

Safety first

The Airbus Safety Magazine

Edition January 2013

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- ▶ The Golden Rules for Pilots Moving from PNF to PM
- ▶ Airbus Crosswind Development and Certification
- ▶ The SMOKE/FUMES/AVNCS SMOKE Procedure
- ▶ Post-Maintenance Foreign Objects Damage (FOD) Prevention
- ▶ Corrosion: A Potential Safety Issue



Issue **15**

 **AIRBUS**

Safety First

The Airbus Safety Magazine

For the enhancement of safe flight through increased knowledge and communications

Safety First is published by the Flight Safety Department of Airbus. It is a source of specialist safety information for the restricted use of flight and ground crew members who fly and maintain Airbus aircraft. It is also distributed to other selected organisations.

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A320
Winter operation in
Yakutsk, Siberia

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Yannick MALINGE

Chief Product Safety Officer

Editorial

Firstly, let me wish you all a Happy and Safe New year as we enter into 2013.

Our first magazine of this year presents to you a variety of articles covering a broad range of topics from good maintenance practices through to an insight into the crosswind certification of our aircraft.

It is sometimes true that we get what we hope for. It is even truer that we often get what we work hard to achieve. All industry Safety professionals have been working hard and successfully, to reduce the rate of accidents and major incidents. We have collectively reached the point where it is now difficult to see obvious and clear trends and “easy to fix” things with the tools we use today. Whilst a surface examination looks good, we also know that not far under that surface lie many threats and risks. We simply cannot allow the system to “relax”, nor can we ever afford to become complacent.

So how should we proceed? We must now dig deeper. We must “dig” into the growing volume of data that is available to us through our various data gathering programmes, be they LOSA, FOQA, FDA, FOA, ASIAs or whatever, and seek out the clues and the threads of information that will lead us to being able to prevent a future accident from happening.

Such an approach represents three challenges. Firstly, the ability to collate, understand and act on so much data across the industry will require dedicated professionals with knowledge and determination to get at the answers. Secondly, and importantly, the industry wide collective challenge to face up to and address issues, which may appear to be minor in themselves, but that may end up developing into major threats over time or when combined with other “minor” threats. Finally, but not least, even if significant progress has been made over the years, we have to find ways of further improving the sharing of lessons learned across boundaries.

We cannot go backwards, nor can we ease up for even a minute in our joint efforts to drive Safety to the next level.

May I therefore wish you all a successful year in your pursuit of increasing levels of Safety, in your area of our business during 2013.

Yannick MALINGE
Chief Product Safety Officer

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Nils FAYAUD

Director Product Safety Information

Information

Magazine distribution

If you wish to subscribe to Safety First, please fill out the subscription form that you will find at the end of this issue.

Please note that the paper copies will only be forwarded to professional addresses.

Your articles

As already said, this magazine is a tool to help share information.

We would appreciate articles from operators, that we can pass to other operators through the magazine.

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Safety Information on the Airbus websites

On the AirbusWorld website we are building up more safety information for you to use.

The present and previous issues of Safety First can be accessed to in the Flight Operations Community- Safety and Operational Materials portal-, at <https://w3.airbusworld.com>

Other safety and operational expertise publications, like the Getting to Grips with... brochures, e-briefings etc... are regularly released as well in the Flight Operations Community at the above site.

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News **SAVE THE DATE**

19th Flight safety conference →→→

Bangkok, 18-21 March 2013

Another year has nearly passed since our last Flight Safety Conference in Berlin. All the Airbus people who were present enjoyed very much the opportunity to network with our customers and to share ideas and news. It was the most successful conference yet both in terms of the numbers of people and airlines attending and in the feedback we received.

The 19th Flight Safety Conference will take place in Bangkok, Thailand, from the 18th to the 21st of March 2013.

The Flight Safety Conference provides an excellent forum for the exchange of information between Airbus and its customers. To ensure that we can have an open dialogue to promote flight safety across the fleet, we are unable to accept outside parties.

The formal invitations with information regarding registration and logistics, as well as the preliminary agenda have been sent to our customers in December 2012.

For any information regarding invitations, please contact Mrs. Nuria Soler, email nuria.soler@airbus.com

This year we will be looking at several interesting topics including the role of training in leveraging safety, unstable approaches, runway excursions and we will also include some more traditional reminders of issues that simply do not want to go away.

As always, we welcome presentations from our operators. You can participate as a speaker and share your ideas and experience for improving aviation safety.

If you have something you believe will benefit other operators and/or Airbus and if you are interested in being a speaker, please provide us with a brief abstract and a bio or resume at nuria.soler@airbus.com



**David OWENS**

Senior Director Training Policy

The Golden Rules for Pilots

Moving from PNF to PM

1. Introduction

On the 4th of November 2010 Qantas flight QF32 experienced an uncontained engine failure shortly after takeoff from Singapore Changi Airport.

This type of incident is so rare and unpredictable that it does not have an allocated procedure attached to it. The crew of the A380 was able to cope with this event by applying a set of simple basic rules, which are referred to as the Golden Rules for Pilots.

2. QANTAS QF32

Australian Transport Safety Bureau (ATSB) Preliminary Report Released 3 December 2010 :

On 4 November 2010, at 0157 Universal Coordinated Time (UTC), an Airbus A380 aircraft, registered VH-OQA (OQA), being operated as Qantas flight 32, departed from runway 20 centre (20C) at Changi Airport, Singapore for Sydney, New South Wales. On board the aircraft were five flight crew, 24 cabin crew and 440 passengers (a total of 469 persons on board).

Following a normal takeoff, the crew retracted the landing gear and flaps. The crew reported that, while maintaining 250 kts in the climb and passing 7,000 ft above mean sea level, they heard two almost coincident 'loud bangs', followed shortly after by indications of a failure of the No 2 engine. The crew advised Singapore Air Traffic Control of the situation and were provided with radar vectors to a holding pattern. The crew undertook a series of actions before returning the aircraft to land at Singapore. There were no reported injuries to the crew or passengers on the aircraft. A subsequent examination of the aircraft indicated that the No 2 engine had sustained an uncontained failure of the Intermediate Pressure (IP) turbine disc. Sections of the liberated disc penetrated the left wing and the left wing-to-fuselage fairing, resulting in structural and systems damage to the aircraft.



Figure 1
A380 in
Qantas livery

In various interviews and statements the crew recognise that Crew Resource Management (CRM) gave them the ability to manage this challenging event. They have spoken of “Synergy in Action”, the goal of CRM, and effective teamwork. They had plenty of fuel and therefore time and options. They acknowledge the impressive performance of the aircraft and their training and knowledge.

3. The Golden Rules

*On the flight deck of QF32 that day
Captain David Evans:*

“From a training point of view it doesn’t matter what aeroplane you are flying, airmanship has to take over. In fact, Airbus has some Golden Rules which we all adhered to on the day – aviate, navigate and communicate – in that order.”

*Royal Aeronautical Society,
6 December 2010*

So, what are the Golden Rules? When should they be used and why?

