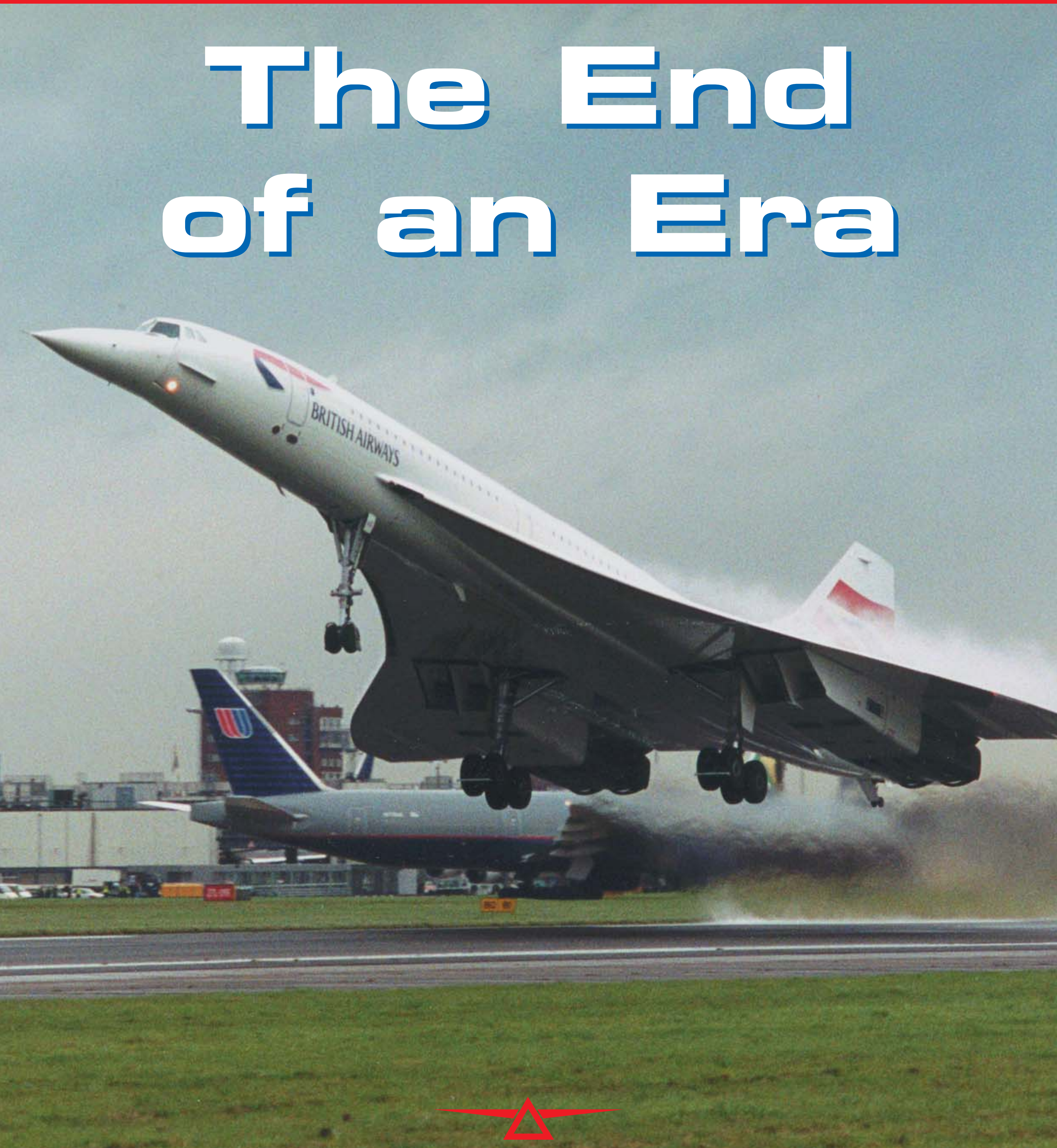
focus

ON COMMERCIAL AVIATION SAFETY

WINTER 2003

The End of an Era



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FOCUS *is a quarterly subscription journal devoted to the promotion of best practises in aviation safety. It includes articles, either original or reprinted from other sources, related to safety issues throughout all areas of air transport operations. Besides providing information on safety related matters,* ***FOCUS*** *aims to promote debate and improve networking within the industry. It must be emphasised that* ***FOCUS*** *is not intended as a substitute for regulatory information or company publications and procedures.*

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Concorde photographed by Adrian Meredith Photography

The End of an Era

Recently we have seen Concorde withdrawn from service by British Airways. Many wonder why it was necessary to do so. Concorde had become the symbol of British and French aviation achievement.

Introduced into commercial operation in the mid 1970s this aircraft has thrilled, not only those passengers who could afford to travel on it, but also the many millions who have seen her in flight.

It had always interested me to watch those around me when Concorde flies overhead. Nearly all stop and stare up at Concorde, almost in awe of her very presence. When asked why they stop and stare, the answer is nearly always "It is just so beautiful, it is awesome". The noise created by the raw power produced by the four Olympus engines that propel Concorde at twice the speed of sound, adds to the awe of the spectacle.

The design of Concorde is a tribute to all those involved in the concept of a supersonic passenger aircraft, whilst it's success is a tribute to the aviation engineers who took the concept through from design to reality and those who have maintained her since introduction. To be able to travel at twice the speed of sound and at 50,000feet above the earth was a great achievement. In spite of all the environmental factors and technical difficulties Concorde had an extremely good safety record, a tribute to the men and women who flew and maintained the aircraft. Far safer in purely statistical terms than the Space Shuttle, with which it shared a very similar gestation and development cycle. The great safety risk management achievement was to convert , in 1960s design competencies, the hostile environment hitherto occupied by combat aircrew in pressure suits and with self –sustaining breathing apparatus, to provide an air conditioning system. The trick in this was to use the fuel in the tanks – a rapidly dwindling resource – to produce the heat sink necessary to cool the incoming air. An exposed part of the internal structure was too hot to touch in the cruise, with an outside skin temperature above 400oC.

The aircraft was difficult and very labour intensive to maintain and it is this dimension that impinges on the commercial viability above all. Human skilled maintenance engineering is fast becoming a dying art as newer aircraft provide instant self-analysis built-in-test and display for ground staff. The ability of flight engineers to describe and identify faulty components and systems from Mach 2 cruise flight observations elevates them to the elite level of that aircrew position. They work flat out for all of the 3.5 hours or so, manually trimming the fuel in the tanks to keep the centre of gravity within a very narrow margin demanded by the Mach 2 envelope.

Concorde catered for those who wanted to utilise their time fully, at a premium price admittedly. They will now have to resort to a slower means of travel with all the attendant attributes of mass transport - over crowding, queuing, jostling and waiting, but mainly - waiting.

The modern emphasis on air travel seems to be on transporting more passengers at less cost over longer distance. To this end we are developing larger aircraft propelled by more powerful and more fuel efficient engines and there is no doubt that this makes good business sense. However, nothing is being done to reduce the time it takes to get from one place to another and time is the one resource that we only have a finite amount of.

So now our skies are quieter and our air a little less polluted but we have nothing to look up at and admire. The end of the Concorde era has therefore left us much the poorer. Those of us who were fortunate enough to have been involved in the production, operation and maintenance of the aircraft or who witnessed Concorde flying overhead will at least be able to look back and say with pride "I can remember when Concorde was flying. Those were truly great days in aviation".

Human Factors, Extended Horizons

by John Dunne, Airclaims

The application of Human Factors to aviation operations has brought tremendous benefits in terms of improvements to Flight Safety. These have been developed over a period from a warm and fuzzy approach into an emerging technology.

The initial focus of Human Factors was quite correctly on the flight deck. As time passed it was recognised that the two major areas of operational interface for the flight crews, Engineering and Cabin Crew, had their own unique cultures, language, issues and priorities. As an Industry we have now developed Human Factors to develop a synergy between these three cultures to gain an overall improvement in the area of Flight Safety.

At the recent UK Flight Safety Committee Seminar the theme was economics and its impact on the safety of the operation. There can be no doubt in any ones mind that without effective financial controls no business venture can succeed. Conversely without an effective operation a business cannot deliver its product to the consumer. If either of these elements are prejudiced the business will decline and ultimately perish. And here lies the issue, we have two competing cultures whose end objective is similar but they don't communicate that well because the language and cultures are so different.

Perhaps the time has come for us to examine the classic SHELL model. In its current form we examine the interface between the individual and the hardware, the software, the environment and other people - but the model sits in a relative vacuum. Our lives are enclosed by boundaries that continue to ebb and flow, maybe the time is right to revisit the SHELL model and develop the interface between the operational teams and the financial teams.

Over the next few months the UK Flight Safety Committee will be reviewing the possibility of developing the Human Factors model to encompass the broader picture both within the committee and with other organisations. Your contributions to this project will be invaluable, many of you have gained managerial and financial qualifications and are well versed in this field, but what about those financial managers who have limited detailed knowledge of the operations, how do we reach them? This is where your expertise will help. Please contact the office with your ideas and contributions.

UK FLIGHT SAFETY COMMITTEE OBJECTIVES

- To pursue the highest standards of aviation safety.
- To constitute a body of experienced aviation flight safety personnel available for consultation.
- To facilitate the free exchange of aviation safety data.
- To maintain an appropriate liaison with other bodies concerned with aviation safety.
- To provide assistance to operators establishing and maintaining a flight safety organisation.

Maintenance of High-Strength Alloy Steel

Many landing gear, flap supporting, and flap actuating components on Boeing airplanes are made of high strength, high-head-treated materials are used in limited-space envelopes. To reap the benefits of high-strength alloy steel components and avoid potential safety issues resulting from damage, airline maintenance procedures and rework practices, checklists, and guidelines during component maintenance and overhaul.

Many landing gear, flap track, flap carriage, and other flap actuating components on Boeing airplanes are made of high-strength alloy steels, such as 300M, Hy-Tuf, 4340M, and 4330M. These components provide structural benefits (e.g., reliable, durable design) and strength characteristics that permit an efficient use of available airframe space. Other steels in use, including 9Ni-4Co-0.3C, AerMet 100, and precipitation-hardened stainless steels, have similar maintenance and over- haul requirements. (Note: High-strength alloy steels referenced in this article generally have been heat-treated above 180 ksi [180,000 psi]: most have been heat-treated above 220 ksi.)

Airline personnel should follow proper maintenance procedures and Boeing-provided rework practices, checklists, and planning guidelines during maintenance and overhaul of these components. This will help operators achieve the benefits associated with high-strength alloy steels and avoid potential safety issues resulting from damage caused by stress concentrations, detrimental surface conditions, corrosion, improper processing, or other factors.

This article discusses some factors that cause damage in service or during overhaul. Most can be attributed to a lack of familiarity with high-strength alloy steels. Operators usually recognize the benefits of using these steels: however, certain characteristics of the steels are not always given proper consideration during component maintenance or overhaul. These characteristics, including sensitivity to corrosion pitting, susceptibility to microstructural damage resulting from embrittlement, and notch sensitivity, can lead to rapid crack growth in some load environments.

This article describes

1. Benefits of high-strength alloy steel
2. Importance of proper inspection and rework
3. Guidelines for reworking high-strength alloy steel components.

1. Benefits of High-Strength Alloy Steel

Components made of high-strength alloy steel generally weigh less and require less space to house than components made of lower strength alloys. Using high-strength alloy steel for component design provides an opportunity to do the same job with less material. When properly maintained and overhauled, high-strength alloy steel components demonstrate high levels of service reliability.

The decision to use high-strength alloy steels is based on weight and economic factors. Airframe space for gear components may be reduced because of smaller diameter shock strut components, smaller pins (reduced space for joints) smaller diameter trucks and axles, and, in some instances, smaller drag brace, side brace, and attach fittings. By reducing the space required for these components, the wheel well size can be minimized and aerodynamic surfaces can be optimized, which allow an increase in fuel tank size (optimal wing spar location) or additional space for other uses.

The use of high-strength alloy steel parts is economical because it reduces weight, thereby allowing for more efficient aerodynamic surfaces arid providing the potential for increased payload and fuel.

For example, the trailing edge of the wing is relatively shallow. Using high-strength alloy steel flap tracks, flap carriages, and flap actuating components reduces the profile and decreases spatial envelope requirements while meeting or improving aerodynamic requirements. This also optimizes wing shape and reduces the potential need for bulging aerodynamic surfaces, which in turn reduces drag and increases airplane performance.

