMENTS**

On 4th December, 2002, Airbus issued a single set of documents by aircraft family (A300/A310, A320 and A330/A340 Families) to satisfy both the JAA INT/POL 25/12 and FAA SFAR 88 requirements. These reports provide the results of the design, safety and maintenance review carried out on the fuel systems and zones adjacent to the fuel tanks of each Airbus aircraft family.

Airbus assessment considers only safety. The solutions considered cost and retrofit feasibility. The results of the Airbus assessment are based on Authority, Industry and Airline meetings and on the FAA statement that “Non compliance with SFAR 88 by itself is not automatically an unsafe condition”.

The assessment identified the following subjects where corrective action/modification is required to correct non-compliance:

1. In-tank wiring
2. Pump wiring
3. Pump dry running
4. Bonding
5. Adjacent systems
6. Arc gaps

Many of the modifications were developed by Airbus as part of Continued Airworthiness Process prior to the new JAA and FAA regulations, but were not mandated for all aircraft by the Airworthiness Authorities. The complete list of modifications can be found in the Airbus-On-Line-Services FTP site “Aircraft Fuel Tank Safety”.

The only wiring inside the Airbus fuel tanks is intrinsically safe wiring associated with the fuel quantity indicating (FQI) and fuel level sense systems (FLSS). There are no high-power cables in the fuel tanks including all fuel pump wirings which are routed externally to the fuel tanks.

Investigations prior to the SFAR 88 regulation showed on A319 and A320 aircraft that shorting between 28V DC and FQI probe wiring could cause the FQI probes to be heated to a temperature in excess of 200°C (230°C is the auto ignition temperature of Jet A fuel). All FQI probes are cornered with 28V DC wires. In 1999 Airbus introduced fused adapters for the FQI probe harnesses of the centre tanks and fused plug connectors for the FQI probe harnesses of the wing tanks. The fuses prevent the FQI probe temperature from exceeding 200°C in the event of a short
circuit between 28V DC wires and the FQI probe wires. This modification, applied in production since 2000, is identified as required for compliance to the SFAR 88 and FAA INT/POL 25/12.

Airbus identified a possible use of non-fuel resistant “P” clips in some fuel tanks. This could facilitate the potential for FQI and FLSS harnesses chafing against the metallic part of the clip. Airbus will issue an Inspection Service Bulletin to check the clips and where necessary replace them with fuel resistant clips.

In investigations prior to the SFAR 88 regulation Airbus also identified on A300/A310 and A320 Families aircraft, the lack of segregation between FQI/FLSS wires and 115V wiring, external to the fuel tanks. Short circuits between these wires could introduce energy levels in excess of 200µJ into the fuel tank. Modifications have been developed to reduce that risk to acceptable levels.

The FAA has re-defined in-tank energy and current standards with AC 25-981-1B, leading to non-compliance with SFAR 88 within Airbus fuel tanks. Airbus fuel tanks were designed to the most stringent intrinsic safety standards at the time of certification. Airbus has assessed that this non-compliance is not an unsafe condition (The FAA agrees that “Non compliance with SFAR 88 by itself is not automatically an unsafe condition”) and therefore there is no need for modifications such as wiring segregation, shielding, or barrier devices to limit the amount of current and energy into the tank such as Transient Suppression Units (TSU).

2. PUMP WIRING

Threat: Spark erosion and hot spots due to short circuits of pump wiring.

The fuel pump wiring is external to fuel tanks in all Airbus aircraft.

The FAA acknowledges that routing of the cables outside fuel tanks is a good practice.

Prior to SFAR 88, Airbus analysis of in-service experience highlighted that some flight & maintenance crews reset tripped circuit breakers (C/B) without checking the circuit for continuity and short circuits to ground. This practice if repeated could cause damage to equipment and or structure that could lead to energy in excess of 200µJ being released in an adjacent zone containing flammable vapours or cause heating or spark erosion of the structure. Airbus updated the Aircraft Flight Manual (AFM) and Aircraft Maintenance Manual (AMM) to include the statement not to reset the C/B until the fault is isolated in the event that any fuel tank pump C/B is tripped.

In November 2002 the FAA made a specific request to all manufacturers to assess Ground Fault Interrupter (GFI) devices. A GFI is a device that monitors the pump supply and isolates it when a short circuit to ground is detected. A summation of the currents flowing in the 3-phase supply is detected by a hall effect sensor. If a short circuit to ground is detected the supply to the pump is cut by a relay. Arc occurrence to isolation takes approximately 10msec. Airbus did not identify any unsafe condition that would require GFIs to be installed. So GFIs were not included in the Airbus compliance document.