The following four Golden Rules for Pilots are applicable to all normal operations and any abnormal or emergency situations:

- ▶ **Fly, navigate and communicate**
- ▶ **Use the appropriate level of automation at all times**
- ▶ **Understand the FMA at all times**
- ▶ **Take action if things do not go as expected.**

3.1 Fly, navigate and communicate

In this order and with appropriate tasksharing.

Just as the crew of QF 32 stated, the number one priority in any event and at all times is to fly the aircraft; this is the first Golden Rule.



Figure 2
QF32 n°2 engine after it sustained an uncontained failure of the Intermediate Pressure (IP) turbine disc

Tasksharing should be adapted to the prevailing situation (i.e. task-sharing for hand flying or with the Auto Pilot engaged, task sharing for normal operation or for abnormal / emergency conditions) and tasks should be accomplished in accordance with the following priorities:

3.1.1 Fly

The Pilot Flying (PF) must focus on flying the aircraft by controlling and / or monitoring the pitch attitude, bank angle, airspeed, thrust, sideslip, heading etc. to capture and maintain the desired vertical and lateral flight path.

The Pilot Not Flying (PNF) must assist the Pilot Flying (PF) by actively monitoring all flight parameters and actively directing the attention of the PF to any excessive deviation.

Actively monitoring is a key message, we want to emphasize the

MONITORING role, which is why Airbus will be changing its documentation over the next year to fully reflect and highlight the importance of Pilot Monitoring (PM). Wherever you see PNF, think PM!

Both pilots must remain focused on their task as PF or PM, not allow anything to distract them. This is what we mean by appropriate tasksharing.

Both pilots must maintain their Situational Awareness and immediately resolve any uncertainty as a crew.

3.1.2 Navigate

Navigate can be summarized by the following three statements of situational awareness:

- ▶ **Know where you are**
- ▶ **Know where you should be**
- ▶ **Know where the weather, terrain and obstacles are.**

3.1.3 Communicate

Effective crew communication includes communication between:

- ▶ The PF and the PM
- ▶ The flight crew and air traffic control
- ▶ The flight crew and the cabin crew or any other crew on-board
- ▶ The flight crew and ground crew.

Effective communication enables the sharing of goals and intentions and enhances situational awareness. To ensure positive communication, the flight crew must use **standard phraseology and applicable callouts**.

3.2 Use the appropriate level of automation at all times

To fly the aircraft the crew must comply with Golden Rule number 2. On highly automated and integrated aircraft, several levels of automation are available to perform a given task. The appropriate level of automation depends on the situation and task; taking into account the forecast or actual weather, any malfunction or crew incapacitation. Pilot judgment prevails for the choice of automation level, including the choice to fly manually.

- ▶ **Understand** the implication of the intended level of automation
- ▶ **Select** the intended level
- ▶ **Confirm** the aircraft responds as expected.

This leads us to Golden Rule number 3.

3.3 Understand the FMA at all times

Any action on the FCU, or on the MCDU/KCCU, should be confirmed by crosschecking the corresponding annunciation or data on the PFD or ND.

At all times, the PF and PM should be aware of:

- ▶ The armed or engaged modes
- ▶ The guidance targets set
- ▶ The aircraft response in terms of attitude, speed and trajectory, etc
- ▶ Any mode transitions or reversions.

To sum up:

- ▶ **Monitor your FMA**
- ▶ **Announce your FMA**
- ▶ **Confirm your FMA**
- ▶ **Understand your FMA.**

Finally, if any problems occur, refer to the Golden Rule number 4.

3.4 Take action if things do not go as expected

If the aircraft does not follow the desired vertical or lateral flight path or the selected target, the crew should react without delay:

- ▶ By PF changing the level of automation:
 - From managed guidance to selected guidance, or
 - From selected guidance to manual flying; or

- ▶ By PM taking action, again we want to emphasize the PM function and its essential role in flight safety:

- Questioning, and if that is not enough
- Challenging, and if that is still not enough
- Taking-over.

Never assume that any crewmember is aware of a particular threat, error or deviation and remember that incapacitation may be subtle; act before it is too late.

4. Conclusion

- 1 Fly, navigate and communicate:**
In this order and with appropriate tasksharing
- 2 Use the appropriate level of automation at all times**
- 3 Understand the FMA at all times**
- 4 Take action if things do not go as expected**



Apply these Golden Rules, use them always and support each other. The rules have been proven to make a difference. Just like the crew of Qantas QF 32, remember to always...

Fly the Aircraft Fly the Aircraft..... Fly the Aircraft

**Frank CHAPMAN**

Experimental Test Pilot

Airbus Crosswind Development and Certification

1. Introduction

This article is one of a series in which we in Airbus try to create a bridge of information across the gap that exists between the manufacturers world of certification and the operators day to day environment.

At first glance, the issue of crosswind certification for a large transport aircraft may seem simple. The following is an extract from the EASA CS25.237(a) requirements:

A 90 deg cross component of wind velocity, demonstrated to be safe for take-off and landing must be established for dry runways and must be at least 20 kt or V_s MLW (1 g stall speed at Max Landing Weight) whichever is greater, except that it need not exceed 25 kt.

However, the subject is far more complicated than this short sentence may lead you to believe. So how do we deal with crosswinds during flight test and certification and what are the implications for operators?

2. History

Historically, there were two methods of computation. For early certifications, ATC tower winds were used to assess the level of crosswind experienced at take-off and landing by flight test crews. This was done with an old fashioned anemometric recording system, registering wind values at a nominal 10 metres above ground level. This method evolved into using aircraft generated cross wind data by calculating the 10 m high wind using the difference between the True Air Speed (TAS) vector and the IRS computed Ground Speed (GS) vector during a 20 second period (+_10 sec) around take-off and landing. However, as natural IRS drift creates inaccuracy, this had to be taken into account. The drift value had to be periodically measured in order to correct IRS Ground Speed. With the advent of Differential GPS (DGPS) and more recent on-board instrumentation systems, the GS vector is now calculated using highly accurate data and, therefore, this correction is no longer necessary.

In the early days of certification, when using tower winds, the aver-

age wind values were taken over the previous two minutes and the gust values over the previous 10 min period. Although ICAO considers wind gusts only if the peak value exceeds the two minute average by 10 kt, some airport weather services provide gust values lower than 10 kt. This method is still used for the broadcast of ATC tower winds. With the new flight test methodology, however, a much more representative assessment of the aircraft capability is achieved.

With the early Airbus certifications, we provided 'Average plus Gust' values in our FCOMs. However, it was felt by many that this format complicated the decision making process. Therefore, following a period of study beginning in 2004 we have now moved to a 'Single Value, Gust Included'. This effectively means that a direct comparison of the maximum demonstrated value (provided by us, the manufacturer) can be made against the maximum value communicated by the Tower or ATIS, including the gust if announced.

3. Maximum Demonstrated Crosswind Definition

Today, **maximum demonstrated crosswind** figuring in the FCOM is derived from the maximum crosswind that has been encountered during the complete certification process and recorded in a particular manner that has been agreed in conjunction with the authorities. It is **not necessarily the maximum aircraft crosswind capability** of the aircraft. It is purely based upon data recorded within the aircraft during the period of the certification process. Furthermore, it is often observed to be significantly different from the wind provided by ATC.