2. Importance of Proper Inspection and Rework

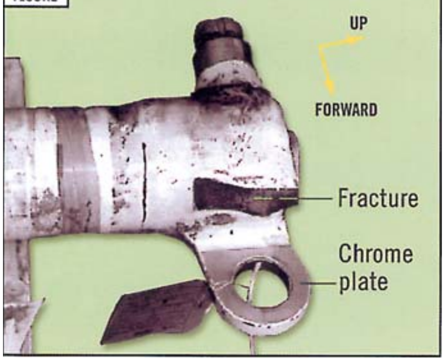
Following proper rework practices and using Boeing-provided documents during maintenance and overhaul are necessary to achieve the benefits associated with high-strength alloy steel components and help ensure safe airplane operation. Airline personnel who participate in component rework, maintenance, and overhaul tasks should be familiar with the properties of high-strength steels and understand the negative effects that can result from

- Sensitivity to stress concentrations (notch sensitivity).
- Microstructural damage from embrittlement or overheating.
- Detrimental surface conditions.
- Corrosion.
- Improper processing.

Improper rework practices can result in unscheduled maintenance or surface damage that causes crack initiation. Maintenance efforts focus on corrosion prevention and removal in addition to normal checks for wear and free play.

High-strength alloy steels can experience rapid crack propagation from stress corrosion under certain loading conditions. Therefore, surface damage detection is important during overhaul and on components in service. Removing visible surface corrosion before pitting begins (such as during a C-check) helps prevent conditions that can lead to crack initiation. The best safeguard against corrosion is to ensure that finishes conform to the design and that design improvements are incorporated as minor changes whenever possible.

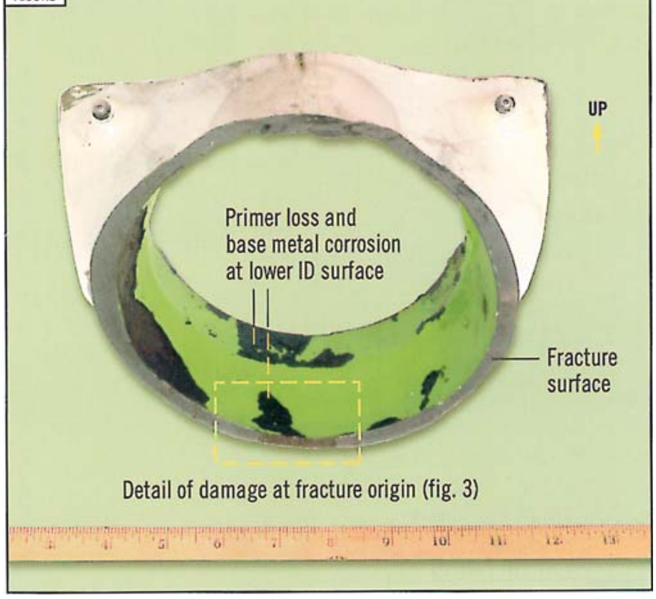
FIGURE 1 CRACK INITIATION AT CHROME PLATE RUNOUT INTO RADIUS



Components manufactured from steel alloys heat-treated above 180 ksi (180,000 psi) should be reworked in accordance with guidelines in Component Maintenance Manuals (CMM) 32-00-05, 32-00-06, and 32-00-07. Although these guidelines apply directly to landing gear components, they can be used to plan the overhaul rework of all high-strength steel components. Standard Overhaul Practices Manual (SOPM) 20-10-01 generally is specified in each CMM section for the rework of wing components (e.g., flap tracks, flap carriages). For repair of high-strength, 300M steel parts on DC-10 and MD-11 airplanes, use CMM 20-11-02: for DC-9, MD-80, MD-90, and 717 airplanes, use CMMs 20-10-18 and 20-10-06.

In addition, airline personnel need to understand the importance of maintaining component finishes while in service (in situ, or on the airplane). This includes repairing damaged finishes to prevent corrosion and ensuring that solvents and materials that come in contact with the finishes do not result in premature degradation and unscheduled component removal.

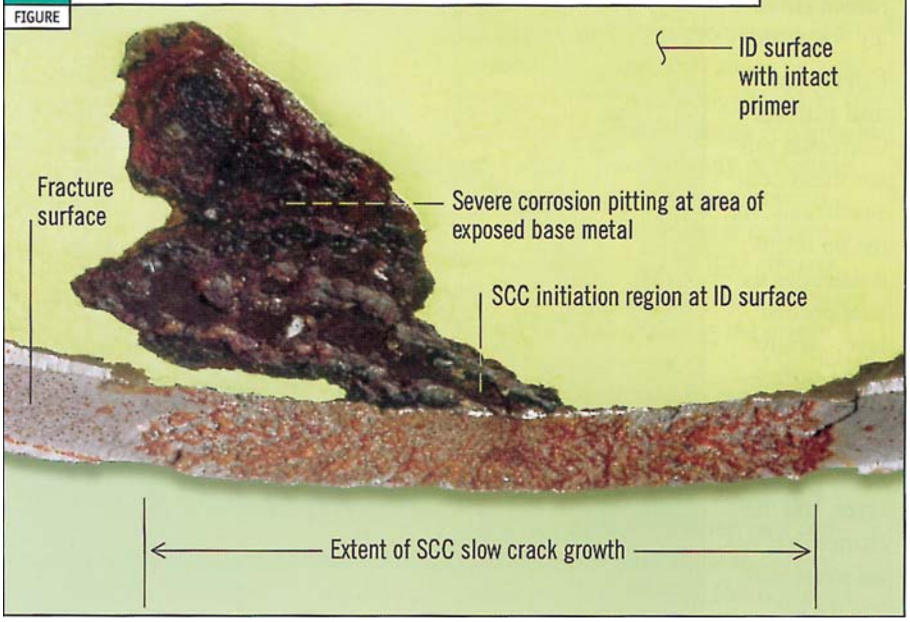
FIGURE 2 FINISH DAMAGE ALONG LOWER ID SURFACE AND AREAS OF CORROSION PITTING AT FRACTURE ORIGIN



Boeing documentation describes the methods for detecting base metal damage while in service and during overhaul. Common techniques include detailed visual inspections and other nondestructive inspection methods, such as magnetic particle inspection (MPI) and fluorescent penetrant inspection (FPI). (See SOPMs 20-20-01 and 20-20-02.) Ultrasonic or eddy current inspections also may be useful for in situ inspections.

Boeing also is developing supplemental, specialized techniques, such as the Barkhausen inspection, to detect base metal heat damage under chrome plating or other protective finishes. This technique can be used successfully to screen components with suspect damage. For example, if an axle fractures as a result of chrome-grinding heat damage during manufacture or overhaul, the Barkhausen inspection allows other suspect components to be screened without first performing a chrome strip and temper etch (e.g., nital etch) inspection on all suspect axles.

3 FIGURE CLOSE-UP VIEW OF CORROSION PITTING AT FRACTURE ORIGIN



3. Guidelines For Reworking High-Strength Alloy Steel Components

This section provides guidelines for reworking high-strength alloy steel components and describes some of the implications of improper rework procedures.

Stress concentrations.
Overheating components.
Hydrogen embrittlement.
Cadmium embrittlement.
Improper finishing.

Stress Concentrations

During component design, eliminating or minimizing areas of stress concentrations is a key objective. Special attention is given to protective finish runouts adjacent to stress concentration details. In addition, all stress concentration details are subject to extensive testing and/or analysis to ensure that no detrimental effects are introduced into a part. Any rework or repair must not increase stress concentrations that degrade component durability.

High-strength alloy steel components (along with those made from other materials) are shot-peened to create a shallow layer of compressive residual stress at the surface. This layer helps to Minimize the effects of stress concentrations in transition areas. Impede crack initiation and initial crack growth caused by fatigue or stress corrosion.

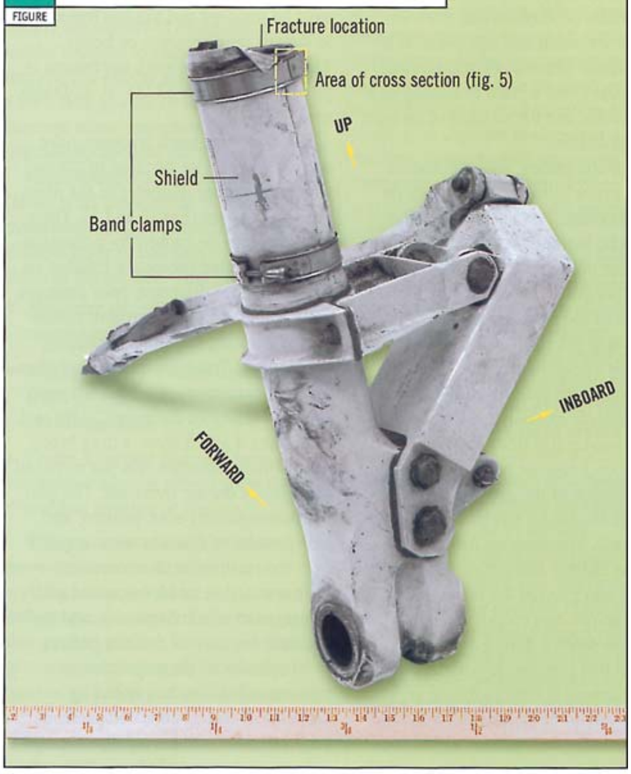
Create a surface that will have minimal adverse effects from the residual stresses of plating.

When a surface is machined or ground to remove damage, the reworked area should be shot-peened with proper overlap onto the existing shot-peened surface. During overhaul, personnel must observe the plating runouts specified in the CMM sections and SOPMs 20-10-01 and 20-42-03.

For example, when a coating such as chrome or nickel plating is applied to surfaces to prevent wear or corrosion, the coating must exhibit proper runouts that terminate before the tangent of fillet radii, edges, or other shape changes. Boeing SOPM guidelines should be followed for the rework of any component and for all types of plating or coating.

Rework or overhaul of components should not introduce stress concentrations, or otherwise increase stresses, which can reduce the service life of a component below that of the

4 FIGURE LOWER PORTION OF FRACTURED DRAG BRACE



original design configuration.

Stress concentrations can lead to initiation of cracking by fatigue, stress corrosion, or hydrogen-assisted stress corrosion. These cracks may result in a fracture or scrap of a component when found while in service or during overhaul. The following are examples of stress concentrations that can lead to cracking.

Transitions or radii that are sharper than original design. When removing damaged material from part surfaces during rework, the new transitions or radii should not cause an unacceptable increase in stress concentration at the location or degrade the original design features. When locally machining out corrosion or damage during overhaul, a gradual transition into the reworked depression is necessary.

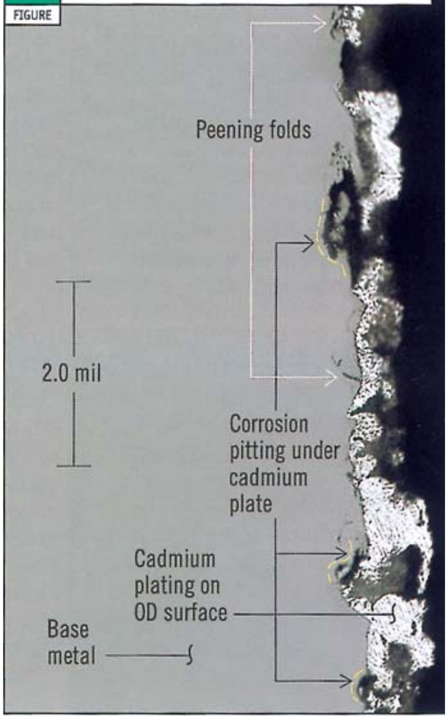
The intent is to remove the least amount of material possible while ensuring that all discrepant material is removed and the original design strength and durability are maintained. There are few options to restore these machined depressions to meet interface requirements. One type of rework or overhaul, sulfamate-nickel plating, is common on shock strut cylinder diameters and is used to repair lug faces to design dimensions as follows:

- Local blends on inner cylinder outer diameter surfaces and outer cylinder inner diameter surfaces often are filled with sulfamate-nickel plating to restore them to dimensions that are suitable for subsequent chrome plate application.
- Spot facing on lugs is controlled to have a generous radius at the transition to the adjacent surface and usually is kept at the minimum depth necessary to clean up the damaged surface. Spot face depressions typically are not filled with plating to restore the dimension but instead are finished in the same manner as the original design. Spot face transition radii need to be such that they can be shot-peened to the requirements of time adjacent surfaces.
- When the entire face of a lug must be machined to remove damage, the new lug transition radii should be shaped and positioned in accordance with CMM requirements. Surface transitions into the lug hole and at the lug edges must have design transitions that will allow restoration of shot-peening on all reworked areas and permit complete seating of bushings without contacting hole edges.