3. PUMP DRY RUNNING

Threat: Mechanical sparking due to component wear or foreign object damage (FOD) inside the pumps.

The FAA requirement as identified in AC 25-981-1B is that contacting of the fuel pump impellers with FOD should not cause an ignition source.

The FAA requirement as identified in AC 25-981-1B is that electrical transients caused by environmental conditions, such as lightning strikes, with the potential to create electrical sparks and arcs in the fuel tank should be limited so that the energy from any electrical spark or arc from the electrical transient is less than 200 micro Joules.

To meet the requirements it must be assumed that:
- vapour in the tank is always flammable,
- vapour in the tank is always flammable,
PREVENTING IGNITION SOURCES INSIDE FUEL TANKS

5. ADJACENT SYSTEMS

Threat:
Ignition sources adjacent to fuel tanks due to:

- Ignition of the fuel in the tank due to electrical arcing external to the fuel tank and causing auto-ignition of the fuel due to heating of the tank wall. (During the assessment normal system operation, system failure and an external fire were considered.)
- Explosion of the adjacent area itself. (The presence of vapours is assumed, therefore no ignition source should be present. Liquid fuel falling on to hot surfaces is also considered).

Prior to SFAR 88 Airbus analysis revealed that the electrical bonding of some equipment in fuel tanks is not in accordance with the appropriate Design Directives and therefore the adequacy of the bonds cannot be assured for the life of the aircraft. Airbus analysis identified that less than five out of the 33 strands are broken. Airbus analysis identified that less than five out of the 33 strands are required to provide an adequate bonding path.

A bonding lead should be replaced if the lead is found broken, frayed or corroded. A lead is considered frayed if more than five out of the 33 strands are broken. Airbus analysis identified that less than five out of the 33 strands are all that are needed to provide an adequate bonding path.

Based on the AFSSP survey findings, the introduction of a scheduled maintenance inspection every 12 years (8C check) on all bonding leads is considered necessary. In addition, an enhanced closing procedure requires a verification of the bonding configuration after each tank entry within the work area to ensure the bonds are maintained in good condition for the life of the aircraft.

A bonding lead should be replaced if the lead is found broken, frayed or corroded. A lead is considered frayed if more than five out of the 33 strands are broken. Airbus analysis identified that less than five out of the 33 strands are all that are needed to provide an adequate bonding path.

Prior to SFAR 88 Airbus analysis revealed that the electrical bonding of some equipment in fuel tanks is not in accordance with the appropriate Design Directives and therefore the adequacy of the bonds cannot be assured for the life of the aircraft. Airbus analysis identified that less than five out of the 33 strands are broken. Airbus analysis identified that less than five out of the 33 strands are all that are needed to provide an adequate bonding path.

A bonding lead should be replaced if the lead is found broken, frayed or corroded. A lead is considered frayed if more than five out of the 33 strands are broken. Airbus analysis identified that less than five out of the 33 strands are all that are needed to provide an adequate bonding path.

A bonding lead should be replaced if the lead is found broken, frayed or corroded. A lead is considered frayed if more than five out of the 33 strands are broken. Airbus analysis identified that less than five out of the 33 strands are all that are needed to provide an adequate bonding path.
A300/A310 potential chafing points

Due to the age of the aircraft and the variations between each aircraft, an inspection Service Bulletin (ISB) is being developed in conjunction with the Aging Transport Systems Rulemaking Advisory Committee (ASTRAC). The ISB will require a one-time inspection of the leading and trailing edges with a requirement to correct any installations that could chafe or are not to the correct installation standard.

6. ARC GAPS

Threat: Inadequate separation between components and structure that could allow electrical arcing due to lightning

To prevent electrical discharge between un-bonded metallic components and structure, a minimum separation distance is required. Prior to SFAR 88, Airbus issued some inspection and modification Service Bulletins to ensure that the minimum clearances are met between metallic components in all fuel tanks.

EASA/FAA FEEDBACK

In October 2003 the EASA (European Aviation Safety Agency) replaced the JAA as the prime certification Airworthiness Authority for Airbus. The EASA considers that Airbus has shown compliance for all fuel tanks (high and low flammability), for all identified unsafe conditions, by the existing design and subsequent modifications and actions. The EASA states that they consider ignition risk mitigation, and flammability reduction as separate issues that should not be mixed.

A modification embodiment schedule has been agreed with the EASA:

- EASA require all modifications necessitating entry into the tanks to be embodied by the end of 2009.
- Some modifications external to fuel tanks have a more restrictive compliance date.