4. Flight Test Methodology

Firstly, wind data as experienced by the aircraft is collected for a period of +/-10 sec either side of the take-off or landing. Then, we need to correlate this data to the established reference height of 10 metres. This is done with a mathematical correction to the data, which varies with height to compensate for the boundary layer type effect near the surface.

A conservative proportion of the gusts observed are then added to the maximum steady crosswind value obtained. With this (gust added) value, we check that we have sufficient control authority in an equivalent steady wind case, based upon empirical flight control response data. If this is validated, we propose the value to the authorities for certification and inclusion in the AFM, for take-off and for landing.

On take-off, however, there is another effect, which can have a big influence on crosswind limitation and/or take-off procedure: that of engine intake airflow distortion. This is covered in a separate analysis and many tests are carried out to ensure we provide a suitable operating envelope for our engines during take-

off and landing. However, this may influence the final choice of demonstrated crosswind value provided and will almost certainly impact the procedure for applying take-off power. Manufacturers can choose to automatically limit engine regime for certain Ground Speeds if necessary, in much the same way that they sometimes automatically avoid certain rpm ranges to avoid fan blade flutter for example. However, there is always a slight compromise, in order to ensure that take-off performance is not significantly reduced as a result. Limitations are imposed for the A380 and A340 500/600, for example, where the engine limitations are more penalizing than the demonstrated crosswind limitation and this is published in the FCOM limitations section.

5. Take-Off Technique

Engine manufacturers design choice plays a large part in the initial procedural approach to setting take-off thrust and, as mentioned above, may be crosswind limiting. Significant lateral control should be avoided during the take-off run in order to prevent extension of spoilers which will have a detrimental effect on performance and may induce some directional disturbance. With strong crosswinds there will be a natural tendency for the aircraft to roll away from the wind at lift-off and this can be compensated for by a smooth lateral input as the aircraft becomes airborne.



Figure 1
Take-off from Keflavik, Iceland. Note how the wind lifts the right wing.
Maximum reported crosswind at the time was 56 kt in gusts

Extract from A330/A340 FCTM information on take-off roll (all Airbus programs share the same philosophy):

For crosswind take-offs, routine use of into wind aileron is not recommended. In strong crosswind conditions, small amounts of lateral control may be used to maintain wings level, but the pilot should avoid using excessive amounts. This causes excessive spoiler deployment, which increases the aircraft's tendency to turn into wind, reduces lift, and increases drag. Spoiler deflection starts to become significant with more than half side stick deflection. As the aircraft lifts off, any lateral control applied will result in a roll rate demand. The objective is for the wings to be maintained level.

This philosophy applies to the entire Airbus fleet. Although the lateral stick displacement threshold for spoiler deployment varies a little between types, the objective of avoiding unnecessary spoiler deployment however remains valid.

6. Landing Technique

The wings level technique is recommended. In particularly strong crosswinds kicking off around two third drift as a minimum is normally sufficient to ensure that the lateral stresses are not excessive on the undercarriage at touchdown (max residual drift 5 deg at touchdown), whilst at the same time ensuring minimum risk of a downwind drift away from the runway centreline. This has been applied to all aircraft from the A300/310, where roll/yaw coupling during

decrab is marked due to the wing-sweep/dihedral effect, through the single aisle and long range Fly By Wire (FBW) aircraft where lateral compensation is similarly required and to the A380 where flight control law compensation provides a pure yaw response to rudder pedal input.

Where small amounts of lateral control are eventually required, avoid excessive bank angles (max bank angle 5 deg). Aim for a positive touchdown and do not be tempted to finesse the touchdown or float for any considerable time. This will inevitably lead to a downwind drift away from the centreline.

For the A380, and in the near future for the A350 XWB, there is no apparent induced roll when kicking off drift in the flare due to flight control law compensation. The flare laws in these two types have been adapted to produce a pure yaw demand when applying rudder to reduce drift prior to touchdown. Of course, the flight control surfaces are providing the lateral input for you, behind the scenes, in order to prevent the natural lateral stability of the aircraft from producing the induced rolling effect. However, this is transparent to the pilot who is looking down the runway to ensure he lands his aircraft in the right place without excessive drift.



Extract from A380 FCTM information on lateral and directional control (all Airbus programs share the same philosophy):

FINAL APPROACH

In crosswind conditions, the flight crew should fly a "crabbed" final approach wings level, with the aircraft (cockpit) positioned on the extended runway centerline until the flare.

FLARE

The objectives of the lateral and directional control of the aircraft during the flare are:

- To land on the centerline
- To minimize the loads on the main landing gear.

The recommended de-crab technique is to use the following:

- The rudder to align the aircraft with the runway heading during the flare
- The roll control, if needed, to maintain the aircraft on the runway centerline.

The flight crew should counteract any tendency to drift downwind by an appropriate lateral(roll) input on the sidestick.

In the case of strong crosswind during the de-crab phase, the PF should be prepared to add small bank angle into the wind to maintain the aircraft on the runway centerline. The flight crew can land the aircraft with a partial de-crab (i.e. a residual crab angle up to about 5 deg) to prevent an excessive bank. This technique prevents wing tip or engine nacelle strike caused by an excessive bank angle. Therefore it is wise to know what the maximum bank angle is during the flare phase for the type you are flying so as to ensure no such strikes.

As a consequence, this can result in touching down with some bank angle into the wind, therefore, with the upwind landing gear first.

Figure 2

"Crabbed" final approach to Keflavik, Iceland. Picture taken from the south taxiway with the runway easily visible. Maximum reported crosswind at the time was 56 kt in gusts

One further point is worth mentioning, because we see repeated cases in Flight Operational Quality Assurance (FOQA) data in which less than optimum crosswind touchdowns are made: the response to rudder pedal input at the decrab is positive for all our aircraft. However, due to pure aerodynamics and inertia it takes a reasonable time from the input being made to the aircraft reacting. If we were hand-flying in crosswinds every day, we would become very well tuned to the aircraft response and make a perfect crosswind landing every time (I wish!). However, there appears to be a tendency, borne out by operational Digital Flight Data Recorder (DFDR) data, towards a late initiation of the decrab. This is perhaps natural, since the risks associated with an early decrab are perhaps more severe. However, practice, as always, is the key. Any opportunity in the simulator, even if not truly representative of the flying the real aircraft is invaluable, as the response time to rudder input should be representative.

7. Effect of Thrust Reverse

Of course, touchdown is not the complete story, as the roll-out is an equally important phase of the crosswind landing. This is where ground based dynamics come into play, even though there are still varying degrees of aerodynamic controllability during the deceleration phase.

When selecting reverse thrust with a given crab angle, the reverse thrust results into two force components:

- ▶ A stopping force aligned along the aircraft direction of travel (runway centerline)
- ▶ A side force, perpendicular to the runway centerline, which further increases the tendency to skid sideways.