FIGURE 6 CRACKED MAIN GEAR OUTER CYLINDER WALL

Abrupt changes in sections, holes, and sharp-cornered keyways should be avoided. Proper design will reflect generous fillets, gradual changes of shape, and the use of relief grooves in areas of high stress. Finer surface finishes also may be needed to eliminate unnecessary stress concentrations, especially in areas of machined radii or undercuts. Overhaul should reflect the same careful, detailed review that occurred during the original design. Plating conditions and runout controls that are not in accordance with design standards. During overhaul, many landing gear components are completely stripped to replace nickel and chrome plating. In most instances, these repairs involve rework of the base metal. The new plating deposits frequently are thicker than the original design configuration.

FIGURE 5 CROSS-SECTION VIEW OF RESIDUAL CORROSION UNDER CADMIUM PLATING



In all cases, it is important to adhere to the SOPM recommendations. This will ensure that the restored plating is of high quality and that it does not terminate with an abrupt edge. Through-thickness cracks in chrome plate (generally present where there is evidence of chicken-wire cracking) can lead to corrosion at the base metal interface and deterioration of the plating adhesion. Through-thickness cracking also can lead to fatigue or stress corrosion cracking of the base metal beneath the plating.

Visual evidence of chicken-wire cracking after chrome grinding indicates poor chrome quality and also may indicate the possibility of base metal heat damage. Chicken-wire cracking noted in SOPM 20-10-04 indicates that the chrome should be stripped and replated.
If the plating runouts are blended or

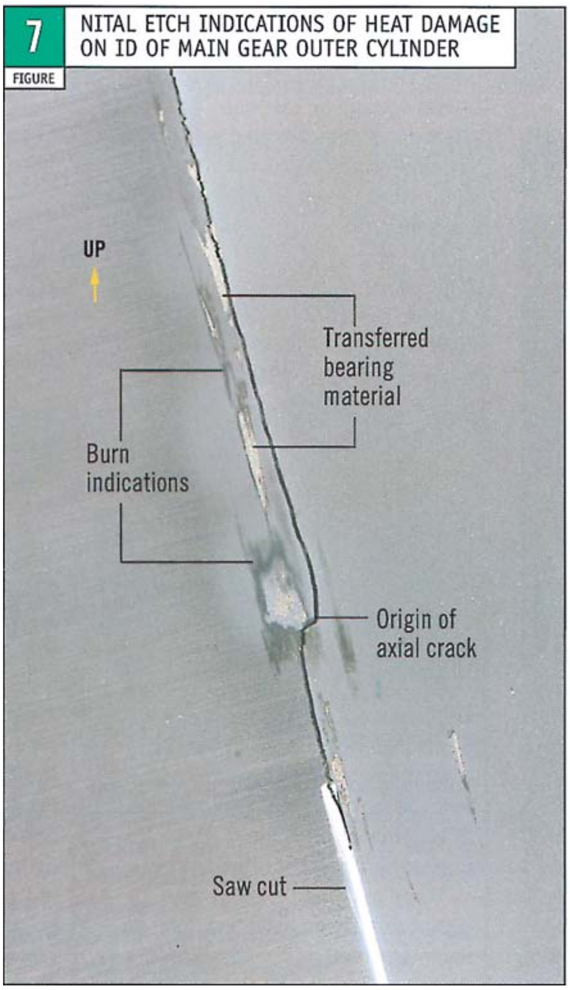


FIGURE 7 NITAL ETCH INDICATIONS OF HEAT DAMAGE ON ID OF MAIN GEAR OUTER CYLINDER

machined to remove the abrupt plating edge, the techniques must be well controlled to avoid damaging the adjacent base metal. Improper blending can remove the required shot-peened layer or create undercuts or grooves at the edge of the plating and cause cracking in service.

Several in-service fractures have been attributed to improper plating technique, poor-quality plating, improper runout conditions, and base metal damage caused by poor blending or machining control.

Proper use of special plating techniques, such as conforming anodes amid robbers, can control plating thicknesses and runouts. This can reduce the possibility of chrome chicken-wire cracking and poor runout details.

Plating into a transition (radius transition or undercut) will create a stress concentration that can cause crack initiation. For example, figure 1 shows an outer cylinder clevis plated into the lug transition. In service, fatigue cracking initiated at the plating runout led to lug fracture.

Corrosion and pitting

Corrosion pits are stress concentrations. As the pit forms, it damages the shot-peened layer locally at the surface. The pit then grows through the compressive layer, and the change in residual stress state and the pit geometry initiate stress corrosion cracking. This type of cracking most often occurs on surfaces that are both prone to corrosion and exposed to sustained tensile stresses while in service, such as the lower surface of landing gear trucks, axles, and the surfaces of forward and aft trunnions.

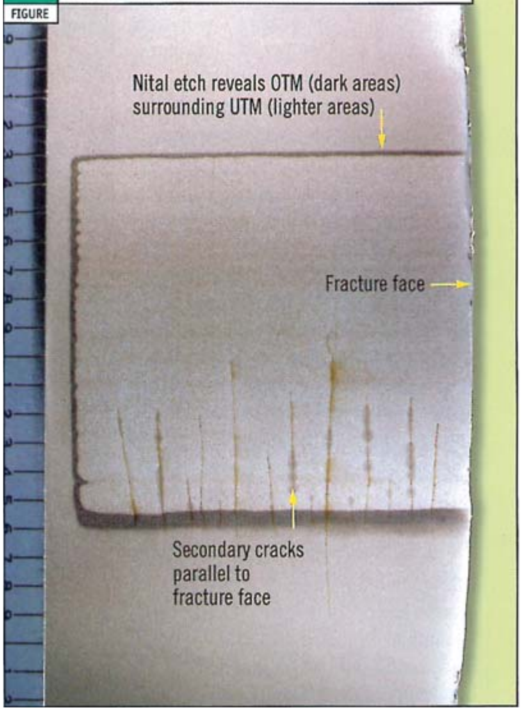
Corrosion pitting also can lead to fatigue crack initiation depending on the component, the location of pitting, and cyclic loading conditions. In these cases, the cracks can propagate to the critical length and result in ductile fracture of the component. The degree of cracking tolerated before fracture varies by component, crack location, and component loading conditions.

To prevent excessive corrosion, thorough visual inspections should be performed on a regular basis to evaluate the condition of the protective finishes. Damage should be repaired soon after it is found. Touching up damage to accessible enamel and primer in a timely manner can prevent the formation of corrosion pits and reduce the need for excessive rework during overhaul. Rework that requires low-hydrogen-embrittlement (LHE) cadmium stylus plating should be performed when the component is not loaded.
When the component is removed for overhaul, all evidence of corrosion must be removed and finishes restored to design requirements or better. The sequence of rework operations is provided in CMMs 32-00-05, 32-00-06, and 32-00-07.

Landing gear truck fractures have occurred in service because of corrosion on the inner diameter of the main gear truck beam (figs. 2 and 3). These fractures may be caused by a combination of degraded protective finishes on the truck inner diameter, poor drainage, and contact with the corrosive chemicals in washing solutions or deicing

FIGURE 8 FRACTURED MAIN LANDING GEAR AXLE

FIGURE 9 NITAL ETCH INDICATIONS OF HEAT DAMAGE ON OD OF AXLE AFTER CHROME REMOVED



compounds. Truck fractures most often occur at maximum ground loads such as after fueling or during preflight taxi.

Figures 4 and 5 show a drag brace from which corrosion was not removed completely during overhaul. The part was subsequently shot-peened, and new protective finishes were applied over the residual active corrosion. This resulted in crack initiation and propagation while in service and the eventual fracture of the component.

Mechanical damage. Stress concentrations can be created by mechanical damage that compromises the protective finishes and alters the compressive shot-peen layer. This damage often is caused by improper maintenance practices such as jacking adjacent to a jack pad or an inadvertent impact with tools or ground-support equipment (e.g., tow vehicles).

Although high-strength alloy steels are hard and resist dents, scratches, and nicks, stress concentrations caused by mechanical damage can dramatically reduce the service life of a component.

High-strength alloy steel components also can be damaged by mishandling during shop rework (e.g., dropping, impact), and in some circumstances, by foreign object debris. Possible mechanical damage to a high-strength alloy steel component should be evaluated by the operator and repaired as needed.

If the damage is local and widespread deformations are not evident, repair may be similar to that required for corrosion and pitting. All deformed material must be removed before refinishing: deformed high-strength steel alloy components must not be straightened. Contact Boeing for assistance, if needed.

Overheating Components

Overheating of components can change the original steel temper and mechanical properties of the affected area. Overheating damage can be caused by:

- Frictional heating while in service.
- Abusive machining and grinding operations during manufacture or overhaul.
- Exposure to high temperatures during overhaul hake cycles.
- Unusual conditions such as refused takeoffs and local fires.
- The degree to which the mechanical properties are changed depends on the temperature and duration of exposure.

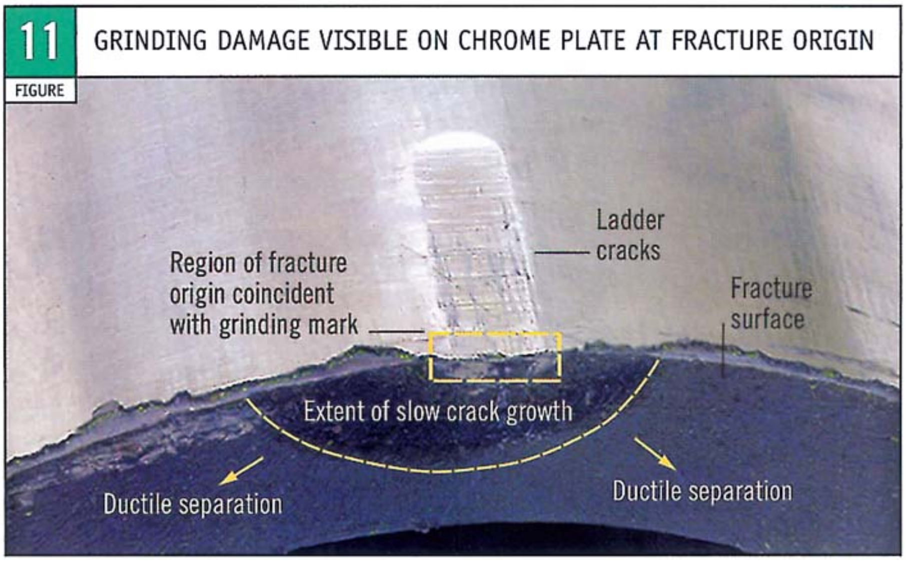
Overheating can result in overtempered martensite (OTM) on untempered martensite (UTM) formations in the base metal. Both conditions can be detected by a temper etch (i.e., nital etch) inspection of the base metal. UTM indications show white during temper etch inspections and often are found within patches of OTM which show dark gray to black during temper etch inspection. SOPM 20-10-02 provides details about the inspection process and interpretation of the results.

Heat damage generally is removed by carefully machining the base metal.

Afterwards, another temper etch inspection is done to ensure that the machining did not create more heat damage.

UTM formations may be accompanied by heat-induced cracking within these overheated areas that, if left in place, can propagate while in service. Figures 6 amid 7 show service-induced heat damage on the inside diameter of a main gear outer cylinder. This component developed extensive frictional heat damage in the upper bearing contact area as a result of improper clamp-up. The heat damage led to cracking through the cylinder wall. Salvage was not possible.

FIGURE 10 FRACTURE THROUGH FLAP CARRIAGE SPINDLE



Less severe friction-induced heat damage can be found on inner cylinders during component overhaul. This damage, which occurs on a more frequent basis, is caused by vertical motion against the lower bearing surfaces. This damage generally is shallow and can be removed by machining. After overhaul operations are completed the component is returned to service in accordance with CMM requirements.

When grinding chrome to finish dimensions, overheating the base metal can create UTM and OTM formations under the chrome. Figures 8 arid 9 show a severe grinding burn on a main landing gear axle that resulted in a fracture. Similar grinding burns also have led to the fracture of flap carriage spindle journals (figs. 10 and 11).

