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Robert A. Feeler, editorial coordinator

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Managing Aircraft-tire Wear and Damage Requires Adherence to Removal Limits

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FSF Editorial Staff

Aircraft tire/wheel-assembly failures involve various operational and maintenance factors, but detectable damage to one or more tires sometimes is the underlying cause. Such failures occur infrequently; nevertheless, correctly maintaining tire components — whether in a new tire or a retreaded tire — helps ensure that tire/wheel assemblies will perform reliably under high static loads and dynamic loads. The airframe manufacturer's procedures typically specify limits for wear and damage.

Airlines typically establish tire-maintenance procedures that anticipate the use of products from different tire manufacturers. The procedures are written to comply with applicable regulations and safe practices developed by airframe, wheel and tire manufacturers. Whenever the safety of a tire is in question, the tire should be removed from service and should be sent to a certified repair-and-retread station for further inspection and disposition.

For most tire anomalies, a consensus based on experience and testing in the aviation industry guides an appropriate response or a range of appropriate responses. Separation of plies and tread or tire bulges, for example, require immediate removal of the tire from service. Nevertheless, differences in perception or in the evaluation criteria applied by flight crews and maintenance crews sometimes generate questions about airworthiness, as shown in the following incident report.

The report to the U.K. Confidential Human Factors Incident Reporting Program (CHIRP) in 1998 said, "During completion of the exterior inspection prior to departure, I noticed that the right nose-wheel tire [of a Boeing 777] was bald with several cuts down to and, in one case, through the tire cords. An inspection of the technical log shows that the [extended-range twin-engine operations (ETOPS) predeparture check], transit [predeparture check] and ramp check had been signed off as satisfactory. A verbal question to the ground engineer as to the serviceability of the nose wheel received the response, 'Oh, that's OK for lots more landings.' Only when I entered a defect in the tech log to the effect of 'Please confirm serviceability of right nose wheel' [was] a wheel change … called for. It was then apparent that … nose wheels were out of stock and that one needed to be obtained from an outside contractor. A two-hour delay resulted. I am sure that commercial pressure played a strong part in the attempt to dispatch the aircraft in this state. But two people had to sign the relevant checks and inspections in the tech log, and I am sure that at least one of the signatories was signing for someone else's work. (CHIRP note: This incident was investigated by the airline and the tire was, in fact, serviceable, with two millimeters [(mm); 0.079 inch] of tread remaining over more than 75 percent of the tire. The 'cuts' referred to by the reporter were ozone-induced cracks and were acceptable. The airline has since issued [tire-tread] depth gauges to be used on this [aircraft] type)."[1]

The report shows that some anomalies in tire/wheel assemblies are "acceptable conditions" and are not cause for removal of the tire from service. Maintenance technicians must communicate clearly the approved tire-maintenance procedures and the applicable wear limits or damage limits in a given situation. For example, spiral wrap — the reinforcing cords wound into the tread of some retreaded tires to reduce chevron cutting and tread chunking — typically begins to show as a tire wears, but the appearance of these cords does not compromise safety. (See "Limits for Tire Damage Also Involve Common Principles" on page 9 for a discussion of chevron cutting and tread chunking.)

Deviations from approved tire-maintenance practices — including assessment of wear and damage — have potentially serious consequences. Separation of tires and tire treads from tire/wheel assemblies has been cited as a causal factor in some accidents and incidents. Typically, the reports do not say whether the underlying damage or wear could have been detected prior to the event.[2] Nevertheless, one typical consequence with adverse safety implications has been tire-tread delamination on takeoff, with various degrees of foreign-object damage to aircraft engines, control surfaces and other components.

The accident and incident reporting system (ADREP) maintained by the International Civil Aviation Organization (ICAO) contained the following events involving various types of damage that originated in one or more tires:

- The report for a March 1992 incident involving a tire failure on a Boeing 737-400 during takeoff from Milan, Italy, said, "On takeoff, just after V_1, the pilot felt a slight bump. The crew were unaware of any damage until the [air traffic] controller advised them of debris on the runway and a passenger reported damage to the right wing. The pilot reasoned that the right main gear had suffered tire damage and diverted to [London Stansted Airport, England]. A tendency to roll to the right dictated a 30-degree flap landing, but a safe landing was made. The tread of the right outboard main-wheel tire had separated completely, although the tire remained inflated throughout the landing. Half of the right gear-leg door had been torn off, and the inboard flap assembly was dented. A falsework [access] panel on the wing undersurface was also damaged, and the inboard ground spoiler had a 10-inch [25-centimeter (cm)] hole in the trailing edge. The tire, which was on its second retread, failed after 236 landings. Examination of the tire tread indicated a number of cuts consistent with the tire having run over a foreign object. It was not possible to establish where or when the tire had suffered the damage, which led to the tread failure, although it was likely to have been within the last one or two departures."