Unequal weight distribution on the main landing gear during touchdown and braking also produces a yawing moment. This can be destabilizing should the asymmetric

wheel loading and braking be sufficiently high and this can be caused by the crosswind itself or by lateral stick input. Furthermore, autobrake systems do not always provide a useful aid in this regard, as they will apply braking regardless of whether one main-wheel bogie alone has released brake pressure due to antiskid operation.

In all cases, brakes and reverse should be applied smoothly. If there is any concern with directional controllability then reduce or cancel reverse as necessary and reduce braking until control is regained. Then smoothly re-apply brakes and reverse if necessary.

8. Operational Implications

With the FCOM provided maximum demonstrated crosswind value and the tower provided current wind value, the decision making process is not always easy for the pilot on approach in limiting wind conditions. Runway condition is also a factor critical to maintaining lateral control once on the ground and has to be considered. Companies may provide operation recommendations, but the topography around the touchdown zone can sometimes lead to significant variations of actual winds experienced. Local knowledge is very useful and often incorporated in specific airfield briefs. It is perhaps natural, therefore, that many pilots glance at the ND wind-speed indication during approach to help them in their decision making process. There is a catch here, how-

ever. As ND wind on A320 Family/A330/A340 is derived from IRS data, indications may be significantly different from reality. This is due to the lack of correction for the IRS drift, mentioned earlier. On A380 (and in the future for A350 XWB), the use of GPS Ground Speed for the ND wind display provides a more reliable additional source of information. Ultimately, it is the Captain who is called upon to use his judgement and skill, based upon all the data and knowledge available to him.

Remember also that if your aircraft has a degraded flight control system through MEL clearance or in flight failure, then a more severe crosswind limitation may apply. Similarly, an engine out condition will imply a limited ability to correct for drift in one direction. Again a more restrictive limitation may exist.

9. Autoland Certification

Certification of autoland and its associated wind limitations is done based upon a statistical analysis of autolands carried out during flight test and certification. These values should be treated as hard limits for the autoland system. Although, in theory, if the tower winds indicate that you are within the autoland crosswind limit you can continue to make your autoland, common sense would indicate that you take care, as in reality the winds could be beyond the autoland system capability. As always, be ever ready to take over manually should the need occur.

10. Conclusion

The maximum demonstrated crosswind is just that: a demonstrated value that was observed during certification based upon the weather conditions that we were able to find during the flight test campaign. Companies may define their own limitations based upon their own experience. For the line Captain, asking himself whether he can land or take-off in the crosswind condi-

tions of the day, he should take all information available to him in the decision making process. Tower wind may be the starting point, but it is not the whole story. Ultimately the responsibility rests with the Captain and if there is any doubt, discontinue the approach. As always, the anticipation of what is coming is the key to a successful outcome.



Peimann TOFIGHI-NIAKI

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Flight Operations Support and Safety Enhancement

The SMOKE/FUMES/ AVNCS SMOKE Procedure

1. Introduction

Until 2002 the Quick Reference Handbook (QRH) contained six independent smoke procedures. The crew had to decide which one to apply according to the suspected smoke source: CARGO, LAVATORY, CREW REST COMPARTMENT, AVIONICS, AIR COND, CABIN EQUIPMENT.

In practice, it is often difficult to discriminate between the last three sources of fire: AVIONICS, AIR COND, CABIN EQUIPMENT.

The procedures applicable to these sources were therefore merged into the single SMOKE/FUMES/AVNCS SMOKE procedure, thus relieving

the crew from having to flip back and forth through the QRH pages and from repeating actions in case of switch to another suspected smoke source.

The first three sources of smoke - CARGO, LAVATORY, CREW REST COMPARTMENT-, which are easier to trace, have kept their own dedicated procedures.

This article will describe how the Airbus SMOKE/FUMES/AVNCS SMOKE procedure was developed. It will then explain its philosophy, thereby providing guidelines into the decision making process from the early stage of the procedure.

with a LAND ASAP message. In the frame of this procedure, the LAND ASAP message requests crews to be prepared for a diversion.

The “Immediate Landing” term, found in the QRH paper procedure, means: “Accept exceptional circumstances such as a tailwind landing, ditching, off airport landing etc”

2.2 The Difficulty to Identify the Smoke Source

As stated in the introduction, Airbus decided to classify the known sources of smoke into two different categories:

- ▶ The smoke sources that are easier to locate, because they have an ECAM and/or a local warning, and for which there are available means of fire treatment:
 - CARGO
 - LAVATORY
 - CREW REST COMPARTMENT
- ▶ The smoke sources that are more difficult to locate, which may, or may not, be covered by an ECAM alert and that are considered more difficult to deal with:
 - AVIONICS
 - AIR COND
 - CABIN EQUIPMENT

2. Procedure Development

The procedure takes into account three decisive challenges common to non immediately identified sources of smoke:

- ▶ **The shortage of time**
- ▶ **The difficulty to identify the smoke source**
- ▶ **The need for two ways cockpit/cabin crew communication.**

2.1 The Shortage of Time

In a smoke situation, timing is critical. Studies show that a fire may become uncontrollable in as little as 8 minutes and that, in this case, the fight crew may have as little as 15 minutes to bring the aircraft on the ground.

For this reason the SMOKE/FUMES/AVNCS SMOKE ECAM and QRH paper procedures both start

As stated above, these three smoke sources call for the single SMOKE/FUMES/AVNCS SMOKE procedure.

note 1

The QRH SMOKE/FUMES/AVNCS SMOKE paper procedure is to be applied whenever the source of smoke is suspected to be AVIONICS, AIR COND, CABIN EQUIPMENT or in case of doubt about the smoke origin. If another smoke warning is triggered (e.g. LAVATORY SMOKE), the flight crew must apply the dedicated existing procedure.

2.3 The Need for two Ways Cockpit/Cabin Communication

Establishing good two ways communication with the cabin crew is essential in a smoke situation.

In case of smoke in the cabin, the cabin crew should inform the flight crew of the situation as soon as possible and should follow up on smoke dissipation. Vice versa, in case of smoke in the cockpit, the feedback from the cabin crew may prove useful to identify the smoke source.

Communication between cockpit and cabin is important in many situations. However, in a smoke/fire/fumes situation it is so important that Airbus added the CKPT/CABIN COM... ESTABLISH action step in the procedure.

3. Procedure Philosophy

The trigger of a smoke alert is either an ECAM message, or a visual or olfactory perception of smoke (by either cabin or cockpit crew). As soon as an alert is triggered, for which there is no dedicated procedure, the flight crew must apply the SMOKE/FUMES/AVNCS SMOKE procedure without delay. Both ECAM and QRH paper procedures are totally compatible with one another.

As mentioned in 2.1, the procedure starts with a LAND ASAP message.

In a smoke situation this message alerts the crew to anticipate the diversion.

The procedure is then designed around the following action blocks:

- ▶ Immediate Actions
- ▶ AT ANY TIME Items
- ▶ Diversion Decision
- ▶ Troubleshooting.

3.1 Immediate Actions

The first action block of the procedure is referred to as the “Immediate Actions” (fig. 1).