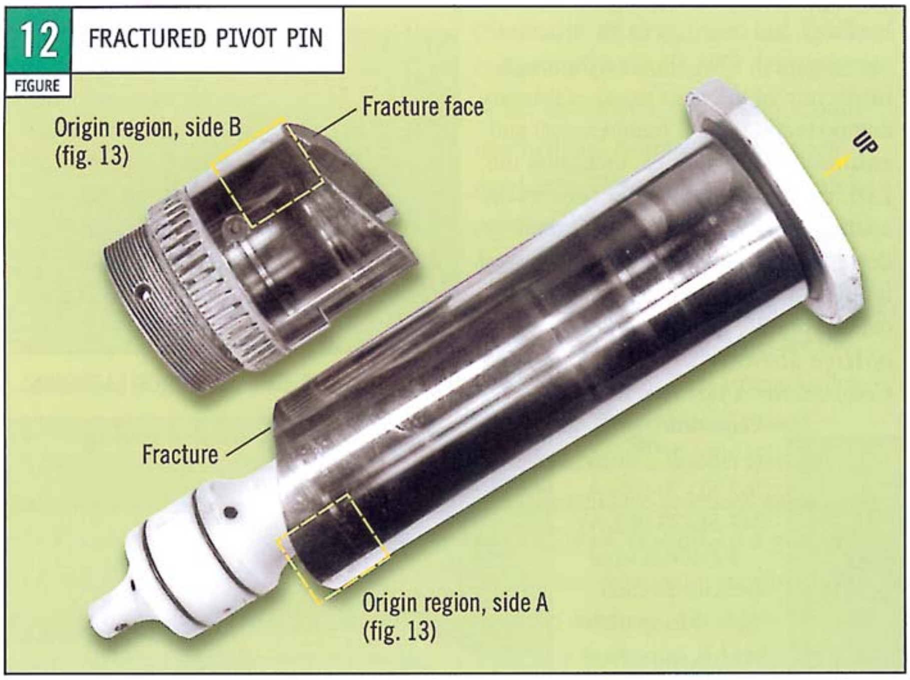
Any visible evidence of chronic plate distress can indicate the likelihood of base metal heat damage. Figures 12 and 13 show a grinding burn that led to the fracture of a pivot pin. SOPM 20-10-04 and CMMs 32-00-05, 32-00-06, and 32-00-07 provide guidelines that indicate when chrome must be removed during overhaul.

Some heat damage is so severe that the heat-treat condition of material is altered in adjacent areas.

This widespread reduction in metal hardiness (Rockwell-C hardness readings) may indicate that the component cannot be salvaged. Axle heat damage caused by a wheel bearing fracture may lead to such a condition. Shop procedures such as magnetic particle inspection and LHE cadmium stylus plating can cause arc burns if appropriate precautions are not maintained during processing. Figures l4 and 15 show a fracture resulting from an arc burn that developed during LHE stylus cadmium plating. (Note: In this article, cadmium plating means cadmium-titanium or LHE cadmium plating.)

Overheating will not alter the heat-treat conditions of the base metal if the temperatures are below the original tempering temperature. However, the component still may require special considerations (or rework) because

- Shot-peeninig may be compromised (heated above 400 oF).
- Cadmium embrittlement may occur (heated above 450 oF with cadmium plating present).
- Chromate conversion coating may be degraded (heated above 400 oF).
- Organic coatings or sealants may crack or become brittle or discolored (wide range of temperatures).



These situations often occur when components are:

- Inadvertently overheated in an oven.
- Exposed to elevated temperatures with some finishes intact or bushings installed.
- Exposed to fire.

Residual cadmium often is left on a part during overhaul processing to protect it from corrosion. The part is then stripped of all cadmium and replated near the end of overhaul. Parts within residual cadmium should not be heated over 4OO oF during overhaul.

Bushings should not remain installed during overhaul unless retained by specific CMM requirements. Bushings must be removed to permit a thorough inspection of the base metal and to avoid bushing-to-bore interface degradation during bake cycles. Design finishes are restored and new bushings with design interferences and dimensions are installed because bushing wear limits do not apply during overhaul.

Wheel bearing fractures or high-energy refused takeoffs often result in high local treat on an axle. Discoloration of the enamel, primer, or chrome or evidence of cadmium damage on the inner diameter of the axle may require the heat-damaged component to be removed from service.

Overheating affects components to various degrees; in some instances, only finish durability is degraded. This may result in a shorter than planned time between component overhauls. Contact Boeing for assistance with questions about repairing or salvaging high-strength alloy steel components that appear to have been damaged by overheating.

Hydrogen Embrittlement

Hydrogen embrittlement occurs when a high-strength alloy steel component absorbs hydrogen, which is not removed in a timely manner in accordance with the SOPM (e.g., embrittlement relief baking).

When hydrogen remains in a component for an extended time, the microstructural damage that develops significantly degrades the mechanical properties of the steel. The infused hydrogen migrates to areas of high stress (e.g., material internal stresses) and creates local microstructural damage. When the component is installed on an airplane, this internal damage can lead to crack initiation and propagation resulting in component fracture.

The elevated temperatures reached during hydrogen embrittlement relief baking, which is performed directly after stripping or plating operations during overhaul, effectively remove hydrogen generated during these operations. Processes that must be followed with relief baking include chrome, sulfamate-nickel, and LHE cadmium plating: stripping operations: and many nital etch inspections. After hydrogen-generating operations, relief bake delay time limits must be observed to ensure complete hydrogen removal. In general, the best practice is to initiate baking as soon as possible following a plating operation.

The delay time between plating completion and baking start typically is observed. However, when thick plating deposits or multiple plating operations are performed on a single component, the total time between initial plating start and baking start is a key factor when determining the maximum delay time allowed. For example, embrittlement relief baking must begin 10 hrs after sulfamate-nickel plating is completed or within 24 hrs after plating begins, whichever results in the shortest overall bake delay.

FIGURE 13 CLOSE-UP VIEW OF PIVOT PIN OD AT FRACTURE ORIGIN

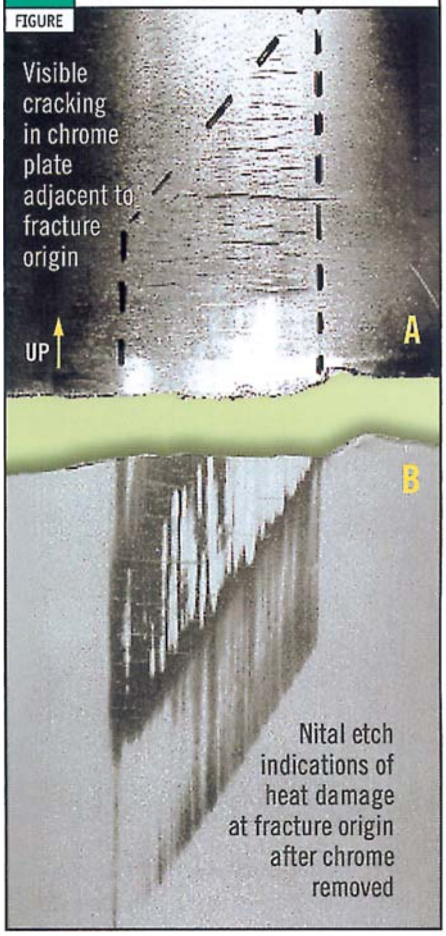
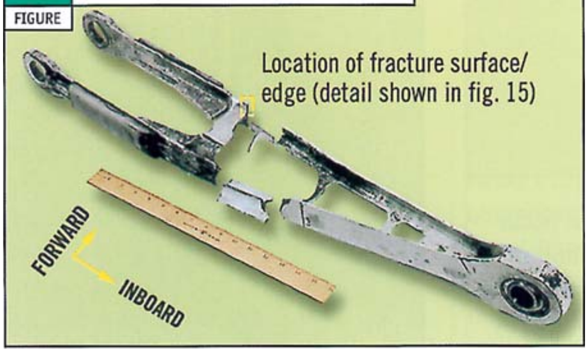


Figure 16 shows a flap track that cracked because of hydrogen embrittlement 149 flight cycles after overhaul. Figure 17 is a scanning electron microscope view of a typical hydrogen embrittlement crack where separation occurs along grain boundaries. Typically, hydrogen embrittlement cracks propagate rapidly once loads are applied to the part. In some cases, internal residual stresses are sufficiently higher to cause cracking even before the part is installed.

FIGURE 14 FRACTURED ACTUATOR BEAM



Cadmimum Embrittlement

Overheating LHE cadmium or cadmium-titanium plated components causes embrittlement of high-strength alloy steel by cadmium, resulting in cadmium diffusion into the steel grain boundaries. Solid-metal embrittlement by cadmium can occur at temperatures below the cadmium melting point. These effects on the base metal can begin to occur at 450 oF, whereas the cadmium melting point is generally 6l0 oF. The microstructural anomalies resulting from cadmium embrittlement can lead to component fractures in service.

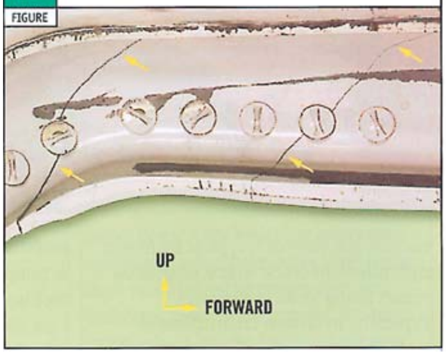
Determining whether cadmium has migrated into the grain boundaries of cadmium-plated, high-strength alloy steel components requires destructive testing of the components. If these components have been overheated, salvage may not be possible. However, if high-temperature exposure was short arid discoloration of the enamel or primer was minimal, the component may be a candidate for salvage. Slight or no discoloration of the enamel or primer may indicate the cadmium plating was not heated to the extent that cadmium embrittlement would be suspected. Boeing can assist in this determination.

Improper Finishing

Improper application of protective finishes during manufacture or overhaul can lead to finish degradation, corrosion, and corrosion pitting, which can result in component fracture whilst in service (figs. 2 and 3). Some cleaners and chemicals may accelerate finish degradation and lead to corrosion. Operators should ensure that cleaners and chemicals are tested before use in accordance with Boeing document D6-17487, Evaluation of Airplane Maintenance Materials. Testing to these requirements will determine whether a cleaner or chemical is detrimental to protective finishes or base metal. However, long-term exposure to the solution or material still may adversely affect finishes.

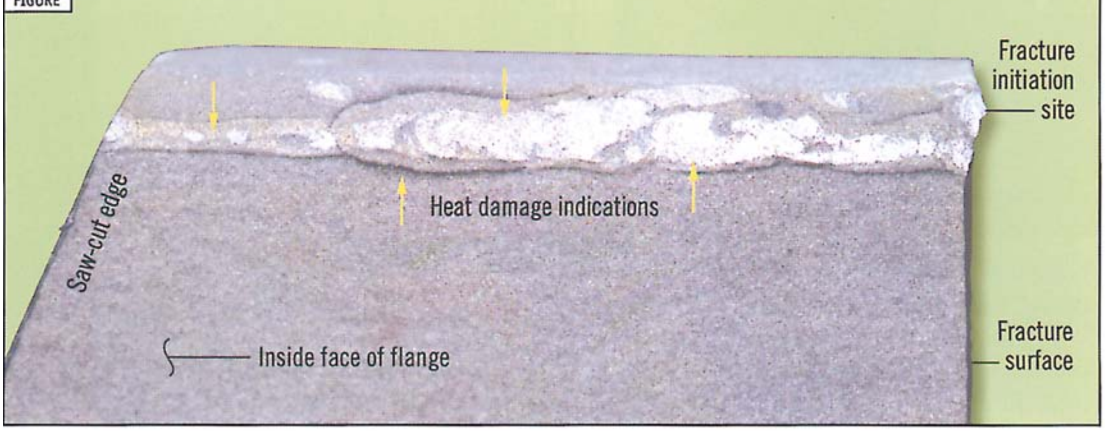
Personnel must ensure that materials used for activities such as cleaning and deicing conform to Boeing document D6-17487 requirements and will accomplish the intended task (verified by the material provider or operator). Refer to the Aircraft Maintenance Manual for materials specified for aircraft cleaning and deicing. The CMM specifies the materials for use in repair.

FIGURE 16 VISIBLE CRACKS IN FLAP TRACK (ARROWS)



High-strength alloy steel components should be stripped completely during overhaul (including removal of bushings and bearings in all structural components). This allows a thorough inspection of the base metal (a primary component overhaul requirement) and ensures that all finishes, including the LHE cadmium plating and conversion coating, are restored to the original design

FIGURE 15 NITAL ETCH INDICATIONS OF ARC BURN HEAT DAMAGE THAT LEAD TO FRACTURE



17 INTERGRANULAR FRACTURE CAUSED BY HYDROGEN EMBRITTLEMENT
FIGURE

requirements. This is addressed in an all-model Boeing service letter dated April 23, 2002, Overhaul of High Strength Steel Components - Cadmium Strip Required (e.g., 757-SL-20-036-A, 767-SL-20-038-A, 747-SL-20-062-A).