- The report of a June 1990 incident involving a tire failure on a McDonnell Douglas DC-9-50 during takeoff from Atlanta, Georgia, U.S., said, "During takeoff, the no. 4 tire blew. The aircraft returned and landed safely. Damage to the [tire] inner liner consistent with underinflation was found. The maintenance program for the operator required tire pressure to be checked with a gauge during layover inspections. The inspection was done the previous day. Recap records revealed that the tire was recapped and delivered to the operator with a pinhole in the liner which allowed a slow leak. The pinhole was not repaired before delivery to the operator."

- The report for a July 1996 incident involving failures of six tires on a Tupolev Tu-154M/Tu-164 during takeoff from Delhi, India, said: "During the takeoff run, as the aircraft accelerated through about 150 kilometers per hour [81 knots], the crew heard a 'bang,' and the aircraft began to veer to the right. The takeoff was aborted, and the aircraft [was] brought to a safe stop on the runway. It was subsequently discovered that four tires on the right main undercarriage and two [tires] on the nose had failed. The accident happened in darkness (0010 local time) but in visual meteorological conditions [with] temperature 28 degrees Celsius [(C); 82 degrees Fahrenheit(F)]. … The tire failure is said to have been caused by the allegedly poor condition of the runway coupled with the premature aging of the tires due to the aircraft being parked at Delhi for long periods in excess of 40 degrees C [104 degrees F]."

- The report for an August 1997 incident involving a tire failure on an Airbus A300 during takeoff from Los Angeles, California, U.S., said, "During takeoff at 145 knots, the crew heard a loud noise. The pilot aborted the takeoff. Pieces of rubber from [the] no. 3 tire were found in [the] no. 2 engine. The engine fan was destroyed, and several … guide vanes were damaged."

A report to CHIRP in 1998 showed the value of careful observation throughout the tire-maintenance process. The report said, "Due to an acute shortage of certifying engineers, I found myself working a 'ghoster' [working a night shift immediately after a day shift]. During the daily inspection on a nightstop aircraft [an aircraft left overnight] the no. 1 mainwheel tire was found to be 'worn to limits.' The main wheel was replaced by myself and the paperwork completed. A mechanic then took the unserviceable wheel to the goods outwards area. It was then that he noticed a locking spacer still attached to the unserviceable item, which should have been transferred to the replacement wheel. The situation was quickly rectified with the spacer being fitted to the aircraft. If the spacer had not been fitted, the main wheel would have been free to move along the axle and disengage from one of the rotors on the brake pack. I had not noticed my error, and, with hindsight, was too fatigued to safely certify the task and the aircraft."[3]

Criteria for judging aircraft-tire wear and damage vary among civil aviation authorities, airframe manufacturers, tire manufacturers and airlines. Nevertheless, several principles are universally applicable, with regular preflight inspection as the foundation. Many airlines and regulatory authorities consider daily inspection of tires — including checks of pressure with calibrated gauges — essential for safe operation. Visual inspection of tire/wheel assemblies after every landing or at every turnaround also is recommended as a good practice.

Successful tire maintenance requires adherence to a program that includes not only the regular-interval checks and preflight inspections, but also thorough inspections of demounted tires (and tubes, if applicable). Policies and procedures also should specify how tire/wheel assemblies will be removed from aircraft and inspected following abnormal events such as rejected takeoffs, hard landings, excessive brake-heat generation or failure of the other tire/wheel assembly on that axle. Disposition of tires based on such inspections should be explicit, and compliance should be documented.

Safety procedures for all inspections of tire wear and tire damage should be followed carefully and consistently. A tire/wheel assembly that obviously has been damaged, for example, should be deflated by a remote means after cooling for at least three hours. Maintenance technicians also should follow approved safety instructions for approaching any tire/wheel assembly in service. Some specialists recommend approaching tires from an oblique angle in the direction of the tire's shoulder (the edge where the tread meets the sidewall). Other authorities recommend approaching in the direction of the tire tread; that is, not in the direction of the sidewall.

Some forms of damage are insidious because they are difficult to detect visually or develop slowly with no symptoms. For example, long-term operation of tire/wheel assemblies at less than specified operating pressure gradually weakens tires; use of greater-than-normal braking energy may cause internal structural damage to tires; and the effects of bottoming a tire (wheel flange contact with the runway) on landing may not become apparent until symptoms appear several landings later.

Tires should remain mounted and inflated, however, until inspections have been completed and suspected damage areas have been marked with a chalk stick, light-colored crayon, wax marker or paint stick, and the reason for removal from service has been written on a tag attached to the tire.

Normal-wear Baseline Simplifies Problem Detection

Aircraft manufacturers, regulatory authorities, tire manufacturers, operators and various engineering-standards and technical organizations issue procedures, criteria, photographs and other tools for systematically judging whether or not any wear limits or limits of tire damage have been exceeded.