They have been designed to be quick, simple, and reversible. They are actions that will not make the situation worse, and prevent recirculation. They protect the crew and ensure communication. Immediate Actions must be applied without delay and prior to any further assessment from the flight crew.

SMOKE/FUMES/AVNCS SMOKE

LAND ASAP

APPLY IMMEDIATELY

VENT EXTRACT OVRD

CAB FANS OFF

GALLEYS OFF

SIGNS ON

CKPT/CAB COM ESTABLISH

● IF REQUIRED:
CREW OXY MASKS ON/100%/EMERG

● IF SMOKE SOURCE IMMEDIATELY OBVIOUS, ACCESSIBLE AND EXTINGUISHABLE:
FAULTY EQPT ISOLATE

● IF SMOKE SOURCE NOT IMMEDIATELY ISOLATED:
DIVERSION INITIATE
DESCENT (FL 100MEA, min obstacle clearance altitude) INITIATE

SMOKE/FUMES/AVNCS SMOKE

LAND ASAP

APPLY IMMEDIATELY

VENT EXTRACT OVRD

CAB FANS OFF

GALLEYS OFF

SIGNS ON

CKPT/CAB COM ESTABLISH

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FAULTY EQPT ISOLATE

● IF SMOKE SOURCE NOT IMMEDIATELY ISOLATED:
DIVERSION INITIATE
DESCENT (FL 100MEA, min obstacle clearance altitude) INITIATE

● At ANY TIME of the procedure, if smoke/fumes becomes the GREATEST THREAT:
SMOKE FUMES REMOVAL CONSIDER
ELEC EMER CONFIG CONSIDER
Refer to the end of the procedure to set ELEC EMER CONFIG

● At ANY TIME of the procedure, if situation becomes UNMANAGEABLE:
IMMEDIATE LANDING CONSIDER

Figure 1 Immediate Actions

Figure 2 AT ANYTIME items

3.2 AT ANY TIME Items

The “AT ANY TIME” items must be applied if the smoke becomes the greatest threat or if the situation becomes unmanageable (fig. 2).

As the name suggests, the flight crew can apply the “AT ANY TIME” items at any stage of the procedure, provided that they have at least completed the immediate actions. These items must be known by memory.

It is important to keep in mind that the smoke removal procedure does not stop the smoke source but rather aims at removing the smoke from the cockpit.

"AT ANYTIME" items

● At ANY TIME of the procedure, if smoke/fumes becomes the GREATEST THREAT:
SMOKE FUMES REMOVAL CONSIDER
ELEC EMER CONFIG CONSIDER
Refer to the end of procedure to set ELEC EMER CONFIG

● At ANY TIME of the procedure, if situation becomes UNMANAGEABLE:
IMMEDIATE LANDING CONSIDER

The electrical emergency configuration aims to shed as much equipment as possible. On the A330/A340 Family, it is important to note that in electrical emergency configuration, smoke removal cannot be performed. Therefore if considered necessary, the smoke removal procedure must be applied before the electrical emergency configuration is set.

Finally, if the situation becomes unmanageable, if the flight crew is not able to maintain the control of the aircraft until an airfield is reached, then an immediate landing is to be considered.

note 2

As mentioned in 2.1, The “Immediate Landing” term, found in the paper SMOKE/FUMES/AVNCS SMOKE procedure, means: “Accept exceptional circumstances such as a tailwind landing, ditching, off airport landing etc”.

3.3 Diversion Decision Making

The crew should consider the following two questions, which constitute the core of the SMOKE/FUMES/AVNCS procedure:

- ▶ **Is the smoke source immediately obvious, accessible and extinguishable?**
- ▶ **If this is the case, can it be isolated?**

If the answer to these two questions is YES, then this is the end of the procedure.

On the other hand, if the answer to at least one of the two above questions is NO, then the diversion must be initiated. In case of doubt a diversion should be initiated (fig. 3).

TASK SHARING FOR CABIN CREW

Airbus has developed a precise task sharing for cabin crew, which can be found in the Operator’s Cabin Crew Operating Manual (CCOM), or in the “Getting To Grips with Cabin Safety” publication, available on Airbus World. The task sharing identifies three main roles within a cabin crew working team, each having a specific task to best prevent any escalation of the event.

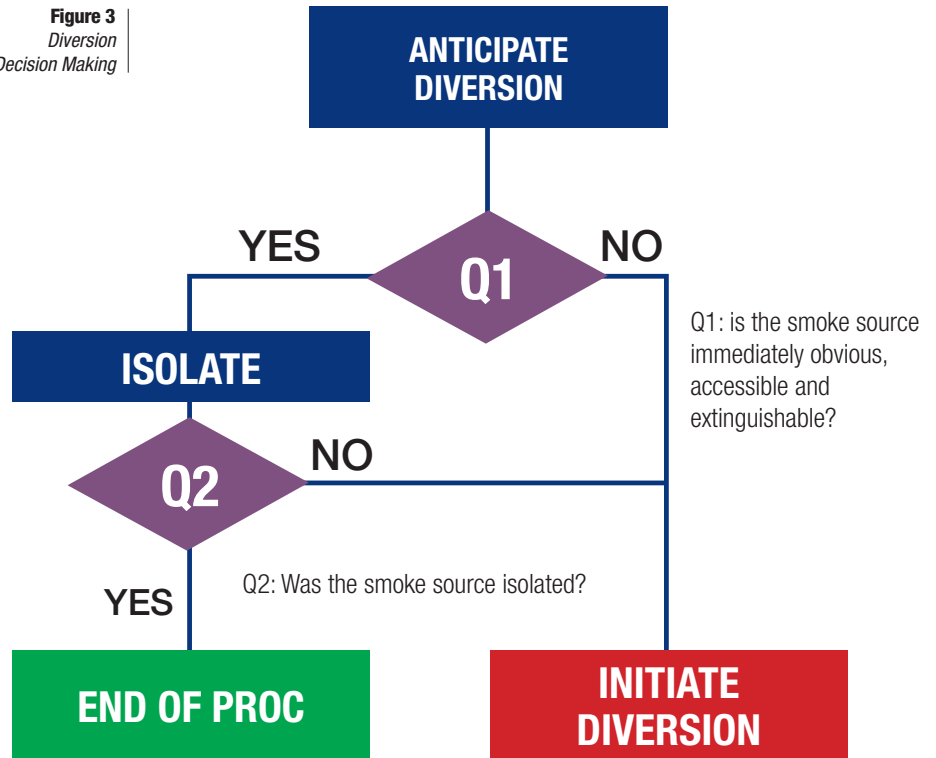
3.4 Troubleshooting

Once the diversion is initiated, the troubleshooting may be carried on in an attempt to identify and fight the origin of the smoke. The identification will be undertaken by

isolating different systems and assessing smoke dissipation.

The different smoke sources listed for troubleshooting in the procedure appear in the most probable to least probable order.

Figure 3
Diversion
Decision Making



4. Conclusion

In 2002 the SMOKE/FUMES/AVNCS procedure replaced three different smoke procedures applicable to smoke sources that were difficult to locate: AVIONICS, AIR COND, CABIN EQUIPMENT. The other sources of smoke - CARGO, LAVATORY, CREW REST COMPARTMENT- , which are easier to trace, have kept their own dedicated procedures.