The FAA has not at the date of writing of this article made a formal response to the Airbus compliance proposal.

Harmonization is needed to achieve one solution for manufacturers and operators and to facilitate transfer of aeroplanes from country to country. The FAA and EASA have previously stated that harmonization is achieved except for High Flammability Tanks. The FAA and EASA are actively working to establish a harmonised position relating in the differences in the rules explained previously.

AIRBUS INVESTIGATIONS ON FLAMMABILITY REDUCTION SYSTEMS

Airbus is investigating the feasibility and benefits of FRS as an additional layer of protection on top of existing ignition risk mitigation. Airbus and the FAA agreed to launch a joint test initiative on A320 MSN1 flight test aircraft using the FAA developed Nitrogen Inerting System. Ground testing of the system included a period of 50 hours mini-endurance test to gain confidence in the system operation. The flight-testing phase included nine flights, exploring system performance over a range of fuel quantities in the tanks, climb and descent rates and different operational configurations of the On-Board Inert Gas Generation System (OBIGGS).

Flight tests have demonstrated the functionality of the system. No major abnormal system operation was observed during different phases of the ground and flight test, and no significant impact can be observed on the Engine Bleed Air system when the FRS operated.

Variation in supply pressure and temperature has a significant effect on the overall system performance. A reasonably uniform oxygen concentration was observed within the tank during the climb and cruise. Normal servicing of the aircraft was not hindered, but the maintenance crew were briefed on the operations associated with the potential hazards of Nitrogen rich atmosphere (e.g. asphyxiation).

Airbus did not identify any unsafe condition that would require FRS, and the FRS was not included in the Airbus compliance proposal. The installation of an FRS system would not remove the requirement to apply the ignition risk mitigation modifications already agreed with the EASA and listed in the Airbus On-Line Services FTP site under Aircraft Fuel Tank Safety.

Conclusion

Airbus has undertaken major activities related to fuel tank ignition prevention. Most of Airbus modifications addressing ignition sources were developed as part of Continued Airworthiness Process prior to the new EASA and FAA regulations.

Airbus issued in December 2002 a single set of documents by aircraft family to satisfy both the JAA INT7:POL 25/12 and FAA SFAR 88 requirements. Airbus assessment considered safety first. The EASA considers that Airbus has shown compliance for all fuel tanks by the existing design and the identified modifications and actions.

As an additional layer of protection, Airbus is investigating a Flammability Reduction System.
Anemometric leak detection using new helium pressure tool

Up to now, localising air data leaks has been a relatively difficult and time-consuming operation for operators. This article describes the new detector which has been tested and validated on A300, A300-600 and A310 to find leaks in the air data systems.

BACKGROUND

Airbus experience shows that airspeed and altitude issues are often reported in service. One cause of trouble could be pressure leaks either on the total pressure line or on the static pressure line.

Airbus A300, A300-600 and A310 are fitted with two main Air Data Systems and one standby system. Each of these main and standby systems includes one pitot probe (total pressure) and two static probes (static pressure) connected directly to the Air Data Computer (ADC) for the two main systems and to the standby instruments (altitude & airspeed indicator) for the standby system. These connections are made through several meters of pressure lines whose length makes leak detection difficult and time-consuming.

THE HELIUM TECHNIQUE

Helium is a non-toxic, inert gas, which does not react chemically with any other element, making it intrinsically safe. In addition, due to its low relative molecular mass, it has a high penetration capability allowing it to pass through the smallest gaps. Helium is particularly effective for leak detection because of its low concentration in the atmosphere, which allows easy detection of any small increase.

Finally, it is an industrial gas available anywhere in the world.

The procedure starts with a leak check as described in the AMM (34.10.00 Page Block 501) to confirm the leak on the affected system. Then, using the Helium Detection Kit (referenced in the Tool Equipment Manual 34.13.00), the air data pressure line is filled with helium, with pressure maintained at 20mb/30mb. The helium pumped into the tube is then detected. When the sniffer probe is moved along the pressure pipes, there will be different sound frequencies emitted by the detection device depending on how far the probe is from the leak of helium.

Moreover, an optional telescopic probe (1.5m long) can be adapted to the equipment for use under floor without having to remove the floor panels to gain access to the pipes to be tested. This process permits significant timesaving for aircraft maintenance and availability, and the flexibility of the equipment means that it can be used on all types of aircraft.