The following principles concerning tire wear and damage generally apply to aircraft tire/wheel assemblies, but aircraft maintenance manuals, component maintenance manuals and technical bulletins should be consulted for any specific aircraft:

- All tires (and tubes, if used) should be inspected immediately after delivery by qualified tire-shop personnel for damage from shipping, handling or storage. Such damage could include cuts, tears or foreign objects penetrating the rubber; cuts, contamination or wrinkling of the inner liner; bulges and permanent deformations; debris or cuts on the bead seating surfaces; bead distortions; cracking that reaches cords; and rubber-attacking contaminants (especially hydrocarbon products such as fuel, oil, grease, brake fluid or solvents) that can cause visible blisters or swelling. Appropriate tables of limits for cut length and cut depth should be consulted to determine whether a cut or crack is acceptable;

- A bulge in the tread or sidewall typically warrants immediate removal of the tire from service. Bulges often indicate cord-body damage, or internal separation of tread or plies. Areas that show bulges must be marked carefully before deflating the tire to enable identification later;

- If the fuse plug of a tire/wheel assembly melts and releases nitrogen while a tire is rolling, *some procedures require the tire and its axle mate to be tagged immediately as unsuitable for further service and discarded*;

- Any rub marks on tires, gear or wheel wells require verification of adequate clearance for the tire/wheel assembly;

- Hydrocarbon contaminants should be removed from the tire according to specifications, then possible damage should be assessed by pressing the contaminated area to detect abnormal texture (sponginess or softening). Such damage warrants removal of the tire from service.

Limits for Tread Wear Emphasize Variation From Expected Patterns

Tread depth on aircraft tires affects contact with runways and taxiways similar to the way automobile tires "grip the road." Tread grooves also must be deep enough for water to pass under the tires, minimizing the risk of skidding or hydroplaning on wet runways. Inspections usually include descriptive visual criteria and wear values that can be measured with a tread-depth gauge — typically calibrated in thirty-secondths of an inch and/or in millimeters — according to manufacturers' specifications.

A basic principle of tire inspection is that the tread should show a normal wear pattern, which is relatively even over time. Achieving this requires strict use of specified operational inflation pressures and consistent maintenance practices. In normal wear, the wear limits are reached first along the centerline of the tire tread. Accentuated centerline wear is the typical symptom of overinflation. Accentuated shoulder wear is the typical symptom of underinflation. Correct balancing of the tire/wheel assembly also is important. Imbalance can cause severe vibration and irregular tread wear.

During normal wear of a retreadable bias-ply tire, gradual removal of tread first exposes the tread-reinforcing ply. Beneath this ply is the undertread layer, and beneath that layer are carcass plies. During normal wear of a retreadable radial tire, gradual removal of tread first exposes the protector ply. Beneath this ply is the undertread layer, followed by belt plies and carcass plies.

For both types of tire construction, tread-wear criteria for retreadable tires typically cite that wear must not expose more than a specified amount of tread-reinforcing ply (bias tire) or protector ply (radial tire) to keep a tire in service. Assessment of damage, however, may include detailed criteria for measurement of penetration.

Criteria for measuring and evaluating tire wear should be obtained from the airframe manufacturer's aircraft operations manual, aircraft maintenance manual, service bulletins and similar approved documents for the specific aircraft. Among other topics, the aircraft operations manual typically specifies whether return-to-base flights are permitted if tires reach specified wear limits on an aircraft at a remote location, and under what operating conditions. More conservative wear limits might be specified for aircraft operating conditions that could cause hydroplaning.

One major manufacturer, for example, recommends the following wear-removal criteria for the company's products based on examination of the fastest-wearing area along the tread:[4]

- The wear limit for nonretreadable tires is the first appearance of casing cords (any amount of exposed casing-cord area) for bias-ply tires or the first appearance of belt-ply cords (any amount of exposed belt-ply cord area) for radial tires; and,
- Retreadable tires should be removed from service before the

wear exceeds the retreadable limit. This limit is when the wear level reaches the bottom of any tread groove along more than one-eighth of the circumference on any part of the tread, or the tread-reinforcing ply of a bias-ply tire or the protector ply of a radial tire is exposed for more than one-eighth of the circumference at a given location.

The following special types of tread wear also have limits:

- Tread-rubber reversion, skid burn and flat spotting (typically oval areas where abrasion and excessive heat generation have converted tread rubber to the uncured state or caused localized tread-rubber loss) occur for several reasons, such as when a brake lockup occurs or the aircraft skids on a wet or ice-covered runway. Tire manufacturers specify criteria for evaluating this type of wear, such as whether a specified amount of cord-ply fabric has been exposed. For flat spotting, for example, one manufacturer recommends continued use of the tire except when the worn area exposes any of the reinforcing ply of a bias-ply tire or the protector ply of a radial tire, or this rubber loss causes aircraft vibrations.

- Asymmetrical (laterally uneven) tread wear — which may occur from misadjustment of landing gear, poor taxi technique or other reasons — sometimes can be corrected by reversing the tire's position on the wheel.