The SMOKE/FUMES/AVNCS procedure had to integrate the need to act quickly, the difficulty to identify the smoke source and the necessity to involve both cockpit and cabin crews. Equally, the challenge was to design a single procedure that would cover the largest number of situations while keeping it as simple as possible.

The SMOKE/FUMES/AVNCS procedure starts with an alert to anticipate a diversion and is then designed around four action blocks:

- ▶ Immediate Actions
- ▶ AT ANY TIME Items
- ▶ Diversion Decision Making
- ▶ Troubleshooting.

The general action flow calls for the Immediate Actions to be performed first, followed by the decision on whether or not to divert. The troubleshooting actions are performed last.

As implied by the title, the AT ANY TIME items should be performed immediately whenever the smoke/fumes becomes the greatest threat or whenever the situation becomes unmanageable.



François LEFEBVRE

Head of Quality Basics and FOD

Post-Maintenance Foreign Objects Damage (FOD) Prevention

1. Introduction

A Foreign Object Damage (FOD) is any damage attributed to an object, referred to as Foreign Object Debris (FOD), that is not part of an aircraft. FODs are usually associated to external causes like runway debris or bird strikes, but they can also be caused by foreign objects inside the aircraft, in which case they are referred to as internal FODs.

Internal FODs generally result from maintenance or outstanding work on aircraft, and may be divided into several families:

- ▶ Debris (swarfs, chips, paper, rubber, ...)
- ▶ Hardware (consumables like rivets, nuts...)

- ▶ Aircraft parts
- ▶ Personal Objects (phones, pencils, cigarettes, ...)
- ▶ Tools (mainly hand tools like screwdrivers, wrenches, lights, drilling tools, ...)
- ▶ Protections (plastic, foam, ...).

The common point to all these families of objects is that they may all affect the safety of operations, depending on where they are located on-board aircraft.

This article will illustrate, through a few examples, how foreign objects may impact safety and will give some recommendations on how to implement an efficient prevention program to minimize FOD occurrences.

2. Examples of FODs

There are many ways in which a foreign object can impair safety: a small metallic part may lead to an electric arc inside an electric cupboard, a plastic sheet may clog a bleed pipe or a fuel pump etc...

Here is an in-service incident, which illustrates the potential ef-

fect of internal foreign objects: on a landing A380, the crew perceived an electrical burning smell. They were then unable to stow an engine and experienced problems with the Auxiliary Power Unit (APU). Then, at power-off, the Ram Air Turbine (RAT) deployed.

Post-flight investigation revealed that the aircraft's Primary Electrical Power Distribution Centre (PEPDC), located at the rear of the cockpit, was partially burnt.

Figure 1
A short circuit caused by a contact pin burnt an A380 power distribution centre



The root cause for the short circuit was a contact pin, which had migrated through the ventilation grid of the equipment (**fig. 1**).

Here are three examples of different foreign objects that were luckily found before any damage could be created:

- ▶ Gloves, earplugs, metal clamps and a plastic cap were discovered in the Auxiliary Power Unit (APU) compartment. It was determined that these objects could have led to an APU shutdown (**fig. 2**).

Figure 2
Foreign objects found in an APU compartment



- ▶ A wrench was found in the horizontal stabilizer. This FOD could have led to a blockage of the elevator servo control (Fig. 3 & 4).



Figure 3
A320 horizontal stabilizer



Figure 4
Wrench left in A320 horizontal stabilizer

3. FOD Prevention

Herewith are six recommendations to implement an efficient FOD prevention program:

- ▶ **Define FOD risk zones**
- ▶ **Introduce housekeeping/cleanliness rules**
- ▶ **Manage hand tools**
- ▶ **Introduce FOD declaration, recording and feedback**
- ▶ **Train for FOD awareness**
- ▶ **Involve the management.**

3.1 Definition of FOD Risk Zones

An aircraft may be divided into three classes of FOD risk zones:

- ▶ **Non-sensitive zones:** characterized by a low risk of FOD e.g. primary parts, sections/products without zones closure.
- ▶ **Sensitive zones:** characterized by a moderate FOD risk. The zones are closed, but the impact of foreign objects is assessed as limited, notably concerning the migration of these foreign objects to other areas e.g. cabin overhead bins.

- ▶ **Critical zones:** characterized by a major FOD risk. The zones are closed and a clear safety impact has been identified. There is a high risk of migration of foreign objects to adjacent areas e.g. avionic or electrical bays, tanks, servo-valves or pipes.

Once the zoning has been defined, decisions have to be taken regarding:

- ▶ **The visual identification of these zones,** through standardized FOD logos, ground markings, etc
- ▶ **The rules to be applied within these zones,** linked to access rights, work rules, tool usage and carriage of personal objects.
- ▶ **The communication channels to be used,** to ensure that the rules are widely known and understood by all stakeholders.

3.2 Introduction of Housekeeping and Cleanliness Rules

Introducing proper housekeeping and cleanliness rules will help minimizing the number of foreign objects. **The 5S standard** (ref A) has been originally developed by the automotive industry. This international standard calls for a reduction of the number of tools and other objects to be used in the work areas and contains simple rules related to housekeeping and cleanliness.

A good practice to avoid FODs, is to install code protected lockers in the vicinity of FOD risky areas, where personnel entering these zones may leave non-useful tools and personal objects like mobile phone, money, keys etc (Fig. 5). A further good practice is to define a dress code including work-wears without pockets, but with a dedicated belt and bag to carry a limited number of personal objects like a pen or handkerchief (Fig. 6).

Figure 5
Code protected lockers in the vicinity of FOD risky areas

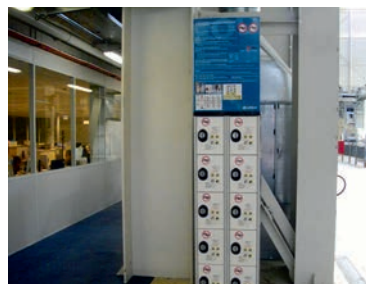
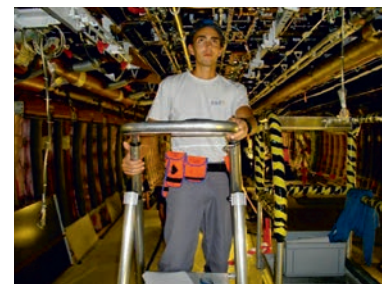


Figure 6
Dedicated dress code against FODs



3.3 Management of Hand Tools

Managing hand tools is key to avoid having screwdrivers, lights, wrenches, drill bits, etc. remain in the aircraft. Several solutions should be considered:

- ▶ Equipping tool boxes/cabinets with shadow boards, one form per tool, allows to easily detect missing tools (Fig. 7).
- ▶ Introducing inventory rules at the beginning and end of each shift ensures that no missing tool goes undetected.
- ▶ Limiting access to tool cabinets by badge ensures that only the authorized user of that cabinet will utilize the enclosed tools.
- ▶ Setting RFID chips on individual tools will allow for an efficient tracing.
- ▶ Tools kitting consist in having small tools boxes or mallets prepared with only the tools needed for a specified job, not more!
- ▶ Means should be put in place to declare lost tools and to analyse the data so as to come up with answers to reduce these occurrences. These solutions should then be promoted to the shop floor. The implementation of a lost tool process highlights the message that leaving a tool in an aircraft is not acceptable. The personnel declaring a loss is expected to do his/her best to relocate the missing effect.
- ▶ Tools identification, through laser etching for example, will ease the missing tool list cross-checking when a tool is found. It will also allow to identify the owner of the tool.