Restoration of the shot-peened layer during overhaul is important to ensure that the shot-peen compressive residual stresses are maintained or restored. Removing or damaging the shot-peened layer can reduce the protection that this compressive layer provides against fatigue and stress corrosion crack initiation. Discontinuous shot-peening can lead to crack initiation at the tensile surface stresses adjacent to edges of abrupt compressive layer runouts (no fade-out). All reworked surfaces must be shot-peened after removing material damaged by corrosion, head, and deformation.

As a rule, if material removal exceeds 0.0015 in (or 10 percent of the Almen strip intensity), the surface should then be shot-peened to CMM requirements. Exceeding shot-peen requirements is better than leaving areas without shot-peening. All portions of a component that are to be shot-peened should first be completely stripped; no cadmium residue should remain on the surface.

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SUMMARY

High-strength alloy steels are used widely in landing gear, flap track, flap support carriage, and flap actuating components on Boeing airplanes.

These high-strength materials provide significant structural benefits and can result in weight savings. These parts often are selected for placement in limited-space envelopes (e.g., wheel wells and wing trailing-edge support structures) because of their reduced profile or smaller diameters.

With these benefits comes a need for airline personnel to exercise precise care when reworking high-strength alloy steel components during scheduled maintenance and overhaul. They need to understand the importance of maintaining component finishes while in service, follow proper rework practices, and use Boeing-provided maintenance procedures, planning guidelines, and checklists during scheduled maintenance and overhaul processes.

Improper rework and overhaul practices may result in loss of finish, corrosion, and damage to or alteration of the base metal, which may require unscheduled maintenance between overhauls. The resulting damage also could precipitate crack initiation and removal of the part from service. Removing corrosion and restoring worn interfaces on a periodic basis are the main emphases of high-strength alloy steel component overhaul rework.

Key benefits of proper rework and maintenance practices include the possibility of extending the gear or component overhaul intervals (time between overhaul). Operators also will benefit from the enhanced reliability and durability of high-strength alloy steel components on their airplanes.

Operators should ensure that proper SOPM and CMM documentation is used during overhaul and rework of high-strength alloy steel components. The planning flowcharts in CMMs 32-00-05, 32-00-06, and 32-00-07 are value-added guidelines for planning the rework of any high-strength alloy steel component on a Boeing airplane.

Editor's note: The SOPMs and CMMs identified in this article can be ordered through the Data and Services Catalog.

Human Factors and Occurrence Reporting Systems from a Maintenance Organisation's Perspective

In the last issue of Focus magazine an example was provided of how flybe. Aviation Services has introduced a simple but effective system to meet the JAR 145 requirements for occurrence reporting. Implicit in the system is a process for recognising the Human Factor issues that are associated with errors made during maintenance and introducing effective preventative measures to minimise the risk of a re-occurrence. The process adopted by the organisation has been designated the ERROR AVOIDANCE PROGRAMME (EAP).

The criteria for our EAP were the same as for the existing occurrence reporting systems, in that it should be simple and cost effective with measurable enhancement to safety. With this system comes the bonus of increased effectiveness leading to greater efficiency and subsequent cost savings. In order to make the process acceptable and provide the necessary high profile it was launched as a company initiative fully supported by senior management and administered by a full time EAP Co-ordinator. The title was also carefully chosen to ensure it could be understood by all staff yet fully encompass the Human Factor requirement.

The system comprises a number of processes currently within the organisation's procedures but modified to meet the requirements. There are basically four elements which interlink.

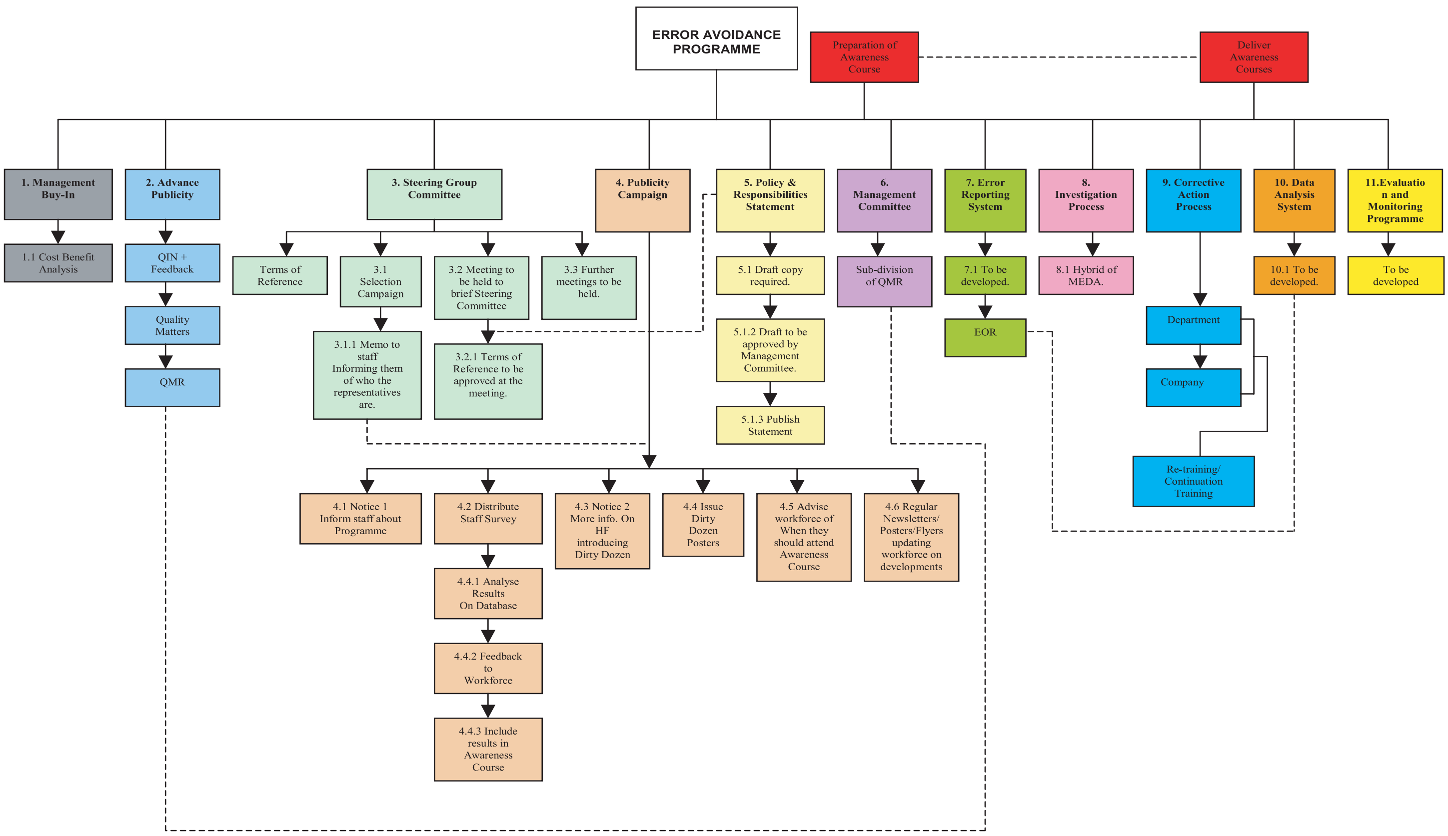
1. A confidential reporting system.
2. The Review Committee.
3. Management implementations of corrective action.
4. Human Factor awareness courses.

Additionally, there are support functions in place to cover feedback, programme awareness, verification analysis and review. These, with the exception of a stand alone company intranet site, are incorporated into basic organisational processes.

The confidential reporting system, supported by an agreed company Policy for EAP and an Amnesty statement endorsed by senior management, gives all staff the opportunity to report errors without fear or reprisal. It works well once it is seen to be an honest and credible reporting system.

The Review Committee play an important role in general acceptance of the system by staff. It not only makes recommendations on investigation reports but committee members act as

Error Avoidance Programme Structure



Miss K Dyer, EAP Co-ordinator

ambassadors for the initiative and provide vital feedback from staff.

The commitment from senior management to implement recommended changes is vital, although some suggested preventative measures may well be modified following discussion. Trust and mutual respect are a necessary part of the process.

Human Factor awareness courses are the foundation stone of EAP. They provide understanding, promote debate, raise awareness and foster reporting. It is imperative that courses are structured to suit the organisation as well as satisfying the requirement criteria. To ensure success the content of any course must contain information that staff can relate to with clear understandable analysis of how specific errors could have been avoided. Our HF awareness courses are given to all staff, as errors made in support departments can also have a direct impact on safety.

EAP Intranet Site

BE Intranet Homepage ▶ Departments ▶ EAP

- About the EAP
  - Programme Objective
  - EAP Procedures
    - PRO Q15
    - PRO Q49
  - Programme Structure
  - Policy Statement
  - Amnesty Statement
- About Human Factors
  - The History of Human Factors
- EAP Committees
  - Steering Committee
    - Members
    - Terms of Reference
    - Objective
    - Minutes of the Last Meeting
    - Date of Next Meeting
  - Management Committee
    - Members
    - Objective
- Publicity
  - An introduction to the EAP and HF – Published December 2000
  - Interim Report on the Human Factor Staff Opinion Survey – Published February 2001
  - Staff Opinion Survey – Overview of Responses – Published April 2001
  - Programme Update – Published September 2001
- HF Workshop
  - Course Schedule – *Under Construction*
  - Course Notes – *Under Construction*
  - Post Course Critiques – *Under Construction*
- Error Reports
  - Confidential Human Factors Incident/Error Reporting Form
    - QA/095
  - Total Estimated Cost of Errors
  - Error Trends – *Under Construction*
  - Report Progress
  - Course Notes
  - Post course critiques
- The Dirty Dozen
  - Posters
- Aviation Humour
- Feedback
- Links
  - Hyperlinks to useful Human Factor web sites
- New
  - Latest Updates to the Site

Experience within flybe. Aviation Services has proved that to ensure an EAP system is effective it requires commitment, support, ongoing resource and above all enthusiasm built on understanding. Commitment must come from the top down and be sustained. Support from all departments is also vital to ensure the process does not falter particularly during the investigation and review stage. It is essential to have a dedicated programme administrator who is respected by the staff and that this resource is maintained. Enthusiasm will be generated by a well delivered, tailored awareness programme, underpinned with effective communication, feedback and staff involvement.

Our EAP system would not suit all organisations. However, the underlying principles when applied sensibly do work and the visible results, in whatever form, convert the disbelievers and silence the sceptics. More importantly, EAP definitely enhances safety and will improve the effectiveness of any organisation.

Miss K Dyer, EAP Co-ordinator

Aviation Safety - The Balance Between Cost and Value

By Peter G Richards FRAeS

The UKFSC held it's Annual Seminar at the Radisson Edwardian Hotel near Heathrow over September 29th and 30th. 90 Delegates and Speakers attended and contributed to this very successful interactive event. As usual this event was generously sponsored by a number of well-known companies, thus keeping the delegate fees to the lowest for any gathering of this stature in London. For some years now, the UKFSC has provided a formal dinner on the evening of the day before the Seminar. This was essentially for the speakers to meet and relax, but latterly providing an important networking opportunity for the many delegates who had arrived ahead of the day's events. Andre Clerc the new CEO at Willis Insurance group gave a rousing endorsement to the programme and wished all attending a successful event.

Safety management can be seen as expensive for all forms of industry. Regulatory obligations notwithstanding, there are many choices that could be made. This Seminar attempted to examine how 'value judgements' are made and to demonstrate how 'Best Practice' need not be 'Cost Prohibitive'.

The Keynote Speaker was Dr Mike Hirst from Loughborough University Management Studies faculty, who simplified the minefield of management choices by posing some simple questions. i.e: Have you ensured that the Quality Standard you aspire to and set as policy is in fact accurately measurable? This particularly applies where you 'outsource services' and you need to have a firm grasp of your standard to ensure that you do not confuse 'value for money' and 'cheap'. He noted the declining availability of appropriate university courses offering Airline Operations degree standard qualifications against the comparatively vast number supplying aero-engineering design and manufacture. With Maintenance Engineering training availability now at a post WWII all time low, a serious safety gap is, I feel, not so far away. He also plugged the availability of the Engineering & Physical Sciences Research Council (EPSRC) who could take on the necessary research by using tools like 'fuzzy logic' to improve management forecasting options. His keynote message was that management needs to 'balance the inputs', not merely rely on 'bean counting'.

David Henry, the former CEO at AirTours and now a Consultant endorsed this viewpoint. He explained how company boards go about making decisions and how the input packaging and presentation could make or break a case. If the objective from Flight Operations was a particular piece of equipment or system, it was up to them to do the research and justify the cost as a benefit. If, by chance, or other outstanding demand, the request is declined, the supplicant should attempt to get their request granted in another year, or by a better argument next time.