Another tire manufacturer said that a tire should be removed from service when the tread has worn to the base of any groove at any spot, or to a depth shown in the aircraft maintenance manual. Another general rule is that tires worn to fabric in the tread area should be removed from service regardless of the amount of tread remaining.[5]

Most tires used by airlines are designed for a service life encompassing multiple remanufacturing (retreading) cycles because the tire-cord bodies wear more slowly than treads in normal operations. Control of quality and safety is performed under the regulations of applicable airworthiness authorities. Some authorities specify a maximum number of retread cycles. Others rely on approved programs in which certified technicians consult records and use quality-control tests to determine when any tire-cord body exceeds safety limits for further retreading. In the United States and Europe, regulations of the Federal Aviation Administration (FAA) and the Joint Aviation Authorities, respectively, require retreading and/or repairing of aircraft tires in certified retread-and-repair stations, which employ certified technicians, maintain service histories of individual tires, and can repair many types of damage if cords have not been cut or damaged.

Tests to determine a tire's suitability for retreading require demounting the tire/wheel assembly and removing the tire. A separate category of tire-wear limits and damage limits applies to assessment of demounted tires for the purpose of determining retreadability. (Retreading limits established by the original tire manufacturers are beyond the scope of this article. Nevertheless, within these limits, tires with evenly worn tread, with a flat-spotted tread or with numerous cuts in the tread area typically are acceptable for renewal of the tread alone or for renewal of a bias-ply tire's tread and reinforcing ply or a radial tire's tread and protector ply.)

Limits for Tire Damage Also Involve Common Principles

The Society of Automotive Engineers (SAE) in 1995 published guidelines representing currently accepted industry practices regarding damage to bias-ply aircraft tires, the most widely used type of tire construction. SAE's guidelines did not include radial tires, but recent tire care and service literature from several major tire manufacturers shows that similar principles apply to radial tires. SAE's recommended practice — like major tire manufacturers' care and service publications — focuses on the primary areas where tire damage may occur: the tread, the sidewall, the bead area and the inner liner.[6]

The following factors are considered important by developers of SAE's recommended practice, the civil aviation authorities and several major tire manufacturers. Maintenance technicians are responsible for determining whether any guideline is applicable to any specific aircraft or operating conditions, and how to comply with the airworthiness requirements of aviation authorities.

In the tread area, cuts, cracks, foreign objects or other tread anomalies (called "injuries") should be evaluated based on length and width of each injury on the outermost cord-body ply; the number of injuries that meet or exceed these dimensions; the extent (percentage) of penetration of any injury through the cord-body plies; and the relative position of injuries that exceed a specified cord-penetration limit along the circumference of the tire.

One of the most serious problems is tread separation, a splitting or void between tread and tread-reinforcing components caused by the failure of tread adhesion. Tread separation typically warrants removal of the tire from service. Tests by tire manufacturers have established that excessive heat generation in tire/wheel assemblies from underinflation or overloading are significant causes of tread separation. Some manufacturers refer to one type of tread separation — tread delamination — to describe partial or complete loss of the tread to the tread fabric ply or casing plies.

Pieces of glass, stones, metal and other foreign objects embedded in the tread or penetrating the cord body should be marked for removal. Removal should be done using correct tools and techniques (including approved eye protection) after the tire has cooled to ambient temperature and has been deflated.

One manufacturer's damage limits call for removal of a tire if cord-ply fabric can be seen without spreading the cut or if cuts extend more than half of the width of a rib and deeper than 50 percent of the remaining groove depth. Another manufacturer's limits are linked to exposure or penetration of the casing-cord body of a bias-ply tire or the tread-belt layers of a radial tire, specify a maximum diameter for superficial openings by foreign objects, and require tire removal if a tire cut or injury severs a tread rib or extends across a tread rib. Tread cuts may progress to a peeled rib (partial or total circumferential delamination of a tread rib) or rib undercutting, in which groove cracking extends under a tread-rib cut. Limits to determine whether a tire must be removed from service may be linked to the extent of exposure of reinforcing ply (on bias-ply tires) or protector ply (on radial tires), or may be linked to exact measurements of cracking, peeling or undercutting.

The appearance of cord-ply fabric also may warrant removal of a tire when tread chipping or tread chunking (missing pieces of tread) are found, circumferential cracking occurs at the base of a tread groove, or chevron cutting is observed (caused by some cross-grooved runway surfaces). A crack in the tread where a tread joint or splice separates in a radial direction — open tread splice — also warrants tire removal.

For the sidewall area, SAE's recommended practice and an FAA advisory circular[7] generally consider normal weather checking or ozone checking (random shallow surface cracks), radial and circumferential cracks, shallow cuts, gouges and snags to be repairable if these anomalies do not exceed specifications for penetration of the reinforcing plies (for example, deeper than one ply). Nevertheless, as in the tread area, several anomalies warrant immediate removal of a tire from service. These include separation of sidewall rubber from the casing fabric and rupture of the tire casing at the sidewall. One insidious type of sidewall damage (that is, an initially invisible damage that may compromise safety over time) is a lower-sidewall compression flex break. This break may begin with cracks on the inner liner side, then weaken the tire through pressure loss. Underinflation of tires and overloading of tires are recognized causes of sidewall damage. Pressure loss that cannot be traced to another cause may be a symptom of lower-sidewall compression flex break. Demounting of the tire and inspection using an approved checklist are appropriate to diagnose the problem before carcass plies severely deteriorate and cause a massive sidewall-ply separation.