Figure 7
Tool box with shadow boards to easily detect missing tools

3.4 FOD Declaration, Recording and Feedback

- ▶ The declaration, recording and communication about lost tools should be broadened to encompass all families of foreign objects. All foreign objects should be declared and recorded. FOD trends should be analysed to identify why they are left in the aircraft and pertinent mitigation means should be defined. Last but not least, these mitigation means should then be actively promoted to all stakeholders to ensure a good implementation.

3.5 Training for FOD Awareness

The training allows to:

- ▶ Make people aware that foreign objects left in an aircraft may impact safety, thereby obtaining their adherence to FOD mitigation procedures.
- ▶ Inform personnel on how to follow these procedures.

That training should be given to all the people working on the aircraft, whether direct employees or external staff, as well as to their managers. It would be advisable as well to give people working in support functions, on the ground floor, a basic FOD awareness course.

3.6 Involvement of the Management

The implementation of an efficient FOD prevention program needs the active involvement of the management at all levels of the hierarchy. This requires a constant effort over time to ensure that habits change durably. It is up to the management to clearly indicate that fighting FODs is a priority, and to put in place the needed mitigation measures.

4. Conclusion

Internal foreign objects may take many forms, but they all potentially represent a threat to safe aircraft operation.

This threat should be mitigated by implementing a sound Foreign Object Damage (FOD) program, which calls for:

- ▶ The definition of FOD risk zones
- ▶ The introduction of house-keeping and cleanliness rules

- ▶ The management of hand tools
- ▶ The declaration, analysis of recordings and feedback of mitigation means against FODs
- ▶ The training for FOD awareness
- ▶ The involvement of the management.

All above recommendations are currently being implemented by Airbus on its manufacturing sites.

References A:

- ▶ “5S for operators: 5 pillars of the visual workplace”
Writer: Hiroyuki HIRANO
Editions: B&T – ISBN: 978-1563271236

**David HILL**

Head of Maintenance Programs Engineering - Structures
Customer Services

Corrosion: A Potential Safety Issue

1. Introduction

Corrosion, if left to propagate, can significantly reduce the strength of the aircraft structure and compromise safety. Corrosion can also affect the aircraft systems and induce failures in components such as landing gear (corrosion initiated crack propagation) and fuel systems (corroded bonding and electrical connectors, micro-biological contamination) to name a few.

To help and enable operators, Airbus has established a Corrosion Prevention and Control Program (CPCP). The CPCP defines regular

inspections on specific parts of the aircraft. The efficiency of the CPCP is dependent on Operators monitoring and reporting findings to ensure the correct type of inspection and interval are selected to prevent propagation of corrosion.

To reduce corrosion, good maintenance practices have to be put in place to keep the aircraft clean (interior and exterior), to ensure the drain paths are clear and to maintain the surface protections (paint, plating, water repellents, etc).

2. What is Corrosion?

Essentially, corrosion is the combination of damaged or missing protective coatings causing exposed metals and fluid ingress or contact between metallic and non metallic structure (e.g. aluminium to carbon fibre). A chemical reaction sets up a positive and negative electrical charge (cathode and anode, like a battery) and the subsequent chemical reaction 'dissolves' and breaks down the metal.

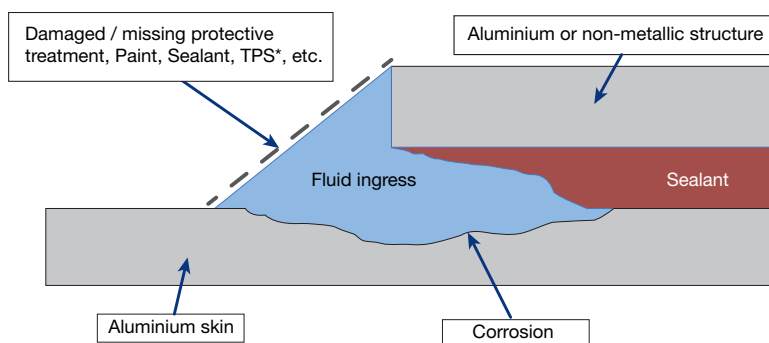


Figure 1
A simplified
illustration of corrosion

*TPS – Temporary Protection System (fluid repellents – Dinitrol, etc)

3. Types of Corrosion

There are several types of corrosion:

- ▶ pitting
- ▶ galvanic
- ▶ crevice
- ▶ exfoliation
- ▶ intergranular.

3.1 Pitting Corrosion

Pitting corrosion is a localized form of corrosion by which cavities or "holes" are produced in the material. Pitting corrosion damage is difficult to detect, predict and design against.

Corrosion products often cover the pits. Many small, narrow pits with minimal overall metal loss can lead to degradation of the structural strength and initiate cracking.



Figure 2
Example of pitting corrosion

3.2 Galvanic Corrosion

When a galvanic couple forms between metals, one of the metals in the couple becomes the anode and corrodes faster than it would all by itself, while the other becomes the cathode (the battery effect) and corrodes slower than it would alone.

In the case of a metallic and non-metallic (Carbon or composite material) couple, then the metal part will corrode and potentially cause deformation damage to the non-metallic part, also reducing the strength of the assembly.

For galvanic corrosion to occur, three conditions must be present:

- ▶ Electrochemically dissimilar metals must be present
- ▶ These metals must be in electrical contact, and
- ▶ The metals must be exposed to an electrolyte.

3.3 Exfoliation Corrosion

Exfoliation corrosion is corrosion that can occur along aluminum grain boundaries. These grain boundaries in both aluminum sheet and plate are oriented in layers parallel due to the rolling process. The delamination of these thin layers of the aluminum, with white corrosion deposits between the layers, is evident as the surface protections appear distorted, revealing the white deposits.

3.4 Crevice Corrosion

Crevice corrosion is a localized form of corrosion usually associated with a stagnant solution on the micro-environmental level (toilet floor beams, bilges, etc). This occurs in crevices (shielded areas) such as under gaskets, washers, insulation material, fastener heads, surface deposits, disbonded coatings, threads, lap joints and clamps. Crevice corrosion is initiated by changes in local chemistry within the crevice.

3.5 Intergranular Corrosion

This type of corrosion is at the grain boundaries of the metal alloys and can be encountered in alloy castings, stainless steel alloys and 2000, 5000, and 7000 series aluminium alloys. Intergranular or intercrystalline corrosion (IGC) is the preferential attack of the grain boundaries or closely adjacent grains without significant attack of the grains themselves. The material can become susceptible to corrosion attack or crack propagation if under tensile stress. Research and design have reduced this phenomena significantly.