David Chapman spoke of the need to embrace the ability to manage rapid changes as a result of the emergence of the European Aviation Safety Agency EASA. David Wright, also of the CAA endorsed the need to keep the regulator 'in the team' citing the emergence of GPS Navigation and Landing Minima as examples. What they feel is necessary is a multi-level series of consultative liaison groups to provide the right Regulatory Impact Assessment. Wright went on to evangelise the forthcoming requirement to comply with OFDM/FOQA from 2005 and applauded the offer by Airbus for the A380 to provide 4 months free Flight Data Monitoring support, for the benefit of both operator and manufacturer.

Captain Mike Wood, Director of Flight Operations for flybe., (and a former Vice Chairman of the UKFSC to boot) made a high quality presentation about how they had made their pitch to the management board about the type of aircraft they wanted for their operational network. They had included as 'evidence' the detailed feedback from their CAA Flight Ops Inspectors during trials. They had ensured that the aircraft would meet all current and foreseeable regulatory standards and above all it had to 'fit' into the Safety Management System culture they had trained their staff to uphold. This latter 'tool' was, to quote his words "Really just quantifying what the best airlines have been doing already; not cutting corners and paying close attention to the selection and training of staff.". With their maintenance provision outsourced, he felt that flybe. were doing all they could to keep their provider involved to the same standards as their own.

Next on the programme came Ian George of InSpace, who gave a sideways look at cost vs value by looking at the accidents to the Space Shuttles. The catalogue of declining oversight by a weakening of management objectivity and an unwillingness to learn from the earlier mistakes. The reduction in the federal budget to run the programme, leading to, amongst other things, a reduction in the number of competent engineers to carry out the all important inspections. Couple to this the investigating authority discovery that the engineer's e mails about faults and lapses never reached the decision levels of the management. He proposed that America has ceded space development to the Russians and the Chinese and posed a key question. Could it be determined that NASA had decided not to keep investing in safety? From which emerged a key answer - Too Little Too Late is no longer an OK management strategy or tactic.

After lunch, Thor Johansen of Boeing gave a short but detailed technical presentation about the costs incurred by risk management failures leading to an accident. In two lines, high levels of inter-airline competition, leading to low margins on return from capital investment and a high level of price sensitivity all mean a close attention to the big purchases. He re-inforced the message that many of the major factors your airline will encounter after an accident are un-insurable and that risk managing the choice of aircraft or system needs to keep this in mind. If you can eliminate or reduce a risk by 'better' resourcing, current trends show a reduction in uninsured losses by greater than 60%. Students of risk management should pay close attention to the detail in this presentation.

Kwok Chan of Airbus made a simple but telling statement: "Our method involves the need to make a profit - for everyone" and to this end have a transparent strategy. They aim to provide as much commonality of avionic components between their family of aircraft to reduce stock holding of spares and make conversion training technical knowledge easier to retain. Technical developments they are anticipating include the ability to detect and then manage Wake Vortex Encounters, hoping to have this available by 2010. He went on to reveal that some airlines have rejected customer options for Non-Mandatory safety related items, because they saw no tangible pay back from a reduction in crew actions, ie in unsafe /marginal crew choice options. He gave as an example the rejection by some purchasers of a fuel leak detection programme as a technical enhancement option.

He was followed by Captain John Savage of British Airways. John gave one of the most fascinating and hence well received of all presentations about the beneficial uses of Non-mandatory flight data recording and what you could do with the data to enhance safety. With hindsight most professional aircrew have a 'feel for the level of energy embodied in the aircraft at that point in the descent or approach in question'. But to have this refined into an ideal energy management curve meant that departures from it could be explored to the mutual benefit of both management and line community. A sudden late change of runway - a frequent occurrence in the USA - or the demands of ATC in Approach Separation spacing to suit their optimum business of 'runway utilisation', are two obvious challenges. He reasoned with us all to examine the bigger picture with flight data values and to guard against absolute values until this has occurred.

Simon Phippard of Barlow Lyde & Gilbert and our 'legal eagle' gave an incisive summary, during which he posed some questions. Given the emergence of EASA compared to the current and relatively well understood oversight by the CAA, would the balance in regulation remain the same if viewed in 10 years time? He voiced concern about the media outcry whenever an accident occurs and wondered if the current and foreseeable tone of political and media environments would generate the best possible safety culture. By the time that this summary is published, we will know whether corporate killing is back on the political agenda for the next session of parliament. What he felt was troubling is the extent to which such legislation might threaten criminal sanctions, not only against senior management but also against 'accountable managers' at a much more junior level within it. Leaving aside issues such as whether those managers are sufficiently senior to ensure that their recommendations are implemented and procedures complied with, if such legislation goes too far, one might predict two consequences. First, will the right people come forward to fill those posts? There is little point in having mandatory safety systems if the consequences for the holders of those positions are so severe that no body is prepared to take on the job. Second, an over zealous approach to identifying culprits after the event will only tend to dampen the existing open safety culture. This, after many years of effort, is in many places highly successful in ensuring that individuals hold their hands up; not only when things go wrong, but also when things might have gone wrong, such that the lessons will be learnt. If those benefits are lost, one wonders what value has been gained and at what cost?

Our aim had been to provide the delegates with something thought provoking for the management levels to consider. Too bad that many UKFSC member airlines declined to send such calibre representatives, but those that did heartily endorsed the programme.

Blood Pressure
A Better Way of Measuring Hypertension?

Blood pressure is a numbers game, and the rules keep changing. Systolic blood pressure (the top number) has replaced diastolic blood pressure (the bottom number) as the main focus for the detection, evaluation and treatment of hypertension. But some experts are now suggesting that the most accurate predictor of heart disease risk may be the difference between these two figures. This third number is called pulse pressure.

That pulse pressure might be illuminating makes sense. Healthy blood vessels, which are nice and elastic, give a little each time a heartbeat causes blood to surge. That elasticity translates into a difference of 40-50 mm Hg between systolic – when the blood is pushing hardest on the walls of the arteries – and diastolic pressure – when the heart is relaxed and the blood isn't being pushed by the heart through the arteries. During the heart's relaxation period, the force pushing blood through the arteries comes from the arteries themselves, which by returning to normal size, squeeze the blood forward.

But if the arteries are thick and stiff, the gap between systolic pressure and diastolic tends to grow. Systolic pressure goes up because the arteries have lost their give, and diastolic pressure tends to go down because the stiffened arteries aren't as responsive to the blood flow between heartbeats. A systolic-diastolic difference of up to 50 mm Hg is pretty normal. But when the pulse pressure mark is 60 mm Hg or more, it is on the high side and starts to concern some doctors. In addition to being a sign of rigid arteries, a high pulse pressure may also hasten the development of atherosclerosis. That can feed a vicious cycle because atherosclerosis is the main reason arteries get stiff and less elastic in the first place.

What the research shows

Some recent research backs up the theoretical appeal that pulse pressure might be a key number to watch. In the July 27, 1999, issue of Circulation, researchers used data collected from the famous Framingham Heart Study to investigate whether pulse pressure was more useful in predicting heart disease than was either systolic pressure or diastolic pressure alone. They calculated the risk of cardiovascular disease for each additional 10 mm Hg correlated with a 23% increase in risk. The equivalent effect of systolic pressure and diastolic pressure alone was 16% and 14% per 10 mm Hg, respectively.

But the plot thickens. French researchers reported in the September 1998 issue of Hypertension that increases in pulse pressure were, indeed, associated with a sizable increase in cardiovascular disease risk in men who, by their definition, had normal blood pressure or better – 140/90 mm Hg or lower. But their study found that increases in pulse pressure translated into a relatively small increase in cardiovascular disease risk in men classified as having high blood pressure, and they didn't find any relationship at all in women. In addition, the research to date hasn't shown any consistent relationship between pulse pressure and stroke. This is troubling. Preventing stroke is one of the major reasons for controlling blood pressure.

What you should do

Pulse pressure is intriguing and could become one of those important health numbers, like your cholesterol level, but you needn't get overly concerned about it right now. For one thing, it isn't at all clear that hypertension treatment would be much different using pulse pressure as a guide. Control of systolic pressure effectively solves the pulse pressure problem in many patients, particularly in people over 55, because it is the systolic pressure that tends to rise as we get older. And most of the hypertension drugs on the market now do a good job of controlling systolic pressure.

Still, some doctors are beginning to take note of pulse pressure as an indication of arterial health and heart disease risk. It is an active topic in hypertension research. And if you're curious about the flex left in your arteries, you might want to do some systolic-minus-diastolic computation of your own.

Too Much Exercise

For most, the problem is getting too little exercise, but for a few, it's getting too much. Here are some signs from the American College of Sports Medicine on whether you are overtraining:

- Decreased strength, endurance, and coordination, and increased recovery time
- Altered resting and exercise heart rates, blood pressure, and breathing
- Body weight and fat loss
- Chronic fatigue
- Sleeping and eating disruptions
- Muscle soreness and damage
- Joint aches and pains
- Increased frequency of illness and decreased rate of healing
- Depression, apathy and decreased self-esteem, confidence and ability to concentrate
- Headaches, geatrointestinal distress

Two of the most typically-given reasons for overtraining are trying to keep up with others or trying to follow a programme outlined in fitness literature. Remember, the body needs rest as well as exercise to grow stronger.

Depressed? Try Exercise

Two recent studies indicate that exercise may be better than anti-depressive drugs in curing the blues. German researchers found that daily 30 minute walks lowered depression scores by as much as 50 percent in just 10 days – faster than with most drug therapies. This was a small study of persons with moderate to severe depression.

In another study reported in the March 15 American Journal of Epidemiology, the researcher evaluated the exercise habits and mood scores of more than 2,000 people aged 50 – 89 over a ten-year period. Those who exercised regularly had lower depression scores.
Eat to Your Heart's Content

Healthy eating could prevent your first

heart attack! That's the position presented to the American Heart Association's annual conference last November. There is mounting evidence that the health benefits of a Mediterranean-style of dining will significantly reduce your risks of developing heart disease.

So, what is Mediterranean-style eating? Artemia P.Simopoulos, MD, author of The Omega Diet (Harper-Collins,1999), and president for the Centre for Genetics, Nutrition, and Health in Washington, D.C., outlines how to do it:
East at least seven servings of fruit and vegetables daily

Have fatty fish, such as salmon (rich in heart-healthy omega-3 fatty acids) at least twice a week, or take one gram of omega-3-rich fish oil in capsule form daily

Substitute heart-healthy olive and canola oils for other oils and saturated or hydrogenated fats.

Mets

Are you getting the exercise you need, based on your age and sex? According to the Centres for Disease Control and Prevention (CDC), fewer than one in four Americans do get the recommended amount of exercise. So how much is enough? The CDC has developed a formula for measuring exercise levels. It uses "metabolic equivalents" called METS to measure exercise intensity. One MET is the amount of energy you expend during rest. METS are multiples of that amount. Here is the formula for the recommended amount of METS.

For men: Multiply your age by 0.55 and then subtract that number from 60. Multiply the result by 0.17.

For women: Multiply your age by 0.37 and then subtract that number from 49. Multiply the result by 0.17.

Example for a 40-year old man:
[60-(40 x 0.55)] x 0.17 = recommended MET level of activity. (60-22) x 0.17 = 6.46

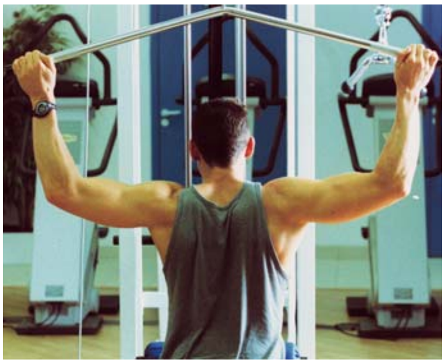


Figure your MET level and then compare it with the MET units for various exercise activities listed below.

Activity	METS
Golf (walking)	4.5
Hiking	6.0
Swimming laps	6.0
Mowing lawn	5.5
Stair climbing	8.0
Jogging	7.0
Walking (leisurely)	3.5

30 Is Better Than 3 Times 10

New research finds that 30 minutes of exercise at a time burns more calories than 3 10-minute bouts of exercise at the same intensity. The extra calories burned if you exercised every day would result in a 5-pound weight loss over the course of a year.

Walking Off Calories

How long does it take to walk off 100 calories? It depends on how fast you walk and how much you weigh. Here are the times in minutes:

	125lbs	150lbs	175lbs	200lbs
2mph	40	33	28	25
3mph	30	24	22	19
4mph	20	17	14	12

Reasons You're Still Fat

Here are some common weight-loss pitfalls that may be keeping you from shedding those extra pounds.