In the bead area of the tire (the inside edge that seals against the wheel flange) repairability is determined by ruling out damage to cord-body plies and verifying that the tire-to-wheel fit will retain the specified inflation pressure. The bead-area surfaces should be smooth, and wear should be within limits. Tire-tool chafing or chafing by the wheel flange should not adversely affect cord plies or cause ply separation. In the bead area, hoops of steel wire called "wire beads" anchor the casing plies and provide a strong mounting surface for contact with the wheel flange. Among serious problems that typically warrant scrapping the tire — that is, permanent removal from service because even basic retreadability limits would be exceeded — are protruding or excessively kinked bead wire, bead-wire separation and damage from excessive heat generation (such as melted, blistering or brittle rubber, or solidified cord-ply fabric).

Inner-liner damage and splices should be assessed for length, number and position. Deterioration that warrants removal of the tire from service may include distorted and wrinkled rubber in a tubeless-tire inner liner; fabric fraying and broken cords in a tube-type tire inner liner; and liner blisters or liner separations that exceed removal limits regarding size, position and number. Small liner blisters (diameter not more than two inches [five cm]), particularly in tubeless tires, typically should be left as found to avoid creating a slow leak.

Some tire wear and tire damage involve causal factors that can be controlled, including improper maintenance and improper pilot technique. Moreover, the resulting tire failures can cause significant damage that leads to an incident or accident. Line experience and tests by airframe and tire manufacturers have demonstrated that sound principles for managing tire wear and tire damage effectively increase the margin of safety in airline operations.♦

References

1. The CHIRP Charitable Trust. "Aircraft Tires (Wheels)." U.K.

Confidential Human Factors Incident Reporting Program Search Request No. 99/3/02, March 25, 1999. The search, requested by Flight Safety Foundation, found two deidentified reports.

2. Examples in this article were selected from three databases. The data included air carrier incidents and accidents from January 1983 to January 1999, maintained by the U.S. Federal Aviation Administration (FAA) and the U.S. National Transportation Safety Board (NTSB), and the accident and incident report system (ADREP) maintained by the International Civil Aviation Organization. Narrative information did not provide causal factors consistently. Nevertheless, studies by tire manufacturers have associated some of the types of tire/wheel-assembly failures with abnormal tire wear and tire damage. FAA and NTSB reports were developed from official records by Air Data Research, 13438 Bandera Road, Suite 106, Helotes, Texas 78023 U.S.

3. The CHIRP Charitable Trust.

4. Michelin Aircraft Tire Corp. *Aircraft Tire Care & Service.* Greenville, South Carolina, U.S.: Michelin Aircraft Tire Corp., 1997.

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6. Society of Automotive Engineers. "Aircraft New Tire Standard: Bias and Radial." Aerospace Standard No. AS4833. June 1995. "Aircraft Tire Retreading Practice: Bias and Radial." Aerospace Recommended Practice No. ARP4834. November 1995. Warrendale, Pennsylvania, U.S.

7. FAA. "Chapter 9: Landing Gear Systems." *Airframe and Powerplant Mechanics Airframe Handbook.* Advisory Circular 65-15A. 1976.

Autopilot-switch Malfunction Causes Airplane Upset

The U.S. National Transportation Safety Board (NTSB) said that an in-flight upset of a McDonnell Douglas DC-10-10 was caused by a malfunctioning control-wheel-steering (CWS) sensor that sent erroneous signals to the autopilot. NTSB recommended modification of the sensor and education of flight crews on the potential for similar upsets.

The DC-10, operated by Continental Airlines, departed from Los Angeles, California, U.S., on May 21, 1998, and was climbing through Flight Level 310 when an uncommanded pitch-attitude increase occurred.

The captain immediately disconnected the autopilot. "Flight data recorder (FDR) data showed that the airplane then went through four up-and-down pitch oscillations, the most severe of which attained vertical accelerations of +1.84 [Gs] to –1.12 Gs," said NTSB.

The first oscillation occurred immediately after the uncommanded pitch up. "Three more complete nose-up and nose-down cycles occurred … as the flight crew tried to regain level flight, because the peak airplane response lagged behind the peak flight-crew inputs by up to one second," said NTSB.

"This significant lag in airplane response led to an airplane-pilot coupled response in which the flight crew was continuously out of phase with the airplane's motions. Three oscillations were completed before the flight crew was able to dampen the airplane's response and return to level flight."

Of the 298 occupants, three occupants (flight attendants) were seriously injured, and five occupants sustained minor injuries. The airplane was not damaged. After the upset, the crew dumped fuel, returned to Los Angeles and landed the airplane without further incident.

"Postflight examination of the airplane revealed that the CWS sensor located in the first officer's control column was malfunctioning and sending an erroneous signal to the autopilot computer," said NTSB.

The malfunction resulted from a short circuit caused by material contamination. Silver, chlorine and sulfur were found inside the CWS sensor. NTSB said that the most likely sources of the silver were gold-plated silver wires connecting strain gauges with the sensor.

The sensor manufacturer, Kulite Semiconducter Products, in 1975 began to use gold wires or gold-plated platinum wires, rather than gold-plated silver wires.