4. Where is Corrosion found?

Corrosion can be found all over the aircraft, however, the evolution in technology, materials, design and manufacturing processes has greatly improved resistance to corrosion. Greater use of titanium, corrosion resistant steels, aluminium-lithium alloys, composite materials, carbon, protective coatings and sealants have all contributed to significantly reduce the level of corrosion experienced a few years ago.

Typically, structure exposed to corrosive products (particularly when the protective coating is damaged or missing) such as water, salty/humid environments,



Figure 3
Example of galvanic corrosion of a galley storage container caused by a well known brand of soft drink

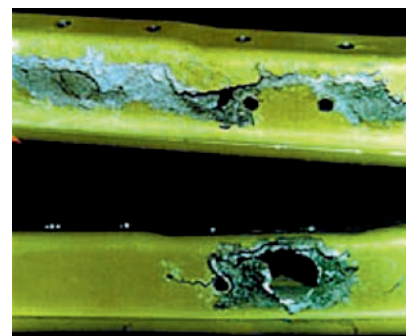


Figure 4
Example of exfoliation corrosion

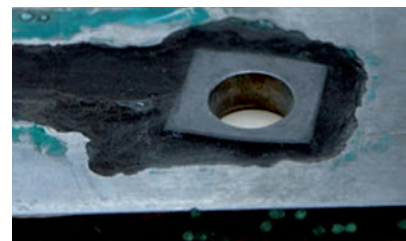


Figure 5
Example of crevice corrosion



Figure 6
Example of intergranular corrosion

runway de-icer, cargo spillages, food/drinks, human waste, etc are susceptible. So, areas around and underneath galleys and toilets, cargo bay bilges, exterior of the aircraft, fwd/aft wing spars, landing gear bays, flight controls, exterior skins, and fuel tanks are all to be considered.

5. Possible Consequences of Corrosion

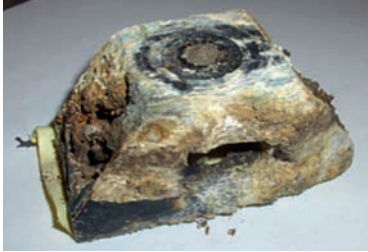


Figure 7
Corrosion of a galley foot fitting may lead to the failure of the security of the galley (or toilet) monument and could cause the monument to detach



Figure 11
Corrosion of electrical bondings, vital for aircraft systems safety (lightening strike, static electricity discharge, etc), could cause them to become ineffective



Figure 12
Corrosion between the interlaying surfaces of aerial connections could lead to loss of communication



Figure 8
Accumulation of corrosive "products" below a leaking toilet could reduce the thickness of the structure (hence the strength). Aside from the potential health concerns, this may lead to structural failure (decompression)



Figures 13 & 14
Missing/damaged protective treatments (Paint, primer, sealant, plating's, etc) will all allow ingress of fluids/corrosive products to cause corrosion damage, hence weakening the structure



Figure 9
Corrosion through accumulation of dirt, debris and fluids in the bilge area



Figure 15
Water ingress to a landing gear pin led to pitting corrosion, which attacked the chrome plating and blocked the lubrication, could lead to the seizure of the landing gear



Figure 16
Pitting corrosion caused the failure of a landing gear bogie beam



Figure 10
Micro-biological growth in the fuel tanks may lead to bacterial build up in the boundary between the fuel and accumulated water in the tanks. The micro-biological growth could affect the structure and/or block fuel filters/pumps



Figure 17
Stress induced corrosion along the fastener holes

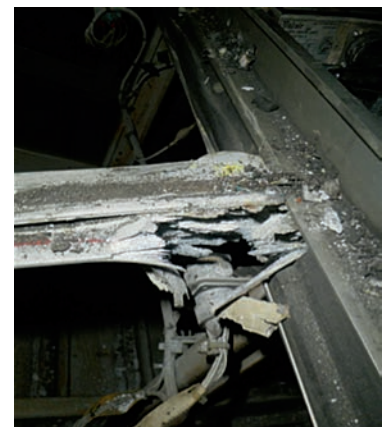


Figure 18
Cargo bay spillages damaged a cargo floor beam

6. Corrosion Prevention and Control Program (CPCP)

Cracks and loss of strength initiated by corrosion and pressurization cycles can lead to major structural failure. After a series of incidents involving old, high flight cycle aircraft, new regulations were introduced by Airworthiness Authorities in the early 1990's requiring manufacturers to develop structural inspections to clearly identify and control corrosion.

To enable operators to do this, Airbus has established a Corrosion Prevention and Control Program (CPCP) for all aircraft maintenance programs. These structural inspections are determined by design analyses, in-service experience and regulations. Implementation of these Inspection Programs is mandatory.

6.1 Three Levels of Corrosion

For the purposes of assessment, corrosion is classified into the following three levels:

- ▶ **Level 1 Corrosion** - Any corrosion of primary structure that does not require structural reinforcement or replacement (minor surface corrosion requiring minor restoration and reapplication of protective treatments, etc) (fig. 19).
- ▶ **Level 2 Corrosion** - Any corrosion of primary structure that requires a structural reinforcement or replacement and which is not considered as level 3 (fig. 20).
- ▶ **Level 3 Corrosion** - Corrosion of any primary structure which may be determined to be an urgent fleet airworthiness concern.



Figure 19
Level 1 Corrosion



Figure 20
Level 2 Corrosion

The regulations state that corrosion shall be controlled to level 1 or better and to ensure that corrosion does not exceed the limits of Level 1 between two successive inspections. If level 1 limits are exceeded there are several options:

- ▶ Decrease the inspection threshold/interval
- ▶ Consider a more detailed inspection level
- ▶ Apply Temporary Protection System more frequently
- ▶ Embody preventive modifications where appropriate.

CPCP is, therefore, self regulating.

6.2 Role of the operators

The task of the operators is to ensure the aircraft remain at the optimum level of performance and safety by:

- ▶ Inspecting the aircraft structure and systems in accordance with Airbus instructions
- ▶ Ensuring the bilge drains are clear, the galleys and toilets are clean and leaktight, the cargo bays are free from spillage and the non textile flooring is in good condition
- ▶ Maintaining the protective treatments
- ▶ Applying temporary protection schemes (TPS), such as Dinitrol, as applicable
- ▶ **Reporting findings to Airworthiness Authorities and Airbus.**

6.3 Role of Airbus

The task of Airbus, as manufacturer, is to:

- ▶ Lead continuous improvement
- ▶ Monitor trends
- ▶ Introduce corrective actions
- ▶ Adjust the maintenance program accordingly.

7. Conclusion

Corrosion may become a safety issue, as illustrated by past in-service incidents.

The Airbus Corrosion Prevention and Control Program (CPCP) has been established to prevent its propagation. Operators and Airbus have each specific responsibilities to ensure the CPCP is as effective as possible. The capacity of Airbus to meet its obligation is largely dependant upon an efficient reporting of findings by operators.

REMEMBER

**Clean it,
Inspect it, Drain it,
Seal it, Report.**

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