You're starving yourself. If you eat too little, your body tends to conserve calories rather than burn them. Don't cut your calories count by more than 500 calories a day.

You eat too fast. Eating fast doesn't give your body time to recognize that it's full. Eat slowly to give your stomach time to signal your brain that you are satiated.

You're too dry. Have another glass of water… and another… and another. Water is your partner in weight loss; it helps your body break down fat for energy.

Your food is too refined. Processed foods are low in fibre which tends to fill you up. Also, fibre helps control blood glucose in insulin levels, keeping them in normal ranges.

You don't get enough sleep. Sleep deprivation decreases the odds of shedding extra weight and keeping it off. Lack of sleep leads to higher glucose and insulin levels which boosts fat storage.

You think exercise is the answer. Exercise does burn calories, but it takes both exercise and restricting calories to lose.

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AFRASCO 14th Annual General Meeting

by The Editor

The 14th Annual General Meeting of the African Aviation Safety Council (AFRASCO) was held in the Sheraton Hotel, Addis Ababa on the 16th and 17th October 2003.

AFRASCO aims and objectives are:

a. To ensure compliance with, or to, established aviation safety standards and procedures to be uniformly applied by member airlines of the Council
   Where no such standards or procedures are in place to make the necessary recommendations in this regard,

b. To liaise with CAAs, government agencies and airport authorities for the improvement of matters pertaining to the safety of aircraft operations in the region,

c. To assist and participate in the formulation of local rules and regulations to suit the region's environment with the guidance and support of AFRAA, IATA, ICAO and other international safety bodies,

d. To enhance African Airlines' participation in the Safety Committee to IATA (SAC), Flight Safety Foundation and any other International Safety Bodies, thereby offering a forum for the training and development of African Airlines

e. To co-ordinate professional aircraft accident investigations among Council Members if requested. Share aircraft accident investigation resources and skills in order to limit loss of vital clues in aircraft accidents,

f. To produce and circulate to Council Members analyses, or to print for public issue, Air Safety Reports, magazine, books, pamphlets, leaflets and any other safety documents

g. Affiliate, or become affiliated to, any organisation having similar purposes and to promote and organise co-operation in the achievement of the above objectives,

h. To do all such lawful acts or things as are incidental to the attainment of the primary objectives of the Council and in so far as may be necessary or desirable to do such acts in collaboration with any person, body, institution or authority,

i. Arrange and provide for or join other air safety bodies in arranging and providing for exhibitions, seminars, workshops, lectures and conferences.

The theme of this year's AGM was "Aviation Safety Awareness for Africa"

The meeting was well attended with over 50 representatives from more then 20 organisations, including: Air Botswana, Airbus, Air Kenya, Air Madagascar, Air Malawi, Air Mozambique, Air Zimbabwe, ALPA Ethiopia, British Mediterranean Airways, The Boeing Company, Ethiopian Airports Enterprise, Ethiopian Airlines, Ethiopian Air Traffic Control Association, Ethiopian Cabin Crew Association, Ethiopian Civil Aviation Authority, International Air Transport Association, International Civil Aviation Organisation, Kenya Airways, Pratt & Whitney, South African Airways, United Kingdom Flight Safety Committee and USA National Transportation Safety Board.

During the two days a number of interesting and thought provoking presentations were made including:

Enhancing Safety in the Africa – G. Konate – IATA Regional Office

Enhancing Air Safety through Partnership – J. Wallace /R. Aman - Boeing Company

One Way to View Company Safety – N. Biwott – Kenya Airways

Accident Investigation – D. Jones - NTSB

Safety Information Sharing – Cost v Benefit – E. Paintin - UK Flight Safety Committee

Flight Operations Quality Assurance – J. Scully – Airbus

left to right: Bles Kavayi FSO of Air Zimbabwe & Secretary General of AFRASCO. Captain Mangwana FSO of Air Malawi, Ed Paintin Chief Executive of UK Flight Safety Committee.

An Almost CFIT Accident at Addis Ababa – R. Berry – British Mediterranean

Airbus Safety Initiatives – H. Hendel – Airbus

Prevention Lessons from Investigations – D. Jones – NTSB

ICAO Audit Report – Mr. Kumelachew - ICAO

Cuban Cigar – N. Biwott – Kenya Airways

Causes of Recent Accidents v Accidents of the Past Decade – D. Jones – NTSB

It is always difficult to summarize the content of the many interesting presentations and besides this would take many pages to achieve. Suffice it to say that all the delegated learned a great deal from the two day meeting. They learned even more from one another during the many social interactions. One very important point that became clear from several presentations was that some African states were not meeting their obligations to their signing of the ICAO convention. This was mainly because they did not have staff with the correct levels knowledge and skills. Hopefully the ICAO Audit programme will place these states under pressure to conform. There is little hope of improving the many safety concerns if the states in which the operations take place do not have adequate infrastructure and staff to support the operations.

Some may wonder why the UK Flight Safety Committee attends the ARFASCO meetings. Many members of the UK Flight Safety Committee fly into one or more of the African States. Many African operators fly into European and the UK airspace and airports. Our members therefore share the use of the airspace and by sharing relevant safety information we hope to improve the overall safety of aviation in both Europe and Africa. Participation by more European airlines operating into Africa would be very much appreciated by the members of AFRASCO.

In closing the meeting the Chairman of AFRASCO, Captain Joao Martins de Abreu, declared the 14th AGM to be the most successful meeting held to date.

The next AFRASCO Annual General Meeting will be held on the 14th/15th October 2004 in Botswana. Those wishing to attend should contact the Secretary General, Bles Kavayi at the following e-mail address: bkavayi@airzim.co.zw

The Rome Convention Re-visited – A Cap on the Price of Terror?

by Giles Kavanagh and Edward Spencer - Barlow Lyde & Gilbert

Fears of widespread industry collapse in the wake of 9/11 have, so far, proved unfounded. But how would the airlines and their insurers cope with another such catastrophe? As the Montreal Convention 1999 introduces a new regime to govern passenger and cargo liability, we turn our attention to surface damage and examine the latest proposals for a modernising framework that would extend the Rome Convention 1952 explicitly to cover acts of terror.

Images of tanks being deployed to Heathrow and of surface-to-air missiles being fired at passenger aircraft confirm that terrorists continue to look towards civil aviation as a vehicle for their atrocities. Short of deliberately flying an aircraft into a nuclear installation, it is perhaps difficult to imagine a more destructive scenario than that of 9/11. This event was unprecedented in many ways, but perhaps the most telling was the sheer magnitude of losses on the ground compared to the usual air disaster exposures associated with hull, passenger, crew and cargo liability.

This realisation has led airlines and representative bodies to consider whether the liability of airlines in any repeat scenario should be tiered or capped.

Internationally, the liability regime which governs damage caused by aircraft to third parties on the surface finds its basis in the Rome Convention of 1952. Its primary effect is to impose absolute liability on the aircraft operator, regardless of any fault on its part. A claimant, therefore, only needs to meet the burden of proving that (subject to extremely limited defences), he or she has suffered damage on the surface and that the damage itself has been caused by an aircraft in flight or by a person or object falling from it. Importantly, the Convention only applies to damage caused on the surface of one Contracting State by an aircraft in flight registered in another Contracting State.

In keeping with parallel Conventions in the field of international air transport, the Rome regime incorporates certain limits of liability. In 1978, the Montreal Protocol was introduced to amend the Rome Convention specifically to increase such limits. Under the Protocol, the maximum liability in respect of personal injury or loss of life was limited to 125,000 SDRs (approximately US$180,000) per person and this remains the case today.

Particularly given the current environment, one could be forgiven for thinking that the Rome regime has proved popular. In fact it has not. The Rome Convention has been ratified by 46 states, of which only Italy and the Russian Federation are G8 members. Support for the Montreal Protocol has been even thinner. Achieving the five ratifications necessary for its entry into force took until July 2002, some 24 years after signature. This seems to reflect something of a benevolent consensus on the part of individual states that there should be no liability limits for episodes of surface damage.

The UK is one such state which has concurred with this view. In the UK liability for surface damage caused by aircraft are currently governed by the Civil Aviation Act 1982. Like the Rome Convention, this applies a regime of strict liability; however, in contrast, there are no financial limits which attach to that liability. Many other states, particularly the more developed ones, have adopted a similar approach.

Since 9/11 and the subsequent withdrawal of terrorist cover for airlines, the aviation industry has been lobbying hard for a fundamental re-assessment of the position; the primary aim being to encourage central government to retain a larger share of terrorist risks which, arguably, find their origin in political rather than business decisions or activities.

The impetus has been driven by substantial rate increases over the last two years and the inability of Globaltime, ICAO's prospective special purpose insurance company backed by multi-

government guarantees, to match the protection afforded to US carriers – albeit temporarily – by the Terrorism Risk Insurance Act 2002.

Unconditional participation in the Globaltime scheme was confirmed by only 15% of ICAO member states, a fraction of the 51% required for Globaltime to be implemented. In consequence and by way of a compromise, it now seems that Globaltime cover will only be triggered after another serious occurrence and only then if ICAO considers that there has been a failure of the insurance market to respond. Airlines therefore remain haunted by the spectre of another 9/11, with the consequent risk to their own solvency and that of the aviation insurance market.

It is against this background that ICAO has set up a special Secretariat Study Group to re-examine the legal regime created by the Rome Convention and the Montreal Protocol. The aim is to extend the liability regime for surface damage expressly to encompass terrorist acts. The vehicle would be a new Rome Convention which, broadly, would bring liability for surface damage into line with the new passenger framework introduced by the Montreal Convention 1999. The ICAO Secretariat Study Group has so far advanced the following proposals:-

- A first tier of risk where strict liability is imposed on the aircraft operator up to a certain limit (perhaps 100,000 SDRs) for proven damages.

- A second tier of risk where the operator's liability is unlimited unless it can be proved that either (a) the damage was not due to its negligence or wrongful act or omission; or (b) that the damage was solely due to the negligence or other wrongful act of a third party.

- That purely in respect of acts of unlawful interference (including acts of terrorism), the second tier identified above would be capped with a global sum for each aircraft and incident, based on different categories of weight; although there would probably be scope for the cap to be broken under very limited circumstances (perhaps where there is evidence of serious breaches or shortcomings on the part of the operator).

- The new regime would be capable of applying to environmental damage (presumably associated with noise, pollution or vibration) and also to mid-air collisions.

- Mechanisms would exist for advance payments and a review of limits.

In terms of progress, the Secretariat Study Group currently anticipates submitting a proposed text to ICAO's legal committee for approval by the end of March 2004. It is hoped that a final text will be put to all ICAO member states, in conference, at some point during 2005 for formal adoption and subsequent transposition into a binding Convention or Treaty instrument.

In the interim, and in the absence of a willingness on the part of governments to underwrite these risks themselves, airlines and their insurers will have to place their faith in more advanced security measures and better intelligence.

2004

UKFSC SEMINAR

Please make a note of 20th & 21st September 2004 in your diaries as the date for the next UKFSC Seminar.

Missed Calls and "Sleeping receivers"

by Thomas J. Perry, UK CAA (SRG)

1. Background.

Tactical communication between aircraft and ATC is conducted over VHF radio channels. A single frequency is used in both the air-to ground and ground to air directions. This has the benefit of situation awareness, in that all parties "on frequency" hear all messages, but successful communication on this "simplex" frequency requires all parties to exercise care and to "listen before transmitting". The latter is even more important in the air-ground direction, because the aircraft radio equipment is a "transceiver" and cannot receive while transmitting.

2. Communication facilities.

To be effective, the ATC frequency must be available to all aircraft within the respective service volume. The aircraft under control are, of course, mobile and sufficient ground stations must be provided to ensure adequate coverage of the service volume. The ground stations must also serve aircraft at varying altitudes within the service volume and additional ground stations may be required to overcome radio range problems created by obstructions (hills or tall buildings) between the desired aircraft and the ground station. These problems diminish when the desired aircraft operate at higher altitudes but some frequencies are required to provide communication to aircraft operating at a variety of altitudes.

In the U.K, the "multi-carrier" network (also known as Climax) ensures that an ATC instruction is radiated from two or more ground transmitters, each simultaneous transmission being "offset" from the nominal frequency by a few kHz.

3. Known problems.

3.1. Stuck microphone

A simplex communication channel will be "jammed" if even a single transmitter is accidentally or deliberately, "keyed" for extended periods. A permanent transmission will often be evident when a second transmitter is keyed on the same frequency because the resulting heterodyne product will be demodulated as a "whistle" or "howl" for the duration of the simultaneous transmission. But if the offending transmitter is an aircraft radio, the crew of this aircraft will not be aware because, as previously explained, they cannot receive while transmitting. In contrast, ATC facilities usually provide separate transmitter and receiver equipment that permits the Controller to listen to the frequency while he transmits an instruction to the appropriate aircraft. This feature confirms his transmission and provides a convenient point to make the necessary (legal) recording of ATC radio communications.