NTSB recommended that the U.S. Federal Aviation Administration require DC-10 operators to replace gold-plated silver wires with gold wires or gold-plated platinum wires, and to ensure that DC-10 flight crews are provided information regarding the potential for airplane upsets caused by CWS-sensor malfunctions and the potential for overshoots in recovering from upsets, caused by the airplane's lag in responding to control inputs.

Lightning Damage Spurs Call for Action On Bonding Straps

The U.S. Federal Aviation Administration (FAA) should review the design of the horizontal-stabilizer-hinge bonding straps on Fokker 70 and 100 airplanes, and require operators to modify their airplanes to increase lightning-strike protection, said the U.S. National Transportation Safety Board (NTSB).

The recommendation was generated by the investigation of a Feb. 26, 1998, accident involving a US Airways Fokker 100. The airplane was substantially damaged during an emergency landing at Birmingham (Alabama, U.S.) International Airport.

"The flight crew had declared an emergency because of a dual hydraulic-system failure that occurred after the airplane was struck by lightning," said NTSB.

A misinstalled connector in the alternate brake system caused the brakes to lock when the crew applied brake pressure on landing. "Three main-landing-gear tires failed, and the airplane departed the runway, slid through the grass and came to rest on an adjacent taxiway," said NTSB. None of the 92 occupants was injured.

The right side of the fuselage had numerous small lightning-burn marks, and the right horizontal stabilizer had a large lightning-burn mark. The horizontal-stabilizer-hinge bonding strap, which provides a low-resistance path to allow electrical current to safely discharge, had been melted by an electrical overload.

"Once the bonding strap failed on the accident airplane, the remainder of the electrical current arced across the hydraulic lines in the vertical tail, which led to their failure," said NTSB. The no. 1 hydraulic-system pressure line and the no. 2

hydraulic-system return line had 0.25-inch-diameter (0.64-centimeter-diameter) holes, and both hydraulic reservoirs were empty.

Control Problem Leads To Off-airport Landing

On May 22, 1998, the pilot of a Piper Warrior made a precautionary landing near Ripple Village, Deal, Kent, England, after aileron control became restricted. The pilot sustained minor injuries, his passenger was not hurt, and the airplane was substantially damaged. Investigators found that the autopilot switch functioned intermittently.

The U.K. Air Accidents Investigation Branch (AAIB), in its report on the accident, said that the private pilot conducted a full-and-free control check before departure. During the flight, the low-voltage indicator light illuminated.

"The pilot reported that the ammeter indication remained normal and no other electrical services appeared to have been affected," said the report. The pilot reduced electrical loads but continued using the autopilot with the heading-hold mode engaged. The pilot later selected the autopilot off and then found that he could move the control yoke partially to the left but not to the right. "The autopilot was checked and confirmed to be disengaged," said the report. "The passenger [also a private pilot] checked his controls and confirmed the restriction.

"The pilot reported that even with considerable force, it was not possible to move the yoke to the right, although full control of rudder and elevators appeared to remain available. The decision was taken to make a precautionary landing in the nearest suitable field." The left wing separated from the airplane during the landing.

Initial examination of the airplane revealed no flight-control-system anomalies. The autopilot then was removed from the airplane and tested at an autopilot-overhaul facility.

"Functional testing was carried out with particular reference to the action of the unit's controls during disengagement," said the report. "It was found that the on-off switch was not always positive in its action, with a tendency to stick in both the 'on' and 'off' positions."♦

Process Restores Acrylic Transparencies

The Clearfix™ Acrylic Restoration Process enables maintenance technicians to repair scratch damage to stretched-acrylic cabin windows on aircraft. The process makes scratches disappear on the majority of noncoated-acrylic transparency surfaces without causing optical distortion, removing significant amounts of acrylic or degrading the strength or durability of windows, said the manufacturer.

Two solutions containing abrasives, suspension agents and surfactants (surface-active agents) are applied in sequence with hard and soft applicator pads mounted on a variable-speed power drill. The abrasive grit in the solutions gradually becomes smaller during the process. Transparencies are cleaned with the product's antistatic cleaner before, during and after applying the solutions.

Product testing has been performed by the University of Dayton Research Institute, and regional airlines and other aviation organizations have field-tested the process. Technical approvals also have been obtained from major aircraft manufacturers, said the company.

For more information: Clearfix Corp., 150 E. 58th St. 34th Floor, New York NY 10155 U.S. Telephone: +1(212) 861–3161.

Training Program Probes Maintenance Human Factors

Error management is the subject of *Engineering Solutions to Human Problems*, a new training program for maintenance technicians, maintenance managers, safety managers, engineers, maintenance apprentices and maintenance trainees.

The program helps to fulfill requirements for human-factors training of licensed engineers, said the International Federation of Airworthiness (IFA), which provided technical support and financial support for production of the program.

The requirements for human factors training of licensed engineers are in International Civil Aviation Organization Annex 1 amendment no. 161. The amendment requires all licensed engineers to have knowledge of "human performance and limitations relevant to the duties of an aircraft maintenance holder," said IFA.