Conclusion

Up to now the method used to locate leaks in the air data pressure line was a difficult and time-consuming operation. The helium technique has been tested on several aircraft and has proved its efficiency; it can easily save several hours of ground time. This procedure has already been implemented for the Airbus A310 in the AMM 34-10-00 Page Block 501. A300 and A300-600 AMM will be updated at the next opportunity.
Approach and Landing Part 2

Accidents were a way of life in the very early days of flying. They varied in form from slightly embarrassing to fatal. In those days the light-weight construction which gradually collapsed, and slow speed, largely attenuated the effects of the physical shock.

Mr Brindejonc’s aeroplane, having flown into a crane in 1911. Probably a Bleriot.

Mr Frey’s accident in Cannes in 1910. Probably a Farman.

Geo Chavez was the first person to cross the Alps from Switzerland to Italy, on 18 September 1910. Unfortunately, 10 metres above the ground on approach at Domodossola near Milan, his Bleriot suffered structural failures and crashed. He was severely injured and died in hospital nine days later.

Customer support

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 in North America should be addressed to:
Tel: +1 (703) 729 9000
Fax: +1 (703) 729 4373

AOG Technical and Spares calls outside North America should be addressed to:
Tel: +49 (40) 50 76 3001/3002/3003
Fax: +49 (40) 50 76 3011/3012/3013

Airbus Training centre Toulouse, France
Tel: +33 (0)5 61 93 33 33
Fax: +33 (0)5 61 93 90 94

Airbus Training subsidiaries
Miami, USA - Florida
Tel: +1 (305) 871 36 55
Fax: +1 (305) 871 46 49

Beijing, China
Tel: +86 10 80 48 63 40
Fax: +86 10 80 48 65 76
Customer support

WORLDWIDE
Jean-Daniel Leroy
VP Customer Support
Tel: +33 5 61 93 35 04
Fax: +33 5 61 93 41 01

USA/CANADA
Philippe Bordes
Senior Director Customer Support
Tel: +1 (703) 834 3506
Fax: +1 (703) 834 3464

CHINA
Ron Bollekamp
Director Customer Support
Tel: +86 10 804 86161
Fax: +86 10 804 86162 / 63

RESIDENT CUSTOMER SUPPORT ADMINISTRATION
Jean-Philippe Guillon
Director
Resident Customer Support Administration
Tel: +33 (0) 5 61 93 31 02
Fax: +33 (0) 5 61 93 49 64

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 in North America should be addressed to:
Tel: +1 (703) 729 9000
Fax: +1 (703) 729 4373

AOG Technical and Spares calls outside North America should be addressed to:
Tel: +49 (40) 50 76 3001/3002/3003
Fax: +49 (40) 50 76 3011/3012/3013

Airbus Training centre Toulouse, France
Tel: +33 (0) 5 61 93 33 33
Fax: +33 (0) 5 61 93 20 94

Airbus Training subsidiaries
Miami, USA - Florida
Tel: +1 (305) 871 36 55
Fax: +1 (305) 871 46 49

Beijing, China
Tel: +86 10 80 48 63 40
Fax: +86 10 80 48 65 76

CUSTOMER SUPPORT AROUND THE CLOCK... AROUND THE WORLD

Jean-Daniel Leroy
VP Customer Support
Tel: +33 5 61 93 35 04
Fax: +33 5 61 93 41 01

Philippe Bordes
Senior Director Customer Support
Tel: +1 (703) 834 3506
Fax: +1 (703) 834 3464

Ron Bollekamp
Director Customer Support
Tel: +86 10 804 86161
Fax: +86 10 804 86162 / 63

Jean-Philippe Guillon
Director
Resident Customer Support Administration
Tel: +33 (0) 5 61 93 31 02
Fax: +33 (0) 5 61 93 49 64

Philippe Bordes
Senior Director Customer Support
Tel: +1 (703) 834 3506
Fax: +1 (703) 834 3464

Ron Bollekamp
Director Customer Support
Tel: +86 10 804 86161
Fax: +86 10 804 86162 / 63

Jean-Philippe Guillon
Director
Resident Customer Support Administration
Tel: +33 (0) 5 61 93 31 02
Fax: +33 (0) 5 61 93 49 64
Our service managers know every aircraft down to the last nut and NSA5031-6-19.

Knowing every inch of our aircraft is just a small part of being an Airbus service manager. And we apply the same principle to our customers. By understanding you as well as we understand our planes we can cater to your needs. This takes co-operation, a lot of listening, and, above all, dedication, which is why our Customer Service is so well respected. It’s no big thing, but it means a great deal to our customers. **Airbus. Setting the standards.**