3.2. Overlapping transmissions

A simplex channel ensures situation awareness but transmissions can be garbled or otherwise corrupted if two of more aircraft transmit at similar times. This situation is, unfortunately, more likely to occur when the ATC sector is busy because more aircraft are requiring more instructions and each instruction must be "read back" to confirm successful delivery. At busy times it is therefore not unusual to hear ATC request "aircraft calling say again".

3.3 Multi-carrier effect

The multi-carrier network provides system redundancy by transmission from two or more sites. But a consequence of "multi-carrier" transmission is the creation of one or more heterodyne products in the aircraft receiver. Fortunately the combination of transceiver design and transmitter offset ensures the aircrew does not hear these products and satisfactory reception is usually achieved. However although none of the heterodyne products are audible, the multi-carrier system is not without problems. These problems are a consequence of the introduction of "signal to noise squelch" circuits into the aircraft transceiver equipment.

3.3.1 Signal to noise squelch

This technique was introduced to eliminate the nuisance effect of electrical or static noise on the aircrew and the majority of modern transceivers use the difference in signal level between filtered audio output frequencies and the wider bandwidth unfiltered audio components to determine whether the received signal is "desirable"? The technique has greatly increased the sensitivity and hence the service range of the aircraft transceiver. But in a multi-carrier environment, the receiver sensitivity will be determined by the ratio between the in-band (ATC message) and out-of-band (heterodyne) audio components. The heterodyne products arising from multi-carrier transmission are "seen" as additional noise and the pilot will not be alerted to this transmission unless additional measures are taken to avoid this situation.

3.3.2 Carrier Over-ride

It is therefore common for the aircraft radio manufacturer to incorporate a second muting or "squelch" circuit to determine the received RF level. However, to avoid nuisance interference, this feature will usually require a much higher received signal strength (typically 12 microvolts p.d). The lower sensitivity in the presence of multi-carrier transmissions will limit the service range unless the ground transmitter sites compensate by radiating more power.

4. New problems.

4.1 "Missed calls"

Multi-carrier effect will usually be detected by the aircrew because despite being unaware of ATC transmissions, they are hearing transmissions from other aircraft on the same, shared channel (situation awareness) and will therefore receive a relayed instruction from a co-operating flight. In previous years, the aircrew may have also been able to use a panel mounted "squelch" control. But this feature seems to have been omitted when the newer (8.33 kHz) panels were introduced.

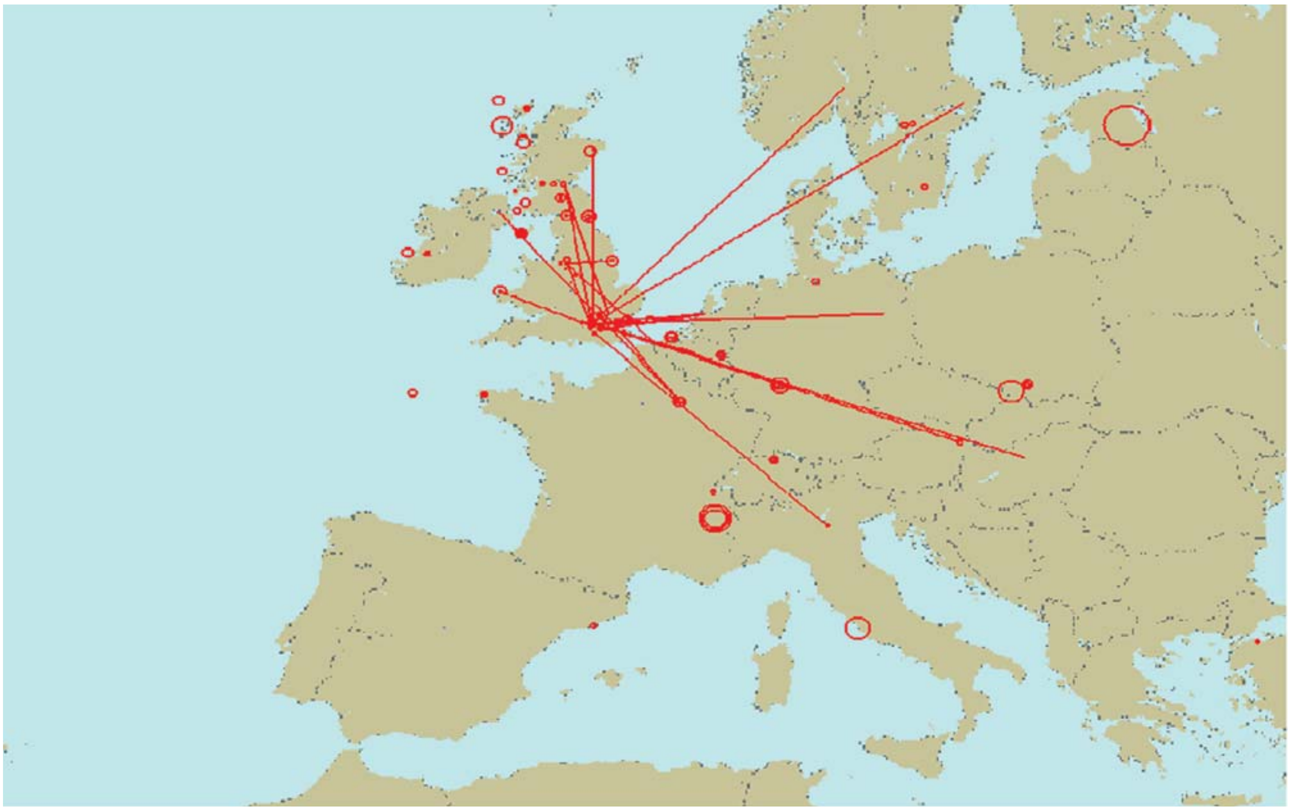
4.1.1 "Sleeping receiver"

Multi-carrier problems are usually infrequent and temporary in nature, but the CAA has been investigating a series of incidents when the aircrew was genuinely "out of comm." These incidents would typically occur in TMA airspace when the affected aircraft was either joining the final approach path or was climbing to join the airway structure en-route. The reports, submitted as MORs, have usually been substantiated by Air Safety Reports (ASRs) and until very recently it was assumed that this problem was perhaps, unique to British Airways? In each case, the problem appeared to be corrected by a "wake-up" call initiated by the crew and BA has now reminded their crews to be aware of the problem and to make a "test call" if they suspect a "sleeping receiver".

5. Investigations

5.1 Background

The likelihood of a loss of separation and increased risk of collision arising from a



Geographic disposition of PLOC across Europe Key:

- Red lines indicate air routes
- Red circles indicate PLOC reports
  The area of each circle is proportional to the number of reports.

prolonged loss of communication (PLOC) was highlighted by the UK Airprox Board in 1999 when two aircraft, on opposing tracks, were both "out of communication" for a period of 5 minutes. The Airprox report (150/99) mentioned that one of the operating companies had experienced several incidents when their aircraft radio was "neither receiving nor transmitting". In the same year, CHIRP (Feedback 52) carried a report of "Missed Calls-Not my Fault".

5.2 Phase One – the database

In March 2000, the CAA received a formal request for assistance from National Air Traffic Services Ltd. The request mentioned, that despite intensive investigation neither they nor BA had been able to identify a common causal factor. The CAA was therefore urged to "take expedient actions to investigate, understand and resolve these problems". In response to this request the CAA, National Air Traffic Services Ltd., Eurocontrol and BA agreed to four-phase plan to establish the likely cause or causes of PLOC. The first phase established a pan - European database of ATC incidents that cited prolonged loss of communication as a contributory factor.

5.2.1 Pan -European data

The U.K incidence of these reports is low (less than 200 in 4 years) but data collated by Eurocontrol indicates that several other airlines are experiencing similar problems. Data collated from German military sources listed 37 incidents of "lost comm" in just 3 months! The longest outage recorded was 39 minutes but 50% of these were at least 20 minutes! The paper mentioned that although the majority of cases evaluated seemed to be caused by human error, they were aware of other causes such as external interference or aircraft specific technical problems. The German authorities pointed out that "lost comm" may result in the interception of a "suspect" aircraft and proposed that the "cost of an intervention by military aircraft would be charged to the operator".

5.3 Phase Two – the Radio Frequency environment

The second phase, conducted by the Aerodrome & Air Traffic Standards Dept. (AALSD) of the Safety Regulation Group, has examined the possibility of external radio frequency interference as a contributory causal factor to a "sleeping receiver" event. This activity was prompted by CAA research work into the use of "portable electronic devices (PEDs)" on air transport aircraft. Some of these "wireless" devices are known to radiate at frequencies that could interfere with aircraft systems. But other terrestrial networks use frequencies much closer to the VHF aeronautical communications band and the UK Radiocommunications Agency (RA) has recently investigated the possibility of harmful interference to marine radio channels from VHF paging systems.

5.3.1 Test Flights

The test flights conducted on behalf of AALSD have used a Piper PA-31 aircraft. This aircraft has been equipped for interference investigation by National Air Traffic Services Ltd. and the RA. These flights have confirmed the presence of strong signals at 138 & 153 MHz. The results are interesting because AALSD has subsequently learned that air transport aircraft are, contrary to expectations, often equipped with "extended band antennas" designed to operate at frequencies up to 156 MHz.

5.3.2 Further flights

The SRG research department has recently fitted an extended band communications antenna to the PA-31. The additional antenna has a gain/frequency characteristic very similar to an air transport antenna. Results obtained with the new antenna will provide the data necessary to simulate the airborne environment before bench testing of a representative sample of airborne transceivers.

6. Causal factors?

6.1 PEDs

The CAA has highlighted the possibility of interference from so called “Portable Electronic Devices” (PEDs). These include portable computers, video games and mobile telephones. The latter are required to be turned off during flight but the operators know that some passengers either accidentally, or deliberately, ignores repeated instructions from the cabin staff. Mobile telephone detectors are of little use because they will generally alert the cabin staff during the climb and descent phases when the passengers are required to remain “seated and belted”. In any case, the detectors are unable to determine the location of the offending ‘phone. The co-incidence of detected ‘phone activity and the occasions when the “sleeping receiver” problem has manifested itself could not be ignored.

6.2. Common factors?

The investigation revealed that some of the newer aircraft radios employ Digital Signal Processors (DSPs) in the signal path between the aircraft antenna and the pilot headset. It was therefore suggested that the affected radios were somehow receiving an in-band component of the mobile ‘phone signal which, after being demodulated, locked the radio into a non-receiving state. According to the pilot reports it would appear that the lock was removed by the subsequent re-application of a Press-to -talk (PPT) signal by the aircrew. But static tests involving mobile ‘phones on a parked aircraft were unable to reproduce the problem reported by BA.

7. Progress

7.1 Testing

It must be pointed out that BA has only reported some 100 events of “sleeping receiver” in a four-year period. This means that the incidence per flight hour is very low indeed. But since BA have now sourced their aircraft radios from a single supplier and the reporting rate appeared to be increasing, the manufacturer of the BA transceiver was asked to conduct further testing of his product.

The outcome of initial tests was not encouraging but extended and automated testing in a semi-realistic exchange of messages set-up, produced just one failure which appeared to be very similar to the problem reported by BA.

7.2. Service Bulletin

The test result suggested that the aircraft radio could, in very rare circumstances, fail to properly return from the transmit mode, to the expected receive mode. The problem appeared to be related to the antenna switch, so although the receiver was correctly tuned and ready to receive an incoming transmission, it was not connected to the aircraft antenna. The manufacturer has acted quickly and responsibly to devise a modification to prevent a reoccurrence of this fault condition and a Service Bulletin is expected soon.

8. Conclusion

The CAA and BA will continue to monitor the radio performance after the completion of the modification programme. But, as the manufacturer has made clear, he cannot be certain that this fault is the sole cause of a “sleeping receiver” because neither we nor BA can be certain of the cause, or causes, of the “corruption” which caused the antenna switch to remain in the transmit state. However, the manufacturer has agreed to share his findings with other manufacturers. This is a worthy example of safety taking evident precedence over commercial or competitive considerations and the CAA hope this will encourage those companies to look again at how and when their product might mis-behave? The CAA research work into PEDs can be seen as complementary to the airborne measurements being conducted by AALSD. The combination of these two programmes is expected to reveal why and how some airborne transceivers exhibit the behavior known as “sleeping receiver”.