The program comprises 11 elements, including four videotapes, briefing and training materials, case histories and human-factors study materials.

The program was produced by TVC Television Communications. The program costs US$3,500.00; IFA members receive a 10% discount.

For more information: TVC Television Communications, 15 Greek Street, London WIV 5LF. Telephone +44 171 734 6840.

Device Measures Viscosity of Turbine-engine Lubricant

VIS-PROBE is an on-site test device designed to test oil viscosity and provide pass/fail results within 10 minutes. The device can be used to test lubricants for aircraft turbine engines, ground-based turbine engines and helicopter gearboxes, said the manufacturer.

Airborne Analytical Labs Vis-Probe

VIS-PROBE is supplied with a certificate of calibration and the manufacturer states that the product accommodates all turbine-engine oils, including PRF-23699 and DOD-L-85734 types. Use of the device requires minimal training.

For more information: Airborne Analytical Labs, P.O. Box 518, East Hanover, NJ 07936. Telephone (800) 989-7692 (U.S.); +1(973) 887-7410 ext. 235 (international).

Niagara Cutter Optimizer™

Machining Information On CD-ROM

Niagara Cutter's Optimizer™ interactive CD-ROM provides product information, engineering charts and demonstration videos. Topics include metal-removal milling techniques and recommendations, sharpening and inspection data, a quick-reference engineering-chart list, and a guide to end-mill styles.

Also included are a video of the company's end-mill manufacturing processes and a short demonstration video showing the chip evacuation and performance of coated end mills.

For more information: Niagara Cutter, 200 John James Audubon Pkwy, Amherst, NY 14228 U.S. Telephone +1(716) 689-8400.

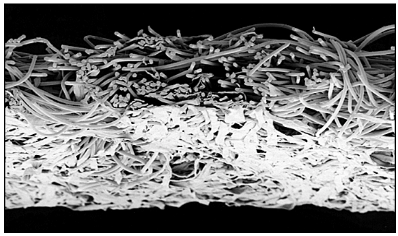
Filters Maintain Compressed-air System Efficiency

LA-MAN Corp. supplies filter-replacement kits for its Extractor/ Dryer® two-stage compressed-air-line filtration systems. Routine filter replacement helps maintain compressed-air systems and air-operated tools and ensures that they can operate more efficiently, said the manufacturer. The kits include first-stage and second-stage filter

LA-MAN
Filter Replacement Kits

elements to remove moisture and contaminants, a honeycomb base core, gaskets and seals.

For more information: LA-MAN Corp., 700 Glades Court, Port Orange, FL 32127 U.S. Telephone: (800) 348-2463 (U.S.); +1(904) 304-0411 (international).



DuPont
SONTARA EC®

Industrial Wiper Made Of Engineered Cloth

SONTARA EC® brand engineered-cloth wipers made by DuPont are suitable for aircraft-maintenance uses including general-purpose cleaning and surface preparation in prepaint applications, said the manufacturer.

SONTARA EC is a spun-lace wiper that resists abrasion and solvents, contains no binders or glues, is low-linting, and is highly absorbent in water, oil and solvents.

For more information: DuPont Sontara Technologies, 1002 Industrial Rd., Old Hickory, TN 37138 U.S. Telephone

(888) 476-6827 (U.S.); +1(615) 385-1100 ext. 274 (international).

Cable Ties Are Strong and Corrosion Resistant

Nelco Self-Lock Stainless Steel Cable Ties are designed for use where rough weather, salt spray, extreme vibration, radiation, chemical exposure and other hostile environments require a strong, durable cable tie, said the manufacturer.

The permanent ties feature 150-pound (68-kilogram) minimum loop tensile strength; are 3/16 inch (in.; 0.48 centimeter [cm]) wide by 0.01 in. (0.03 cm) thick; and are available in sizes ranging from five in. (12.7 cm) long to 47 in. (119 cm) long.

Nelco Self-Lock Stainless Steel Cable Tie

For more information: Nelco Products, 22 Riverside Dr., Pembroke, MA 02359 U.S. Telephone (800) 346-3526 (U.S.); +1(781) 826-3010 (international).

Diagnostic Device Aids Detection of Intermittent Defects In Avionics

The IFD-2000 Intermittent Fault Detector simultaneously and continuously monitors hundreds of lines to detect and diagnose intermittent defects in electronic circuit boards and related equipment, said the manufacturer. The device is a computer-operated tester-analyzer that employs a proprietary "front end" hardware neural network to perform real-time data reduction with sensor-fusion techniques. The basic unit monitors up to 256 single-ended lines, and can be expanded to 4,096 test points/input lines with additional modules.

Because the device tests all lines simultaneously and continuously, it can identify small or short-duration intermittent failures. The device's sensitivity is programmable to detect ohmic events as low as 20 ohms and wide-open intermittents as short as 130 nanoseconds in duration.

For more information: Universal Synaptics, 1801 W. 21st Street, Ogden, UT 84401 U.S. Telephone +1(801) 731-8508.

Aviation Degree On-line

The University of Nebraska at Omaha Aviation Institute and College of Continuing Studies are offering an Internet-based aviation studies degree. Students can complete from 24 to 30 hours of aviation studies course work, and these courses can be combined with other academic and nontraditional credit to complete the requirements for a bachelor's degree with a concentration in aviation studies.

For more information: Aviation Institute, Allwine Hall 422, University of Nebraska at Omaha, Omaha, NE 68182-0508 U.S. Telephone (800) 335-9866 (U.S.); +1(402) 595-2342 (international).

Backup Ring Protects Elastomeric Components

The Split-Lock™ Backup Ring from Greene, Tweed & Co. is designed for field-maintenance technicians who have experienced difficulty assembling multipiece split backup-ring components in aircraft landing gear, said the manufacturer.

Under field-maintenance conditions, the ring halves can be articulated around the circumference to allow the cut ends to meet. This articulation results in the unit assembly opening as a conventional scarf-cut backup ring.

For more information: Greene, Tweed & Co., Aerospace & Defense Group, 1555 Bustard Rd., Suite 130, P.O. Box 217, Kulpsville, PA 19443-0217 U.S. Telephone: +1(215) 256-9521.

Flexible Grinding Discs Used for Aluminum, Steel

Flexible grinding discs made of cotton fiber and impregnated with aluminum oxide provide long service, said the manufacturer. Rex-Cut® Cut-N-Finish™ Discs are nonloading on aluminum and are also suitable for use with mild steel and stainless steel. The discs are available in 24-, 36-, 54-, and 80-grit sizes and come in 4.5-inch (11.4-centimeter) and seven-inch (18-centimeter) diameters.

For more information: Rex-Cut Products, 960 Airport Road, P.O. Box 2109, Fall River, MA 02722 U.S. Telephone: (800) 225-8182 (U.S.); +1(508) 678-1985 (international).♦

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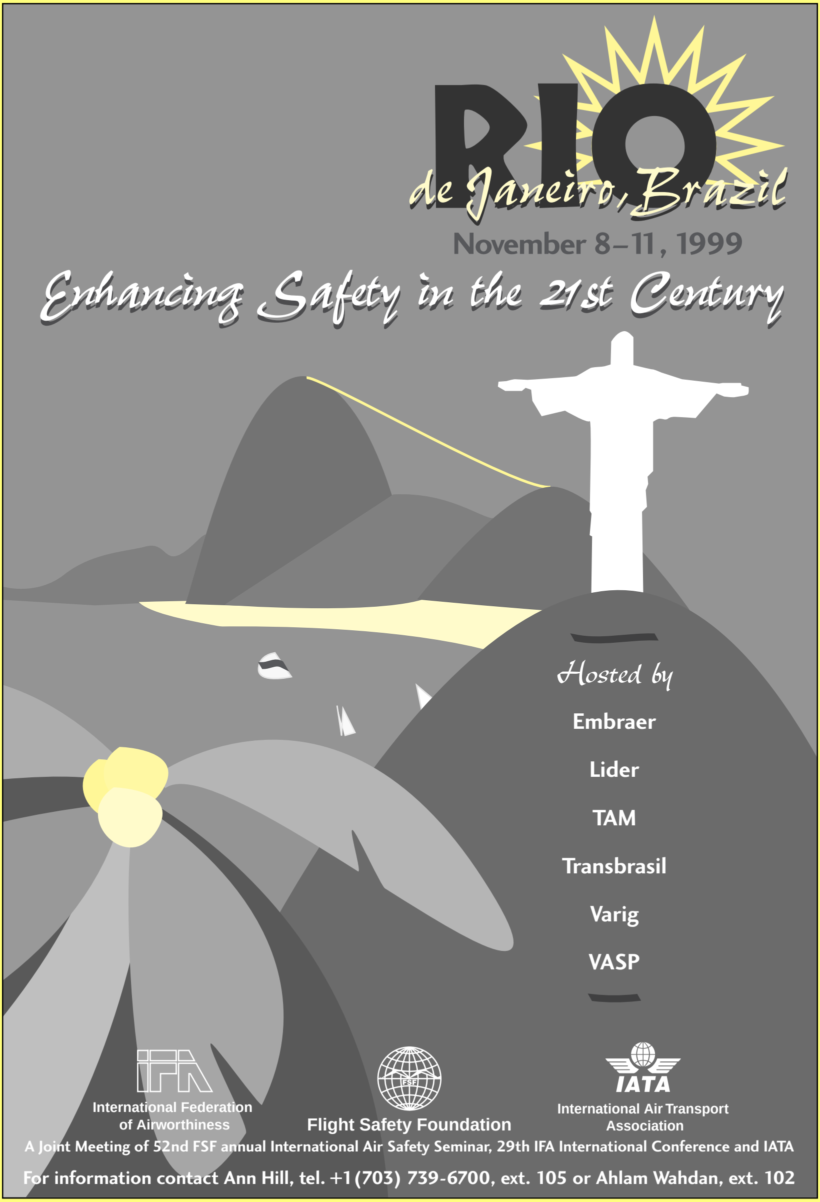

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